

SPECIFICATION

CORROSION PROTECTIVE COVERING STRUCTURE FOR STEEL STRUCTURES

[TECHNICAL FIELD]

5 [0001]

The present invention relates to a corrosion protective covering structure for a steel structure of a steel pipe pile and the like, which are constructed under a corrosive environment such as the ocean, rivers and the like.

[BACKGROUND ART]

10 [0002]

As corrosion prevention measures for a steel structure, a method by coating is used in general, but a corrosion protective covering method is frequently applied for a steel structure installed in the marine environment. In the corrosion protective covering structure, in order to protect an anticorrosive layer, there is installed a protective cover made of plastics and the like on the outside of the protective layer. For installing the protective cover, there is adopted a method of installing the protective cover by forming flange portions on the protective cover, bringing the flange portions to butt with each other and clamping them by bolts and nuts made of metal (refer to Patent Document 1). However, in the method of installing the protective cover by bringing the flange portions to butt with each other, the flange portions become a protrusion and hence driftage collides with the flange portions and the cover is likely to be damaged. In addition, the flange portions are structurally prone to be adhered by adhering materials, resulting in a disagreeable landscape. Further, there is easily generated a gap at the portion where the flange portions are butted with each other and thus there remained also a structural problem.

[0003]

As a means for solving the above problems, as the technique described in Patent Document 2, there is disclosed a technique for installing a protective cover outside an anticorrosive layer, without providing a flange portion on the protective layer, by setting the length of the protective cover such that both ends of the cover are overlapped with

each other when the circumference of the anticorrosive layer is surrounded by the cover, and squeezing a rivet at a portion where the both ends of the cover are overlapped after the circumference of the anticorrosive layer is surrounded by the cover.

[0004]

5 Incidentally, in the above technique, a rivet made of metal is proposed as the rivet, and the head of the rivet is covered with a resin by giving consideration to the corrosion prevention of the rivet and a landscape. However, in this method, since it is required to secure a space on the cover face for covering the head of the rivet with a resin in addition to the covering operation of the resin, the method has a problem that
10 the number of the work steps increases and the processing cost is also increased.

[0005]

Patent Document 1: JP 4-31321Y

Patent Document 2: JP 2003-138592A

[DISCLOSURE OF THE INVENTION]

15 [0006]

The present invention has been made in light of the above problems, and it is an object of the present invention to provide a corrosion protective covering structure for a steel structure in which the number of the work steps may be reduced and the construction cost may be suppressed.

20 [0007]

The above-mentioned object of the present invention has been achieved by providing a corrosion protective covering structure for a steel structure, comprising an anticorrosive layer formed on the surface of an existing steel structure and a covering layer having a protective layer and formed on the outside of the anticorrosive layer.
25 The protective layer is fixed on the outside of the anticorrosive layer by a rivet made of a titanium-based metal. The rivet has a rivet body and a mandrel, wherein the ratio of the breaking load of the rivet body to the breaking load of the mandrel falls the following ratio, rivet body: mandrel = 1 : 1.1 to 2.0.

[BRIEF DESCRIPTION OF THE DRAWINGS]

[0008]

[Fig. 1] Fig. 1 is a perspective view schematically showing the first embodiment of a corrosion protective covering structure for a steel structure of the present invention.

5 [Fig. 2] Fig. 2 is a cross-sectional plan view showing an overlapping portion of the protective layer in Fig.1.

[Fig. 3] Fig. 3 is a view showing an embodiment of a rivet used in the present invention, which is a partial cross-sectional view with only its rivet body half cross-sectional.

10 [Fig. 4] Fig. 4 is a cross-sectional view schematically showing an embodiment of a covering structure of a seam vertical to the longitudinal direction of a protective layer.

[Fig. 5] Fig. 5 is a cross-sectional view schematically showing another embodiment of a covering structure of a seam vertical to the longitudinal direction of a protective layer.

[Fig. 6] Fig. 6 is a cross-sectional plan view schematically showing the second embodiment of a corrosion protective covering structure for a steel structure of the present invention.

20 [Fig. 7] Fig. 7 is a perspective view schematically showing an embodiment of a protective layer provided with a deformation prevention means used in the second embodiment of a corrosion protective covering structure for a steel structure of the present invention.

[Fig. 8] Fig. 8 is a cross-sectional plan view schematically showing main part of the third embodiment of a corrosion protective covering structure for a steel structure of the present invention.

[Fig. 9] Fig. 9 is a chart showing the results of a durability test of a titanium rivet (the current change with time at a constant potential).

[BEST MODE FOR CARRYING OUT THE INVENTION]

[0009]

30 Hereinafter, the present invention will be explained based on the preferred embodiments.

Fig. 1 and Fig. 2 each are a view schematically showing the first embodiment in which the present invention is applied to a corrosion protective covering structure for a

steel pipe pile (hereinafter simply referred to as a corrosion protective covering structure).

[0010]

As shown in Fig.1, in the corrosion protective covering structure 1 of this embodiment, the anticorrosive layer 2 is formed on the surface of the steel pipe pile 10 to be corrosion-protected, the covering layer 4 having the protective layer 3 is formed on the outside of the anticorrosive layer 2 and the protective layer 3 is fixed on the outside of the anticorrosive layer 2 by the rivet 5 made of a titanium-based metal.

[0011]

The anticorrosive layer 2 is preferably composed of one or more kinds of anticorrosive materials selected from a petrolatum-based anticorrosive material, an underwater curing resin and a resin foam material. The petrolatum-based anticorrosive material includes a composition containing petrolatum as the main component and further containing an anticorrosive agent and the like. The petrolatum-based anticorrosive material is used in a form of paste or in a form of a tape or sheet in which the petrolatum in a form of paste is impregnated in a nonwoven fabric made of a synthetic resin such as Nylon, polyester and the like. The curing resin includes epoxy-based resin, urethane-based resin, silicone-based resin, polysulfide-based resin, polyester-based resin and the like. The resin foam material includes polyurethane-based resin, polystyrene-based resin, polyethylene-based resin, rubber-based resin and the like.

[0012]

A water-absorbing polymer is preferably contained in the curing resin. When such a water-absorbing polymer is contained, the water-absorbing polymer immediately absorbs moisture on the surface of a steel pipe pile to remove moisture, which causes a problem of hindering the adhesion of a resin, from the surface of the steel pipe pile, thereby facilitating the adhesion of a cured resin to the steel pipe pile. Such a water-absorbing polymer includes a polyacrylic acid salt-based polymer, a saponification product of a vinyl acetate-acrylic acid ester copolymer, a polyvinyl acetate-maleic anhydride reaction product, a crosslinking product of an isobutylene-maleic acid copolymer, a polyethylene oxide-based polymer, a starch-acrylic acid graft copolymer, a polyvinyl alcohol-based polymer, a

polyvinyl-N-vinyl acetamide-based polymer and the like, and 1 to 200 parts by weight thereof is preferably added, based on 100 parts by weight of the curing resin.

[0013]

5 In addition, a water-soluble anticorrosive agent or an oxygen scavenger is preferably added to the curing resin. As such a water-soluble anticorrosive agent, there can be used ortho-phosphate, polyphosphate, nitrite, benzoate, silicate and the like. As the oxygen scavenger, there can be used sodium nitrite, hydrazine and the like.

[0014]

10 As the protective layer 3, there may be used one made of a material that has been conventionally used in this kind of a protective layer without any particular limitation. The protective layer 3 is preferably composed of, for example, a protective cover comprising a molded product made of a metal, plastics or the fiber-reinforced plastics. In consideration of the mechanical strength, flexibility, workability of the
15 installation of the protective layer 3 and cost, preferred is a molded product made of fiber-reinforced plastics.

[0015]

The metal includes titanium or an alloy thereof, aluminum or an alloy thereof, a seawater resistant stainless steel and the like. In view of corrosion resistance, titanium
20 or an alloy thereof is preferable, and from the viewpoint of easiness of handling and cost, a seawater resistant stainless steel is preferable.

[0016]

A thermosetting resin or a thermoplastic resin may be used as the plastics. The resin includes polyester resin, epoxy resin, polypropylene resin, polyvinyl chloride
25 resin, high strength polyethylene and the like. In addition, a reinforcing fiber for the fiber-reinforced plastics includes glass fiber, carbon fiber, organic fiber and the like. As the form of the reinforcing fiber, there may used one having a shape that has been conventionally used for this kind of a protective layer, such as a reinforcing fiber which is cut to a predetermined length, a nonwoven fabric sheet, a sheet woven in a cross state,
30 a sheet in a napped state and the like, without any particular limitation.

[0017]

A curing agent, which has been conventionally used as a polymerization catalyst, may be contained in an appropriate amount in the plastics depending on the type of the plastics. For example, when a thermosetting resin such as an unsaturated polyester, an epoxy resin and the like is used, there may be used an organic peroxide, an acid anhydride, a modified aliphatic polyamine, an aromatic polyamine and the like as a curing agent. When an organic peroxide is added to an unsaturated polyester, 0.5 to 2.0% by weight of the organic peroxide is preferably blended in consideration of the complete curing and heat generation in curing.

10 [0018]

When there is used a thermoplastic resin such as a saturated polyester, polypropylene, a polyvinyl chloride resin, polyethylene and the like in the plastics, a coupling agent such as a silane compound and the like is preferably contained in an appropriate amount in consideration of the strength enhancement by the bonding with the reinforced fiber.

[0019]

The thickness of the protective layer 3 may be arbitrarily set according to the construction environment of the steel pipe pile 10 such as the size of ocean waves, the appearance frequency of driftage and the like.

20 [0020]

A buffer (not shown), which has been conventionally used for this kind of anticorrosive layer, may be disposed on the inner surface of the protective layer 3. The buffer includes a sheet composed of a resin foam material such as polyethylene, polyurethane, polystyrene and the like or a synthetic rubber.

25 [0021]

The buffer may be fixed on the inner surface of the protective layer 3 with an adhesive. As the adhesive, there may be used one made of a material that has been conventionally used for adhering the protective layer 3 to the buffer without any particular limitation. Considering that the plastics are adhered to one another and the surface of the buffer is porous, there is preferably used an adhesive such as a rubber-based adhesive, an epoxy resin-based adhesive and the like.

[0022]

The rivet used in the present invention is made of a titanium-based metal. Here, the term “the titanium-based metal” refers to titanium or a titanium alloy. The rivet used in the present invention is composed of a tubular rivet body and a mandrel
 5 inserted in the rivet body, wherein the rivet body has a flange portion extending outward at one end, and the mandrel has, at a rear end, a head portion having a diameter larger than the external diameter at its opposite end of the rivet body’s flange portion. In the rivet used in the present invention, the ratio of the breaking load of the rivet body to the breaking load of the mandrel (rivet body: mandrel) is 1: 1.1 to 2.0 and preferably 1: 1.4
 10 to 1.7. When the ratio of the breaking load of the rivet body to that of the mandrel is within the above range, a fastening strength sufficient for fixing the protective cover may be obtained by the deformation of the rivet body and breakage of the mandrel.

[0023]

The breaking load of a rivet body is calculated by multiplying the
 15 cross-sectional area of the rivet body by the tensile strength (wire strength) determined in accordance with the JIS Z2241 method of tensile test for metallic materials by using a wire made of the same material as that of the rivet body used. The preferred range of the breaking load of the rivet body is a range determined by multiplying the preferred cross-sectional area (8.0 to 8.8 mm²) of the rivet body by the wire strength in the range
 20 of 380 to 500 MPa. The cross-section of the rivet body used refers to the cross-section of the tubular portion excluding the flange portion, and the cross-section of the straight portion 502C (refer to Fig. 3) of the deformable portion described later is used. When the breaking load of the rivet body is within the above range, the rivet body is deformed without any trouble and a fastening strength sufficient for fixing the protective cover
 25 may be obtained.

[0024]

The breaking load of a mandrel is represented by the “breaking load” determined by the “breaking load test of a mandrel in accordance with JIS B 1087” using a mandrel to be measured. The preferred range of the breaking load of a
 30 mandrel is in the range of 6,000 to 8,500 N. When the breaking load of a mandrel is within the above range, a rivet body is deformed without any trouble and a fastening strength sufficient for fixing the protective cover may be obtained.

[0025]

The rivet having the ratio of the breaking load as mentioned above includes, for example, preferably those in which the rivet body is made of titanium of JIS class 1 (ASTM G1) to JIS class 3 (ASTM G3), and the mandrel is made of titanium of JIS class 1 to JIS class 4 (ASTM G3), an α - β -based titanium alloy of JIS class 60 (ASTM G5, N: 0.05% by mass, max., C: 0.08% by mass, max., H: 0.015% by mass, max., Fe: 0.30% by mass, max., O: 0.20% by mass, max., Al: 5.5 to 6.75% by mass, V: 3.5 to 4.5% by mass, and the rest: Ti) to JIS class 61 (ASTM G9, N: 0.02% by mass, max., C: 0.08% by mass, max., H: 0.015% by mass, max., Fe: 0.25% by mass, max., O: 0.12% by mass, max., Al: 2.5 to 3.5% by mass, V: 2.0 to 3.0% by mass, and the rest: Ti), and a β -based titanium alloy of Ti+15V-3Cr-3Sn-3Al (ASTM 4914, N: 0.05% by mass, max. C: 0.08% by mass, max., H: 0.030% by mass, max., Fe: 0.25% mass, max., O: 0.13% by mass, max., V: 14.0 to 16.0% by mass, Cr: 2.5 to 3.5% by mass, Sn: 2.5 to 3.5% by mass, Al: 2.5 to 3.5% by mass, and the rest: Ti).

[0026]

It was found from the results of the studies of the present inventors that the preferred combination of the materials of the rivet body and the mandrel composing the rivet is that shown in Table 1.

[0027]

[Table 1]

	Rivet Body	Mandrel
①	Titanium class 1	Titanium class 2
②	Titanium class 1	Titanium class 3
③	Titanium class 2	Titanium class 2
④	Titanium class 2	Titanium class 3
⑤	Titanium class 2	Titanium class 4
⑥	Titanium class 2	Titanium Alloy JIS class 60
⑦	Titanium class 2	Titanium Alloy JIS class 61
⑧	Titanium class 3	Titanium class 4
⑨	Titanium class 3	Titanium Alloy JIS class 60
⑩	Titanium class 3	Titanium Alloy JIS class 61

[0028]

5 For the rivet, a so-called blind rivet is preferably used in consideration of workability and high compression bonding force. Considering the material of the above-mentioned protective cover 30, preferred is a self-plugging type blind rivet.

[0029]

Fig.3 shows a preferred embodiment of a rivet used in the present invention.

10 As shown in Fig.3, the rivet 5 is composed of the tubular rivet body 50 and the mandrel 51 inserted in the rivet body 50. The flange portion 501 extending outward is provided at one end of the rivet body 50. At the other end of the rivet body 50, the deformable portion 502 is provided which expands outward along with the mandrel 51. The protective cover 30 is fastened between the deformable portion 502 which has been
15 crushed and the flange portion 501. The deformable portion 502 has the straight portion 502C between the tapered portions 502A and 502B. The mandrel 51 has the head portion 511 at the rear end. When the protective cover 30 is fastened by the rivet 5, the head portion 511 crushes the deformable portion 502 of the rivet body 50 against the side of the flange portion 501. The cutting-inducing V-type ring groove 512 is

provided on the circumference of the mandrel 51 at a portion located inside the rivet body 50. On the inner circumference face at the tapered portion 502A of the rivet body 50 and on the circumference face of the mandrel 51 opposite to the tapered portion 502A, convexo-concave shapes are formed so that the rivet body 50 and the mandrel 51
5 are engaged with each other.

[0030]

The length from the undersurface of the flange portion 501 to the deformable portion 502 is set according to the thickness of the protective cover 30 and the like. For eliminating the problem of fastening with the rivet 5, the length L502A of the
10 tapered portion 502A is preferably 1.5 to 2.5 mm and more preferably 1.8 to 2.0 mm. Similarly, the length L502B of the tapered portion 502B is preferably 0.5 to 1.5 mm and more preferably 0.8 to 1.0 mm. Similarly, the length L502C of the straight portion 502C is preferably 4.5 to 5.5 mm and more preferably 4.8 to 5.2 mm.

[0031]

15 In addition, there may also be used a blind rivet having other shape, for example, a blind rivet of open type or closed type or the like, if it satisfies the relationship on the ratio of the breaking load of the rivet body to that of the mandrel and the relationship among the titanium-based metals used for the rivet body and the mandrel.

[0032]

20 The rivet 5 can be colored in conformity with the color of the protective cover 30 to provide an anticorrosive structure that does not damage the appearance of the object to be corrosion-protected. The coloration of a rivet is performed by an anodic oxidation method and may be controlled by a liquid used and a voltage applied.

[0033]

25 The spacing between the rivets 5 is set according to the mass of the protective layer 3. When the protective layer 3 has a small mass, the rivets 5 may be disposed in one row. However, when the protective layer 3 has a large mass, the rivets 5 are preferably disposed in two or more rows. The spacing between adjacent rivets (the spacing between the centers of the rivet axes) preferably is 50 to 300 mm and more
30 preferably 70 to 150 mm. In the case of forming plural rows, the rivets may be disposed in a zigzag alignment. When the protective cover 30 forming the protective

layer 3 is made of a relatively soft polyethylene, the rivets are preferably disposed in two rows like this embodiment.

[0034]

Next, the construction method of the corrosion protective covering structure 1 is explained based on the preferred embodiments.

Firstly, surface preparation (substrate treatment) is performed on the surface of the steel pipe pile 10 to be corrosion-protected. As the surface preparation, there may be adopted a surface preparation method (for example, ISO St2) which has been conventionally adopted for this kind of corrosion protective covering structure without any particular limitation.

[0035]

Next, the surface of the steel pipe pile 10, which has been finished with the surface preparation, is covered with the anticorrosive material to form the anticorrosive layer 2.

[0036]

Subsequently, the surface of the anticorrosive layer 2 is covered with the protective cover 30 that forms the protective layer 3, and the overlapping portions are superposed for positioning. And, the insertion hole 31 for the rivet 5 is formed using a tool such as a drill and the like so as to penetrate the overlapping portions of the protective cover 30. Then, the tip portion of the rivet 5 is inserted in the insertion hole 31, and the rivet 5 is squeezed and disposed with a rivet fastening apparatus to fix the protective layer 3 on the surface of the anticorrosive layer 2. Thus, the steel pipe pile 10 is covered with the covering layer 4.

[0037]

As shown in Fig. 4, when the protective cover 30 of the protective layer 3 is fixed by a rivet at a seam vertical to the longitudinal direction, the seam is preferably sealed in the following manner, that is, the seam portion is wound around by a belt-like cover plate 6 having the same material as that of the protective cover 30 of the protective layer 3, the tip portion of the rivet 5 is inserted into an insertion hole 32 for the rivet 5 that is provided so as to penetrate the cover plate 6 and the protective cover 30 of the protective layer 3, and the cover plate 6 is fixed to the anticorrosive layer 2

together with the protective cover 30 of the protective layer 3 by squeezing the rivet 5 with the rivet fastening apparatus.

[0038]

5 In addition, as shown in Fig. 5, overlapping portions are provided at the seam of the upper and lower protective covers 30, the insertion hole 33 for the rivet 5 is formed so as to penetrate the overlapping portions, the tip portion of the rivet 5 is inserted in the insertion hole 33, and the rivet 5 may be squeezed to close the seam.

[0039]

10 A resin may be filled in the gap between the protective covers of a protective layer to perform sealing on the seam without adopting a seam-covering structure as mentioned above.

[0040]

15 As explained above, according to the corrosion preventive covering structure 1 of this embodiment, since the rivet 5 fixing the protective cover 30 is made of a specific titanium-based metal and is composed of a rivet body and a mandrel having a specific ratio of the breaking load, it is not required to perform a conventional operation of resin-filling and the like for the corrosion prevention of the rivet head portion, thus enabling the reduction of the number of the work steps as well as the construction cost. Further, since there is no protective layer at the rivet head portion, the surface is
20 finished with less unevenness and thus the corrosion preventive covering structure 1 has an excellent appearance.

[0041]

25 Next, there will be explained the second and third embodiments of the corrosion preventive covering structure for a steel structure of the present invention. In addition, in the following explanation, the same symbols are used for portions common to the corrosion preventive covering structure for a steel structure of the first embodiment. Therefore, the explanation in the first embodiment is accordingly applied to the portions that are not especially explained.

[0042]

In the corrosion preventive covering structure 1' for a steel structure of the second embodiment shown in Fig. 6, the protective layer 3 is provided with the deformation prevention means 33 so that a spacing with the steel pipe pile 10 is maintained. In this embodiment, the protective layer 3 is mainly composed of the two protective covers 30 of which cross section is a semi-circular arc, the protective covers 30 together are arranged so as to cover the circumference of the steel pipe pile 10 and are fixed by the rivet 5 in such a manner that the side portions of the semi-circular covers are superposed with a predetermined width.

[0043]

The deformation prevention means 33 is provided so that the portions of the protective covers 30 fixed by the rivet 5 are not damaged by bending of the protective covers 30 due to strong force acting on the protective covers 30. That is, even if strong force is instantaneously applied to the protective covers 30 by strong ocean waves and the like, the deformation prevention means 33 functions as a spacer so that the spacing with the steel pipe pile 10 is maintained and suppresses excessive deformation of the protective covers 30, thereby preventing the portions of the protective covers 30 fixed together by the rivet 5 from being damaged. The length of a protrusion from the inner surface of the protective covers 30 is set according to the thickness of the anticorrosive layer 2 and preferably is 60 to 80% of the thickness of the anticorrosive layer 2, considering the wave pressure and dynamic properties of the protective cover. For example, when the anticorrosive layer 2 has a thickness of 5 to 10 mm, the length of the protrusion from the inner surface of the protective covers 30 of the deformation prevention means 33 is preferably 3 to 8 mm.

The deformation prevention means 33 may be disposed so as to be wholly projected from the inside of the protective covers 30 or may be projected partially. In addition, when there are no protrusions such as cut pieces of members and weld beads on the surface of the steel pipe pile 10, it is preferable to dispose the deformation prevention means 33 (the rivet 330 in this embodiment) on the protective covers 30 in advance as shown in Fig. 7, because the working efficiency is increased. When there are welded portions on the surface like a spiral steel pipe pile, the deformation prevention means 33 is preferably disposed so as to avoid the welded portions in order to prevent damage by the contact with the deformation prevention means 33.

[0044]

The deformation prevention means 33 may be provided, so as to function as mentioned above, by fixing a hard member made of a metal or plastics in advance on the inner surface of the protective covers 30. However, it is preferably composed of
5 the rivet 330 as in this embodiment so as to make it to be adapted to irregular shapes in the field. The shape of the rivet 330 as the deformation prevention means 33 is not particularly limited so long as it has a shape with which it is protruded from the inner surface of the protective cover 30 by a predetermined length so that it functions as a spacer for maintaining the spacing with the steel pipe pile 10. The rivet 330 is
10 preferably disposed vertically and horizontally at predetermined spacing on the protective cover 30. Although the rivet 330 is preferably made of the same material as that of the rivets 5, a rivet made of other materials may be used. There may be used, for example, a rivet made of a metallic material such as aluminum or an alloy thereof, a stainless steel and the like, and a rivet made from plastics such as Nylon, a
15 polycarbonate and the like.

[0045]

Since the corrosion preventive covering structure 1' of the second embodiment is provided with the deformation prevention means 33 in the protective cover 30 composing the protective layer 3, it is suitable for the corrosion preventive covering for
20 a steel structure constructed at a place which repetitively receives strong force instantaneously by ocean waves.

[0046]

The corrosion preventive covering structure 1' of the third embodiment, which is shown in Fig. 8, is provided with the covering means 34 for covering the fixation
25 portions of the protective layer 3. The covering means 34 functions so as to diffuse the impact which the fixation portions of the protective layer 3 receive by ocean waves and the like. The covering means 34 is not particularly limited as long as it has a shape capable of covering the fixation portions of the protective layer 3.

[0047]

30 In the corrosion preventive covering structure 1' of this embodiment, the protective covers 30 that form the protective layer 3 together are disposed so as to cover the circumference of the steel pipe pile 10 and are fixed by the rivet 5 in such a manner

that the side portions of the protective covers 30 together are superposed with a predetermined width. In this embodiment, the covering means 34 is mainly composed of the arcuate cover plate 340 covering the portion of the protective covers 30 that form the protective layer 3 fixed by the rivet 5. The cover plate 340 is disposed so as to agree the fixation portion of the protective cover with nearly the center, in the width direction, of the cover plate, thereby to cover the fixation portion of the protective cover 30, and then is fixed to the protective covers 30. Fixing of the cover plate 340 to the protective covers 30 is performed by forming an insertion hole so as to penetrate through both side portions of the cover plate 340 and the protective covers 30 at the positions in contact with the both side portions, and inserting the rivet 341 in the insertion hole to be squeezed. As the rivet 341, there is used a rivet made of a metal such as aluminum or an alloy thereof, a stainless steel and the like, in addition to the same material as that of the rivet 5. As the cover plate 340, preferred is one made of the same material as that of the protective covers 30 from the viewpoint of landscape. The width in the horizontal direction between the adjacent rivets 341 (the spacing between the centers of the rivet axes) may be set according to the shape and the dimensions of a steel pipe pile. For example, when a steel pipe pile has a diameter of 700 mm, the stress exerted on the portion fixed by the rivet may be dispersed by setting the spacing at 100 mm or more. In particular, when the impact resistance and durability are required, it is preferable to fix the rivets 341 by disposing them in two or more rows near the both side portions of the cover plate 340.

[0048]

In the corrosion preventive covering structure 1' of this embodiment, even if a strong impact is applied to the fixation portion, the impact may be dispersed because the covering means 34 is provided at the fixation portion of the protective layer 3. Therefore, the corrosion preventive covering structure 1' is suitable for the corrosion preventive covering for a steel structure constructed in the ocean where the impact by ocean waves is strong.

[0049]

The present invention is not limited by the above-mentioned embodiments and may be changed as necessary in the range not departing from the spirit or scope of the present invention.

[0050]

In the corrosion preventive covering structure 1' of the second embodiment, a rivet is adopted as a deformation prevention means of a protective layer, but a bolt and nut may also be adopted in place of a rivet. In addition, the deformation prevention means may be formed by a protruded portion which is integrally provided to the protective layer and protrudes to the inside of the protective layer. For example, a protruded portion such as a rib, protrusion or the like is formed integrally inside a protective cover composing a protective layer, which may be used as a deformation prevention means.

10 [EXAMPLES]

[0051]

Hereinafter, the present invention will be explained in more detail by Examples.

[Example 1]

A test specimen was prepared by superposing parts (width 25 mm and length 25 mm) of two sheets of FRP (unsaturated polyester-based glass fiber-reinforced plastics) having a width of 25 mm, a length of 200 mm and a design thickness of 2.00 mm and then fixing the parts of the two sheets by a rivet made of titanium having a rivet body with an external diameter of 4.8 mm (the rivet body breaking load: 4,050 N, the mandrel breaking load, 6,570 N; the ratio of the breaking loads between the rivet body and the mandrel, rivet body: mandrel = 1: 1.6). Then, the tensile strength was measured by pulling the both end portions of the test specimens at a tensile rate of 15 mm/min. The results are shown in Table 2.

[0052]

[Table 2]

No.	Tensile Strength (N)			Damaged pattern
	Measured values	Average value	Standard deviation	
1	1629.6	1808.3	344	FRP was damaged at the portion of the insertion hole for the rivet.
2	2107.8			
3	1305.9			
4	2114.5			
5	1883.6			

[0053]

5 As is clear from the results shown in Table 2, the damaged state of the test specimen was the breakage of FRP and not the breakage of the titanium rivet itself, wherein the tensile strength of an FRP applied to anticorrosive construction was 80 to 100 N/mm². In addition, the average value of the tensile strength was extremely high, that is, 1800 N or more. It was found that an anticorrosive layer was strongly
10 protected by a protective layer when fixing with plural rivets in the anticorrosive structure of the present invention.

[0054]

[Example 2]

For a rivet made of titanium (the ratio of breaking load between the rivet body
15 and the mandrel, rivet body: mandrel = 1: 1.6) composed of a rivet body made of titanium class 2 (breaking load: 4,050 N) and a mandrel made of titanium class 3 (breaking load: 6,570 N) as a rivet, the durability was examined as follows. The results are shown in Fig. 9.

[0055]

20 Durability Test:

The durability of a rivet was examined by performing a polarization test of the rivet in the natural seawater. The potential was set at a value potential (2.0 V vs. SSE)

that is higher than the natural potential in seawater (rivet body: -0.3 V vs. SSE, mandrel: -0.1 V vs. SSE) and maintained for approximately 30 days to measure the current (current density) during the period, and then the state of the rivet after the measurement was examined. The results of the polarization test are shown in Fig. 9.

5 [0056]

As shown in Fig.9, the rivet showed high current values immediately after the setting of the potential, but the current was stable at approximately $10\text{ }\mu\text{A}$ (a current density of approximately 330 mA/m^2) after 6 to 10 hours. No changes were observed by the naked eye on the surface of the rivet before and after the test. Further, the
10 change in the concentration of ClO^- in seawater was measured, and the results were compared with the theoretical value of ClO^- for the amount of integrated current. The difference agreed quite well. As a result, it became clear that there was no problem with the corrosion resistance which is most important in view of the long-term durability.

15 [INDUSTRIAL APPLICABILITY]

[0057]

According to the corrosion protective covering structure for a steel structure of the present invention, corrosion preventive covering having high anticorrosion properties is performed for a steel structure installed under a corrosive environment
20 such as the ocean and rivers with good construction performance, and an increase in the construction cost may also be suppressed.

[0058]

The corrosion protective covering structure for a steel structure of the present invention is suitably used for the corrosion preventive covering of a steel pipe pile
25 constructed under a corrosive environment such as the ocean and rivers.

CLAIMS

1. A corrosion protective covering structure for a steel structure, comprising an anticorrosive layer formed on the surface of an existing steel structure and a covering layer having a protective layer and formed on the outside of the anticorrosive layer,
5 the protective layer being fixed on the outside of the anticorrosive layer by a rivet made of a titanium-based metal, and
the rivet having a rivet body and a mandrel, wherein the ratio of the breaking load of the rivet body to the breaking load of the mandrel fills the following ratio, rivet body: mandrel = 1 : 1.1 to 2.0.
- 10 2. The corrosion protective covering structure for a steel structure according to claim 1, wherein the rivet body is made of titanium of JIS class 1 to JIS class 3 and the mandrel is made of titanium of JIS class 2 to JIS class 4 or a titanium alloy of JIS class 60.
- 15 3. The corrosion protective covering structure for a steel structure according to claim 1 or 2, wherein the rivet is a self-plugging type blind rivet.
4. The corrosion protective covering structure for a steel structure according to any of claims 1 to 3, wherein the anticorrosive layer is composed of one or more kinds of anticorrosive materials selected from a petrolatum-based anticorrosive material, an epoxy resin-based resin, a urethane resin-based resin, a silicone resin-based resin, a
20 urethane-based foam and a polyethylene-based foam.
5. The corrosion protective covering structure for a steel structure according to any of claims 1 to 4, wherein the protective layer is composed of a metal, plastics or fiber-reinforced plastics.
- 25 6. The corrosion protective covering structure for a steel structure according to any of claims 1 to 5, wherein the protective layer is provided with a deformation prevention means so as to maintain the spacing with the steel structure.

7. The corrosion protective covering structure for a steel structure according to claim 6, wherein the deformation prevention means is a rivet or bolt which is inserted through the protective layer to protrude to the inside of the protective layer.
- 5 8. The corrosion protective covering structure for a steel structure according to claim 6, wherein the deformation prevention means is a protruded portion which is integrally provided to the protective layer so as to protrude to the inside of the protective layer.
- 10 9. The corrosion protective covering structure for a steel structure according to any of claims 1 to 8, further comprising a cover for covering a fixation portion of the protective layer.