

DESCRIPTION

[Title of Invention] Z-SHAPED STEEL SHEET PILE AND STEEL
SHEET PILE WALL FORMED OF THE Z-SHAPED STEEL SHEET PILES

[Technical Field]

[0001]

The present invention relates to Z-shaped steel sheet piles used for harbor and river revetment, earth retaining, and coffering in the field of civil engineering and construction, and a steel sheet pile wall formed of the Z-shaped steel sheet piles.

In this specification, a Z-shaped steel sheet pile means a steel sheet pile which is approximately Z-shaped and which includes a web that extends obliquely and flanges that extend continuously from both ends of the web.

[Background Art]

[0002]

U-shaped steel sheet piles, Z-shaped steel sheet piles, or hat-shaped steel sheet piles are generally used as steel sheet piles for harbor and river revetment, earth retaining, and coffering in the field of civil engineering and construction. Straight steel sheet piles are mainly used in a steel sheet pile cell construction method. Joint portions of these steel sheet piles are connected to each other to form a steel wall.

The U-shaped steel sheet piles, hat-shaped steel sheet

piles, and Z-shaped steel sheet piles generally include Larsen-type joint portions (see Patent Literatures 1 and 2). The straight steel sheet piles generally include so-called double-claw-type joint portions; however, Larsen-type joint portions are also used in special cases (see Patent Literature 3).

[Citation List]

[Patent Literature]

[0003]

[PTL 1] Japanese Patent No. 3458109

[PTL 2] Japanese Unexamined Patent Application
Publication No. 2009-2110

[PTL 3] Japanese Unexamined Patent Application
Publication No. 2001-170703

[Summary of Invention]

[Technical Problem]

[0004]

In the case where the U-shaped steel sheet piles are connected to each other to form a steel sheet pile wall, since the joint portions are located in a central region of the formed steel sheet pile wall, the center of gravity of each U-shaped steel sheet pile does not coincide with the center of gravity of the steel sheet pile wall. Accordingly, when the steel sheet pile wall receives load of earth pressure or the like and is subjected to bending force,

displacement of the joint portions occurs, and the rigidity and section modulus of the steel sheet pile wall are reduced. Therefore, it is necessary to reduce the joint efficiency.

In the case where the hat-shaped steel sheet piles or Z-shaped steel sheet piles are connected to each other to form a steel sheet pile wall, since the joint portions are at the outermost edges of the formed steel sheet pile wall, the center of gravity of each steel sheet pile coincides with the center of gravity of the steel sheet pile wall. Therefore, even when the steel sheet pile wall receives load of earth pressure or the like and is subjected to bending force, displacement of the joint portions does not occur, and it is not necessary to reduce the joint efficiency.

Therefore, compared to the U-shaped steel sheet piles, the hat-shaped steel sheet piles and Z-shaped steel sheet piles have a good cross sectional performance with respect to weight per unit wall area, and an inexpensive steel sheet pile wall can be formed.

[0005]

Although the hat-shaped steel sheet piles have a good cross sectional performance with respect to weight per unit wall area, due to manufacturing limitations, only two types of hat-shaped steel sheet piles in terms of second moment of area per one meter of wall width are currently commercially available.

In contrast, various types of Z-shaped steel sheet piles are available in terms of second moment of area per one meter of wall width, and the maximum second moment of area of the Z-shaped steel sheet piles is about ten times that of the hat-shaped steel sheet piles. In addition, a hat shape can be formed by connecting the Z-shaped steel sheet piles. Therefore, an inexpensive steel sheet pile wall having a good cross sectional performance can be formed in accordance with the required performance by using the Z-shaped steel sheet piles.

[0006]

As described above, an inexpensive steel sheet pile wall having a good cross sectional performance can be formed by using the Z-shaped steel sheet piles. However, similar to the U-shaped steel sheet piles and hat-shaped steel sheet piles, the Z-shaped steel sheet piles generally include Larsen-type joint portions. The reason why the Larsen-type joint portions are used is that the Larsen-type joint portions are easier to manufacture than double-claw-type joint portions. However, it has not been studied in detail whether or not the Larsen-type joint portions are optimum for the Z-shaped steel sheet piles.

Accordingly, it has been studied whether or not the Larsen-type joint portions according to the related art are optimum for the Z-shaped steel sheet piles. As a result, it

has been found that there are following problems.

[0007]

<Problems in Driving Steel Sheet Piles>

When a steel sheet pile wall is formed by connecting steel sheet piles, generally, a steel sheet pile is driven while a joint portion thereof is engaged with a joint portion of a steel sheet pile that has already been driven. In this case, if the steel sheet pile that is being driven is maintained completely in parallel with the steel sheet pile that has already been driven, the joint portions do not come into contact with each other.

However, since the steel sheet pile that is being driven receives a ground resistance, it is difficult to maintain the steel sheet pile that is being driven in parallel with the steel sheet pile that has already been driven. As a result, the steel sheet pile that is being driven is tilted and the joint portions come into contact with each other, so that the frictional resistance is generated and various types of forces are applied to the joint portions.

[0008]

Fig. 6 schematically illustrates various types of forces applied to Larsen-type joint portions 31 included in Z-shaped steel sheet piles 29 according to the related art. As illustrated in Fig. 6, the forces applied to the joint

portions 31 include a tensile force and a compressive force applied in an axial direction of flange portions 33, a rotational force applied around the joint portions, and a force applied in a direction perpendicular to the flange portions.

The Larsen-type joint portions are easily deformed when a tensile force or a rotational force is applied thereto. When the above-described forces are applied to the joint portions 31, there is a possibility that the opening width of the joint portions 31 will be reduced or increased. If the opening width of the joint portions 31 is excessively increased, there is a risk that the steel sheet piles will be separated from each other. If the opening width of the joint portions 31 is excessively reduced, there is a risk that the subsequent steel sheet pile cannot be driven.

[0009]

In contrast, the U-shaped steel sheet piles and hat-shaped steel sheet piles restrain soil in a space surrounded by a web portion and flange portions. Therefore, compared to the Z-shaped steel sheet piles, the rotational force is not easily applied when a steel sheet pile is driven, and the above-described problems of the joint portions do not easily occur.

Since the Z-shaped steel sheet piles are not shaped so as to restrain soil in a manner similar to the U-shaped

steel sheet piles and the hat-shaped steel sheet piles, rotation or the like of the Z-shaped steel sheet piles easily occur due to the ground resistance when the Z-shaped steel sheet piles are driven. Consequently, the joint portions receive a large force. The Larsen-type joint portions are vulnerable to the tensile force and rotational force as described above, and the degree of freedom thereof is low. Therefore, the joint portions are easily deformed and the above-described problems easily occur.

[0010]

<Problems after Driving Steel Sheet Piles>

Even after the steel sheet piles have been driven, the steel sheet piles receive force from the ground. When, in particular, an earthquake occurs, the Larsen-type joint portions, which are vulnerable to tensile force and highly constrained, are easily deformed. When the joint portions are deformed, the water-stopping effect will be reduced.

[0011]

As described above, the joint portions of the Z-shaped steel sheet piles have a problem in that the joint portions easily receive force while the steel sheet piles are being driven or after the steel sheet piles have been driven, and therefore the joint portions are easily deformed.

The deformation of the joint portions may be suppressed by, for example, increasing the thickness of the joint

portions.

However, the increase in thickness causes an increase in the weight of steel material, and economic efficiency is reduced.

[0012]

An object of the present invention is to provide a Z-shaped steel sheet pile with which the weight of steel material is not increased, deformation or the like of joint portions does not occur while the steel sheet pile is being driven or after the steel sheet pile has been driven, and a high-precision steel sheet pile wall can be formed.

Another object of the present invention is to provide a high-precision steel sheet pile wall.

[Solution to Problem]

[0013]

(1) A Z-shaped steel sheet pile according to the present invention includes a first joint portion formed at an end of one flange portion included in the Z-shaped steel sheet pile and a second joint portion formed at an end of the other flange portion included in the Z-shaped steel sheet pile, a steel sheet pile wall being formed by arranging a plurality of the Z-shaped steel sheet piles next to each other and connecting the Z-shaped steel sheet piles together by engaging the first and second joint portions of the Z-shaped steel sheet piles with each other.

The first joint portion is a double-claw-type joint portion including a main claw and a sub-claw, the main claw including a protruding portion at an end thereof and being arranged on an inner side of the steel sheet pile, the sub-claw being formed so as to oppose the main claw and being arranged on an outer side of the steel sheet pile.

The second joint portion is a double-claw-type joint portion including a main claw and a sub-claw, the main claw including a protruding portion at an end thereof and being arranged on the outer side of the steel sheet pile, the sub-claw being formed so as to oppose the main claw and being arranged on the inner side of the steel sheet pile.

[0014]

(2) In the Z-shaped steel sheet pile of (1), the first joint portion is provided at the end of the corresponding flange portion with a first curved portion interposed therebetween, the first curved portion being bent toward the inner side of the steel sheet pile and being provided so that an outer surface of the sub-claw does not project toward the outer side of the steel sheet pile from the outer surface of the flange portion.

In addition, the second joint portion is provided at the end of the corresponding flange portion with a second curved portion interposed therebetween, the second curved portion being bent toward the inner side of the steel sheet

pile and being provided so that an outer surface of the main claw is shifted toward the inner side of the steel sheet pile by a distance greater than or equal to a thickness of the sub-claw.

[0015]

(3) A steel sheet pile wall according to the present invention is formed by connecting a plurality of the Z-shaped steel sheet piles according to (1) or (2).

[Advantageous Effects of Invention]

[0016]

The Z-shaped steel sheet pile according to the present invention includes a first joint portion and a second joint portion. The first joint portion is a double-claw-type joint portion including a main claw and a sub-claw, the main claw including a protruding portion at an end thereof and being arranged on an inner side of the steel sheet pile, the sub-claw being formed so as to oppose the main claw and being arranged on an outer side of the steel sheet pile. The second joint portion is a double-claw-type joint portion including a main claw and a sub-claw, the main claw including a protruding portion at an end thereof and being arranged on the outer side of the steel sheet pile, the sub-claw being formed so as to oppose the main claw and being arranged on the inner side of the steel sheet pile. Therefore, the weight of steel material is not increased,

deformation or the like of the joint portions does not occur while the steel sheet pile is being driven or after the steel sheet pile has been driven, and a high-precision steel sheet pile wall can be formed.

[Brief Description of Drawings]

[0017]

[Fig. 1] Fig. 1 is a diagram illustrating a Z-shaped steel sheet pile according to an embodiment of the present invention.

[Fig. 2] Fig. 2 is an enlarged view of circled part A in Fig. 1.

[Fig. 3] Fig. 3 is an enlarged view of circled part B in Fig. 1.

[Fig. 4] Fig. 4 is a diagram illustrating the state in which two Z-shaped steel sheet piles having the structure illustrated in Fig. 1 are connected together.

[Fig. 5] Fig. 5 is a diagram illustrating a steel sheet pile wall formed by connecting Z-shaped steel sheet piles having the structure illustrated in Fig. 1.

[Fig. 6] Fig. 6 is a diagram illustrating Z-shaped steel sheet piles according to the related art.

[Description of Embodiments]

[0018]

A Z-shaped steel sheet pile 1 according to the present embodiment includes a first joint portion 5 formed at an end

of a first flange portion 3 included in the Z-shaped steel sheet pile 1 and a second joint portion 9 formed at an end of a second flange portion 7 included in the Z-shaped steel sheet pile 1. A steel sheet pile wall 27 (see Fig. 5) can be formed by arranging a plurality of the Z-shaped steel sheet piles 1 next to each other and connecting the Z-shaped steel sheet piles 1 together by engaging the first joint portions 5 and the second joint portions 9 with each other.

The first joint portion 5 is a double-claw-type joint portion including a main claw 13 and a sub-claw 15, the main claw 13 including a protruding portion 11 at an end thereof and being arranged on an inner side of the steel sheet pile, and the sub-claw 15 being formed so as to oppose the main claw 13 and being arranged on an outer side of the steel sheet pile.

The second joint portion 9 is a double-claw-type joint portion including a main claw 13 and a sub-claw 15, the main claw 13 including a protruding portion 11 at an end thereof and being arranged on the outer side of the steel sheet pile, and the sub-claw 15 being formed so as to oppose the main claw 13 and being arranged on the inner side of the steel sheet pile.

This will be described in detail below.

[0019]

<Overall Shape>

Each Z-shaped steel sheet pile 1 includes a web portion 16 that extends obliquely, the first flange portion 3 provided at one end of the web portion 16, the first joint portion 5 formed at the end of the first flange portion 3, the second flange portion 7 provided at the other end of the web portion 16, and the second joint portion 9 formed at the end of the second flange portion 7, and is approximately Z-shaped.

[0020]

<Joint Portions>

The first joint portion 5 and the second joint portion 9 have the same basic shape, which will now be described with reference to Figs. 2 and 3.

Each of the first joint portion 5 and the second joint portion 9 includes a joint main portion 17 that is formed continuously from the end of the corresponding flange portion, the main claw 13, and the sub-claw 15. The main claw 13 and the sub-claw 15 are formed so as to extend separately from each other from the joint main portion 17 and oppose each other.

The main claw 13 is thin at the proximal end thereof and includes the protruding portion 11 at the distal end thereof. In the present embodiment, the protruding portion 11 of the main claw 13 has an approximately rectangular shape, and the main claw 13 is T-shaped.

[0021]

A bending angle of a connecting portion 19 between the horizontal and vertical portions of the T-shaped main claw 13 at the outer side is more acute than that at the inner side. Since the bending angle at the inner side is obtuse, a joint inner region 21 surrounded by the main claw 13 and the sub-claw 15 of each joint portion has a smooth arc shape. Since the joint inner region 21 has a smooth arc shape, when the joint portions are connected together, the degree of freedom of rotation of the entire body of each Z-shaped steel sheet pile 1 is increased.

[0022]

The sub-claw 15 is thick at the proximal end thereof, and the thickness decreases toward the distal end thereof. The sub-claw 15 has a smooth curved shape.

The joint inner region 21 surrounded by the main claw 13 and the sub-claw 15 receives the main claw 13 of the joint portion to be connected thereto. Since each main claw 13 has the protruding portion 11, the inserted main claw 13 is prevented from being pulled out through the gap between the other main claw 13 and the sub-claw 15.

[0023]

The first joint portion 5 and the second joint portion 9 are common in that they include the above-described main claw 13 and the sub-claw 15. However, the first joint

portion 5 and the second joint portion 9 also have differences. The first joint portion 5 arranged at the left side in Fig. 1 and the second joint portion 9 arranged at the right side in Fig. 1 will now be described individually.

[0024]

(First Joint Portion)

When the steel sheet pile wall 27 (see Fig. 5) is formed by connecting the first joint portions 5 to the corresponding second joint portions 9, the sub-claw 15 of each first joint portion 5 provided at the corresponding joint portion is on the outer side of the steel sheet pile.

Here, the outer side of the steel sheet pile is the side opposite to the side at which the web portion 16 is provided with respect to the axial line of the first flange portion 3, and the inner side of the steel sheet pile is the side opposite to the outer side, that is, the side at which the web portion 16 is provided with respect to the axial line of the first flange portion 3.

[0025]

In each first joint portion 5, the sub-claw 15 is on the outer side of the steel sheet pile, and the main claw 13 is on the inner side of the steel sheet pile so as to oppose the sub-claw 15. The first joint portion 5 is provided at the first flange portion 3 with a first curved portion 23 interposed therebetween, the first curved portion 23 being

bent toward the inner side of the steel sheet pile from the first flange portion 3. Since the first joint portion 5 is provided at the first flange portion 3 with the first curved portion 23 interposed therebetween, an outermost portion of the outer surface of the sub-claw 15 on the outer side of the steel sheet pile is flush with the outer surface of the first flange portion 3 (see Fig. 2).

[0026]

(Second Joint Portion)

When the steel sheet pile wall 27 is formed by connecting the first joint portions 5 to the corresponding second joint portions 9, the main claw 13 of each second joint portion 9 provided at the corresponding joint portion is on the outer side of the steel sheet pile.

In each second joint portion 9, the main claw 13 is on the outer side of the steel sheet pile, and the sub-claw 15 is on the inner side of the steel sheet pile so as to oppose the main claw 13.

The second joint portion 9 is provided at the second flange portion 7 with a second curved portion 25 interposed therebetween, the second curved portion 25 being bent toward the inner side of the steel sheet pile from the second flange portion 7. The second curved portion 25 extends toward the inner side of the steel sheet pile by a larger distance than the first curved portion 23 on the first joint

portion 5.

Since the second joint portion 9 is provided at the second flange portion 7 with the second curved portion 25 interposed therebetween, the outermost portion of the outer surface of the main claw 13 on the outer side of the steel sheet pile is at a position shifted from the outer surface of the second flange portion 7 toward the inner side by a distance S (see Fig. 3). The distance S is set so as to be greater than or equal to the thickness of the sub-claw 15.
[0027]

When the Z-shaped steel sheet piles 1 having the above-described structure are driven, a Z-shaped steel sheet pile 1 is driven while a joint portion (for example, the first joint portion 5) thereof is engaged with a joint portion (for example, the second joint portion 9) of a Z-shaped steel sheet pile 1 that has already been driven. More specifically, as illustrated in Figs. 2, 3, and 4, the first joint portion 5 and the second joint portion 9 are engaged so that the main claw 13 of the left joint portion is inserted into the joint inner region 21 of the second joint portion 9, and the main claw 13 of the second joint portion 9 is inserted into the joint inner region 21 of the first joint portion 5.

As described above, when the Z-shaped steel sheet piles 1 are driven, the Z-shaped steel sheet piles 1 are easily

rotated by the ground force applied thereto. In this case, with the double-claw-type joint portions according to the present embodiment, since the degree of freedom of rotation is high, the joint portions do not receive excessive force. Accordingly, deformation or the like of the joint portions does not occur when the Z-shaped steel sheet piles 1 are being driven. In addition, double-claw-type joint portions are highly resistant against the tensile force, and thus the deformation thereof scarcely occurs. Therefore, a high-precision steel sheet pile wall 27 can be formed.

[0028]

Next, the state in which the Z-shaped steel sheet piles 1 are connected to each other will be described.

The steel sheet pile wall 27 is formed by connecting the first joint portions 5 and the second joint portions 9 of the Z-shaped steel sheet piles 1 (see Fig. 5). In the state in which the first joint portions 5 and the second joint portions 9 are connected (see Figs. 4 and 5), the sub-claws 15 of the first joint portions 5 do not project from the outer surfaces of the second flange portions 7 of the second joint portions 9 to which the first joint portions 5 are connected. In this example, the outer surfaces of the first flange portion 3 and the second flange portion 7 of two Z-shaped steel sheet piles 1 connected to each other are flush with each other.

When the outer surfaces of the first flange portion 3 and the second flange portion 7 of two Z-shaped steel sheet piles 1 connected to each other are flush with each other, a waling member can be arranged directly on the corresponding portion. If, for example, the joint portions project at the connecting portions 19, it is necessary to arrange the waling member on the corresponding portion with backfill concrete or the like interposed therebetween. This is not necessary in the present embodiment, and the work efficiency can be improved accordingly.

[0029]

Also in the connected state, the joint portions according to the present embodiment have a high degree of freedom of rotation. Therefore, even when earthquake force or the like is applied, the joint portions do not receive excessive force, and deformation or the like of the joint portions does not occur.

Also, the double-claw-type joint portions according to the present embodiment have a high tensile strength, and deformation or the like of the joint portions does not occur when the Z-shaped steel sheet piles 1 receive a tensile force. Therefore, the joint portions have a good water-stopping performance.

[0030]

As described above, with the Z-shaped steel sheet piles

1 according to the present embodiment, the weight of steel material is not increased, deformation or the like of the joint portions does not occur while the steel sheet piles are being driven or after the steel sheet piles have been driven, and a high-precision steel sheet pile wall can be formed.

[0031]

In the above-described embodiment, the first joint portion 5 is provided at the end of the first flange portion 3 with the first curved portion 23 interposed therebetween, and the second joint portion 9 is provided at the end of the second flange portion 7 with the second curved portion 25 interposed therebetween. However, the first curved portion 23 and the second curved portion 25 may be omitted, and the first joint portion 5 and the second joint portion 9 may be directly provided at the ends of the first flange portion 3 and the second flange portion 7, respectively.

[Reference Signs List]

[0032]

- 1 Z-shaped steel sheet pile
- 3 first flange portion
- 5 first joint portion
- 7 second flange portion
- 9 second joint portion
- 11 protruding portion

13 main claw

15 sub-claw

16 web portion

17 joint main portion

19 connecting portion

21 joint inner region

23 first curved portion

25 second curved portion

27 steel sheet pile wall

29 Z-shaped steel sheet pile according to related art

31 joint portion

33 flange portion

CLAIMS

[Claim 1]

A Z-shaped steel sheet pile comprising a first joint portion formed at an end of one flange portion included in the Z-shaped steel sheet pile and a second joint portion formed at an end of the other flange portion included in the Z-shaped steel sheet pile, a steel sheet pile wall being formed by arranging a plurality of the Z-shaped steel sheet piles next to each other and connecting the Z-shaped steel sheet piles together by engaging the first and second joint portions of the Z-shaped steel sheet piles with each other,

wherein the first joint portion is a double-claw-type joint portion including a main claw and a sub-claw, the main claw including a protruding portion at an end thereof and being arranged on an inner side of the steel sheet pile, the sub-claw being formed so as to oppose the main claw and being arranged on an outer side of the steel sheet pile, and

wherein the second joint portion is a double-claw-type joint portion including a main claw and a sub-claw, the main claw including a protruding portion at an end thereof and being arranged on the outer side of the steel sheet pile, the sub-claw being formed so as to oppose the main claw and being arranged on the inner side of the steel sheet pile,

wherein the main claw is thin at the proximal end thereof and includes the protruding portion at the distal

end thereof and the protruding portion of the main claw has an approximately rectangular shape and the main claw is T-shaped, and

wherein a bending angle of a connecting portion between the horizontal and vertical portions of the T-shaped main claw at the outer side is more acute than that at the inner side, and the bending angle at the inner side is obtuse and a joint inner region surrounded by the main claw and the sub-claw of each joint portion has a smooth arc shape.

[Claim 2]

The Z-shaped steel sheet pile according to Claim 1,

wherein the first joint portion is provided at the end of the corresponding flange portion with a first curved portion interposed therebetween, the first curved portion being bent toward the inner side of the steel sheet pile and being provided so that an outer surface of the sub-claw does not project toward the outer side of the steel sheet pile from the outer surface of the flange portion, and

wherein the second joint portion is provided at the end of the corresponding flange portion with a second curved portion interposed therebetween, the second curved portion being bent toward the inner side of the steel sheet pile and being provided so that an outer surface of the main claw is shifted toward the inner side of the steel sheet pile by a distance greater than or equal to a thickness of the sub-

claw.

[Claim 3]

A steel sheet pile wall formed by connecting a plurality of the Z-shaped steel sheet piles according to Claim 1 or 2.