

DESCRIPTION

[Title of Invention] COMBINED STEEL WALL

[Technical Field]

[0001]

The present invention relates to a combined steel wall used for harbor and river revetment, earth retaining, and coffering in the field of civil engineering and construction. 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]

A combined steel wall in which U-shaped steel sheet piles and H-beams are combined together is an example of a steel wall used for harbor and river revetment, earth retaining, and coffering in the field of civil engineering and construction (see Patent Literature 1).

Patent Literature 1 describes a combined steel sheet pile including "a U-shaped steel sheet pile which is approximately U-shaped in cross section and which includes a web portion, flange portions provided at both ends of the web portion, and arm portions provided at ends of the respective flange portions, and an H-beam which is provided on one side surface of the U-shaped steel sheet pile such

that one flange of the H-beam is fixed to the web portion
(see Claim 1 of Patent Literature 1).

[Citation List]

[Patent Literature]

[0003]

[PTL 1] Japanese Unexamined Patent Application
Publication No. 2002-212943

[Summary of Invention]

[Technical Problem]

[0004]

With the combined steel wall according to Patent Literature 1, the web portion of the U-shaped steel sheet pile and one flange of the H-beam are fixed to each other by welding or the like to form a combined steel sheet pile in advance, and a plurality of the combined steel sheet piles are successively driven into the ground.

Thus, it is necessary to fix the U-shaped steel sheet pile and the H-beam together in advance. In addition, since each combined steel sheet pile has a complex shape in which the U-shaped steel sheet pile and the H-beam are fixed together in advance, the cross section thereof is large and a large ground resistance is applied. Consequently, it is difficult to drive the combined steel sheet piles.

In addition, since each combined steel sheet pile is shaped such that one flange of the H-beam is fixed to the

web portion of the U-shaped steel sheet pile, the steel weight per unit length is large, and the material cost is high.

[0005]

The H-beams may also be connected in parallel between joint portions of the U-shaped steel sheet piles, hat-shaped steel sheet piles, or Z-shaped steel sheet piles. However, these steel sheet piles have Larsen-type joint portions, which are not shaped such that they can be directly connected to other steel members, such as the H-beams.

Therefore, in order to form a combined steel wall by connecting the Z-shaped steel sheet piles or the like and the H-beams in parallel according to the related art, it is necessary to place connectors for connecting the Z-shaped steel sheet piles or the like and the H-beams between the Z-shaped steel sheet piles or the like and the H-beams.

[0006]

However, when the connectors are additionally provided, the material cost is increased by the cost of the connectors, and the economic efficiency is reduced. In addition, time to attach the connectors is required, and the total time required to form the combined steel wall is increased.

Furthermore, in the case where the Larsen-type joint portions are connected to the H-beams, depending on the shape of the connectors, portions of the connector project

outward from the flange portions of the Z-shaped steel sheet piles, and the flatness of the corresponding portions is degraded. Therefore, when a waling member is installed, a larger amount of backfill concrete is required. Thus, the installation process becomes more complicated.

[0007]

A technical problem of the present invention is to provide a combined steel wall in which Z-shaped steel sheet piles and H-beams are connected without using connectors as additional components.

[Solution to Problem]

[0008]

(1) A combined steel wall according to the present invention is formed by connecting Z-shaped steel sheet piles and H-beams, each Z-shaped steel sheet pile including a web portion, flange portions provided at both ends of the web portion, and joint portions provided at end portions of the respective flange portions.

The combined steel wall includes a combined portion in which a Z-shaped steel sheet pile, an H-beam, and a Z-shaped steel sheet pile are arranged in that order, the H-beam being arranged so that a flange portion thereof extends in an axial direction of the flange portion of one Z-shaped steel sheet pile, the other Z-shaped steel sheet pile being arranged so that the flange portion thereof extends in an axial direction of the flange

portion of the H-beam, and end portions of the flange portion of the H-beam being directly connected to the corresponding joint portions of the Z-shaped steel sheet piles.

[0009]

(2) In the combined steel wall according to (1), the joint portions of each Z-shaped steel sheet pile include 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. When the Z-shaped steel sheet piles are arranged next to other, the first and second joint portions of the Z-shaped steel sheet piles are engageable. The Z-shaped steel sheet piles at ends of a plurality of the combined portions, each of which includes a Z-shaped steel sheet pile, an H-beam, and a Z-shaped steel sheet pile, are connected to each other.

[0010]

(3) In the combined steel wall according to (2), 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, and 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, and the sub-claw being formed so as to oppose the main claw and being arranged on the inner side of the steel sheet pile.

The flange portion of the H-beam has a projection on an end portion thereof, the projection projecting in a thickness direction of the flange portion.

[0011]

(4) In the combined steel wall according to (2), 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, and 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, and the sub-claw being formed so as to oppose the main claw and being arranged on the inner side of the steel sheet pile.

The flange portion of the H-beam has a groove portion in an end portion thereof.

[0012]

(5) In the combined steel wall according to (3) or (4), 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.

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.

[Advantageous Effects of Invention]

[0013]

The combined steel wall according to the present invention includes a combined portion including the Z-shaped steel sheet pile, the H-beam, and the Z-shaped steel sheet pile, the H-beam being arranged so that a flange portion thereof extends in an axial direction of the flange portion of one Z-shaped steel sheet pile, the other Z-shaped steel

sheet pile being arranged so that the flange portion thereof extends in an axial direction of the flange portion of the H-beam, and end portions of the flange portion of the H-beam being directly connected to the corresponding joint portions of the Z-shaped steel sheet piles. Therefore, it is not necessary to fix the Z-shaped steel sheet pile and the H-beam in advance, and each member can be driven into the ground individually. Thus, the combined steel wall can be readily formed. In addition, the end portions of the flange portion of the H-beam are directly connected to the corresponding joint portions of the Z-shaped steel sheet piles. Therefore, no connectors or the like are required to connect the Z-shaped steel sheet piles and the H-beam. Thus, the combined steel wall can be readily formed and the material cost can be reduced.

[Brief Description of Drawings]

[0014]

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

[Fig. 4] Fig. 4 is an enlarged view of circled part C in Fig. 3.

[Fig. 5] Fig. 5 is an enlarged view of circled part D in Fig. 3.

[Fig. 6] Fig. 6 is a diagram illustrating an H-beam included in the combined steel wall according to the embodiment of the present invention.

[Fig. 7] Fig. 7 is a diagram illustrating an H-beam included in the combined steel wall according to another embodiment of the present invention.

[Description of Embodiments]

[0015]

A combined steel wall 1 according to the present embodiment is formed by connecting Z-shaped steel sheet piles 2 and H-beams 4, each Z-shaped steel sheet pile 2 including a web portion, flange portions provided at both ends of the web portion, and joint portions provided at end portions of the respective flange portions. The combined steel wall 1 includes a combined portion in which a Z-shaped steel sheet pile 2, an H-beam 4, and a Z-shaped steel sheet pile 2 are arranged in that order, the H-beam 4 being arranged so that a flange portion thereof extends in an axial direction of the flange portion of one Z-shaped steel sheet pile 2, the other Z-shaped steel sheet pile 2 being arranged so that the flange portion thereof extends in an axial direction of the flange

portion of the H-beam 4, and end portions of the flange portion of the H-beam 4 being directly connected to the corresponding joint portions of the Z-shaped steel sheet piles 2. The Z-shaped steel sheet piles 2 at ends of a plurality of the combined portions, each of which includes a Z-shaped steel sheet pile 2, an H-beam 4, and a Z-shaped steel sheet pile 2, are connected to each other.

The Z-shaped steel sheet piles 2 and the H-beams 4 included in the combined steel wall 1 will now be described in detail.

[0016]

<Z-Shaped Steel Sheet Pile>

As illustrated in Fig. 3, according to the present embodiment, each Z-shaped steel sheet pile 2 includes a first joint portion 5 formed at an end of a first flange portion 3 included in the Z-shaped steel sheet pile 2 and a second joint portion 9 formed at an end of a second flange portion 7 included in the Z-shaped steel sheet pile 2. A plurality of the Z-shaped steel sheet piles 2 can be arranged next to each other and connected to each other by engaging the first and second joint portions 5 and 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 (see Fig. 4).

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 (see Fig. 5).

The details of the overall shape of each Z-shaped steel sheet pile 2 and the joint portions of the Z-shaped steel sheet pile 2 will now be described in detail.

[0017]

<Overall Shape>

Each Z-shaped steel sheet pile 2 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.

[0018]

<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. 4 and 5.

As illustrated in Figs. 4 and 5, 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 a approximately rectangular shape, and the main claw 13 is T-shaped. The shape of the protruding portion 11 is not limited to a rectangular shape, and may instead be a circular shape or an elliptical shape.

[0019]

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 2 is increased.

[0020]

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.

[0021]

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. 3 and the second joint portion 9 arranged at the right side in Fig. 3 will now be described individually.

[0022]

(First Joint Portion)

When the combined steel wall 1 (see Fig. 1) 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 connected to 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.

[0023]

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 Figs. 2 and 4).

[0024]

(Second Joint Portion)

When the combined steel wall 1 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 connected to 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.

[0025]

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. 5). The distance S is set so as to be greater than or equal to the thickness of the sub-claw 15.

[0026]

<H-Beam>

As illustrated in Fig. 6, each H-beam 4 includes a web portion 35, flange portions 37, and projections 39 provided at ends of the flange portions 37 so as to project outward (toward the side opposite to the side at which the web portion 35 is provided with respect to the axial line of the corresponding flange portion 37).

As illustrated in Fig. 1, the projections 39 engage with the first joint portions 5 or the second joint portions 9 of the Z-shaped steel sheet piles 2 when the ends of one flange portion 37 of each H-beam 4 are inserted into the first joint portions 5 or the second joint portions 9. Therefore, even when a tensile force is applied to the H-beam 4 in an axial direction of the flange portion 37, the flange portion 37 of the H-beam 4 is prevented from being pulled out from the first joint portions 5 or the second joint portions 9.

Although the projections 39 may be formed so as to project outward (toward the side opposite to the side at which the web portion 35 is provided with respect to the axial line of each flange portion 37) as in the present

embodiment, the projections 39 may instead be formed so as to project both outward and inward (toward the side at which the web portion 35 is provided with respect to the axial line of each flange portion 37), or only inward.

[0027]

Next, a method for forming the combined steel wall 1 will be described.

Referring to Fig. 1, the leftmost Z-shaped steel sheet pile 2, for example, is driven, and then an H-beam 4 is driven while an end (left end in Fig. 1) of one flange portion 37 of the H-beam 4 is inserted into the joint inner region of the first joint portion 5 of the Z-shaped steel sheet pile 2.

Next, another Z-shaped steel sheet pile 2 is driven such that the other end (right end in Fig. 1) of the flange portion 37 of the H-beam 4 is inserted into the joint inner region of the first joint portion 5 of the Z-shaped steel sheet pile 2. Next, another Z-shaped steel sheet pile 2 is driving such that the first joint portion 5 thereof engages with the second joint portion 9 of the Z-shaped steel sheet pile 2 that has been previously driven. Next, another H-beam 4 is driven while an end (left end in Fig. 1) of one flange portion 37 of the H-beam 4 is inserted into the joint inner region of the second joint portion 9 of the Z-shaped steel sheet pile 2 that has been previously driven. Next,

another Z-shaped steel sheet pile 2 is driven such that the other end (right end in Fig. 1) of the flange portion 37 of the H-beam 4 that has been previously driven is inserted into the joint inner region of the second joint portion 9 of the Z-shaped steel sheet pile 2.

The above-described steps are repeated to form the combined steel wall 1.

[0028]

When the Z-shaped steel sheet piles 2 are driven, the Z-shaped steel sheet piles 2 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 2 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 combined steel wall 1 can be formed.

[0029]

In addition, as illustrated in Fig. 2, in the case where an H-beam 4 is disposed between the first joint portions 5 of two Z-shaped steel sheet piles 2, no component projects from the first flange portions 3 toward the outer

side of the steel sheet piles. In this example, the outer surfaces of the first flange portions 3 of the two Z-shaped steel sheet piles 2 arranged on both sides of the H-beam 4 are flush with each other.

When the outer surfaces of the first flange portions 3 of the two Z-shaped steel sheet piles 2 are flush with each other, a waling member can be arranged directly on the corresponding portion. If, for example, a connector or the like is used and the connector protrudes toward the outside of the steel sheet piles, 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.

[0030]

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 2 receive a tensile

force. Therefore, the joint portions have a good water-stopping performance.

[0031]

As described above, the combined steel wall 1 according to the present embodiment can be formed by directly connecting the Z-shaped steel sheet piles 2 and the H-beams 4 without using connectors as additional components.

[0032]

In the above-described embodiment, as illustrated in Fig. 1, the Z-shaped steel sheet piles 2 and the H-beams 4 are arranged such that a Z-shaped steel sheet pile 2, an H-beam 4, a Z-shaped steel sheet pile 2, a Z-shaped steel sheet pile 2, an H-beam 4, a Z-shaped steel sheet pile 2, ..., are arranged in that order. However, the present invention is not limited to this, and the following arrangements may instead be employed.

(a) The Z-shaped steel sheet piles 2 and the H-beams 4 are alternately arranged. In other words, a Z-shaped steel sheet pile 2, an H-beam 4, a Z-shaped steel sheet pile 2, an H-beam 4, a Z-shaped steel sheet pile 2, an H-beam 4, ..., are arranged in that order.

(b) A plurality of Z-shaped steel sheet piles 2 are arranged next to a combined unit in which a Z-shaped steel sheet pile 2, an H-beam 4, and a Z-shaped steel sheet pile 2 are arranged in that order, and another combined unit in

which a Z-shaped steel sheet pile 2, an H-beam 4, and a Z-shaped steel sheet pile 2 are arranged in that order is arranged next to the plurality of Z-shaped steel sheet piles 2.

[0033]

In the above-described embodiment, the projections 39 are provided at the ends of the flange portions 37 of the H-beams 4. However, as illustrated in Fig. 7, groove portions 40 that engage with the first joint portion 5 or the second joint portion 9 may instead be provided at the ends of the flange portions 37 of the H-beam 4.

The groove portions 40 may be provided at the outer side (side opposite to the side at which the web portion 35 is provided with respect to the axial line of each flange portion 37), as illustrated in Fig. 7. Alternatively, the groove portions 40 may instead be provided at both the outer side and the inner side (side at which the web portion 35 is provided with respect to the axial line of each flange portion 37), or only at the inner side.

[Reference Signs List]

[0034]

- 1 combined steel wall
- 2 Z-shaped steel sheet pile
- 3 first flange portion
- 4 H-beam

- 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

- 35 web portion
- 37 flange portion
- 39 projection
- 40 groove portion

[Claim 1]

A combined steel wall formed by connecting Z-shaped steel sheet piles and H-beams, each Z-shaped steel sheet pile including a web portion, flange portions provided at both ends of the web portion, and joint portions provided at end portions of the respective flange portions, the combined steel wall comprising:

a combined portion in which a Z-shaped steel sheet pile, an H-beam, and a Z-shaped steel sheet pile are arranged in that order, the H-beam being arranged so that a flange portion thereof extends in an axial direction of the flange portion of one Z-shaped steel sheet pile, the other Z-shaped steel sheet pile being arranged so that the flange portion thereof extends in an axial direction of the flange portion of the H-beam, and end portions of the flange portion of the H-beam being directly connected to the corresponding joint portions of the Z-shaped steel sheet piles,

wherein the joint portions of each Z-shaped steel sheet pile include 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, wherein, when the Z-shaped steel sheet piles are arranged next to other, the first and second joint portions of the Z-shaped steel sheet piles are engageable, and wherein the Z-shaped steel sheet piles at ends of a plurality of the combined portions, each of which includes a Z-shaped steel sheet pile, an H-beam, and a Z-shaped steel sheet pile, are connected to 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, and the sub-claw being formed so as to oppose the main claw and being arranged on an outer side of the steel sheet pile,

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, and the sub-claw being formed so as to oppose the main claw and being arranged on the inner side of the steel sheet pile, and

wherein the flange portion of the H-beam has a projection on an end portion thereof, the projection projecting in a thickness direction of the flange portion.

Claim 2

A combined steel wall formed by connecting Z-shaped steel sheet piles and H-beams, each Z-shaped steel sheet pile including a web portion, flange portions provided at both ends of the web portion, and joint portions provided at end portions of the respective flange portions, the combined steel wall comprising:

a combined portion in which a Z-shaped steel sheet pile, an H-beam, and a Z-shaped steel sheet pile are arranged in that order, the H-beam being arranged so that a flange portion thereof extends in an axial direction of the flange portion of one Z-shaped steel sheet pile, the other Z-shaped steel sheet pile being arranged so that the flange portion thereof

extends in an axial direction of the flange portion of the H-beam, and end portions of the flange portion of the H-beam being directly connected to the corresponding joint portions of the Z-shaped steel sheet piles,

wherein the joint portions of each Z-shaped steel sheet pile include 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, wherein, when the Z-shaped steel sheet piles are arranged next to other, the first and second joint portions of the Z-shaped steel sheet piles are engageable, and wherein the Z-shaped steel sheet piles at ends of a plurality of the combined portions, each of which includes a Z-shaped steel sheet pile, an H-beam, and a Z-shaped steel sheet pile, are connected to 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, and the sub-claw being formed so as to oppose the main claw and being arranged on an outer side of the steel sheet pile,

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, and the sub-claw being formed so as to oppose the main claw and being arranged on the inner side of the steel sheet pile, and

wherein the flange portion of the H-beam has a groove portion in an end portion thereof.

[Claim 3]

The combined steel wall according to Claim 1 or 2, 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.