

SPECIFICATION

STEEL PIPE TYPE SHEET PILE, JOINT STRUCTURE OF STEEL PIPE TYPE SHEET PILE AND WALL STRUCTURE, AND METHOD FOR DRAWING STEEL PIPE TYPE SHEET PILE

Technical Field

[0001]

The present invention relates to a steel pipe type sheet pile, a joint structure of the steel pipe type sheet pile, and a wall structure used at the time of constructing a building or a structure such as a civil engineering structure, and the like, and a method for drawing the steel pipe type sheet pile.

The present application claims priority on Japanese Patent Application No. 2008-239397, filed in Japan on September 18, 2008, the contents of which are cited herein by reference.

Background Art

[0002]

Conventionally, since a steel pipe portion serving as a sheet pile body in a steel pipe type sheet pile has high rigidity, such a steel pipe portion is inserted underground so as to surround a construction site of a building or civil engineering structure, and is used to construct a temporary earth-retaining wall at the time of constructing a building or civil engineering structure requiring deep ground excavation.

On the other hand, a joint portion of such a steel pipe type sheet pile is less rigid compared with a steel pipe portion serving as a sheet pile body.

For example, when a steel wall is inserted deep underground, a steel pipe type sheet pile having higher rigidity than that of a steel sheet pile is used when constructing a wall made of steel and having a water stopping performance necessary for temporary coffering in building the structure with an open cut method.

[0003]

The temporary earth-retaining wall is a temporary structure formed such that the joints of the steel pipe type sheet piles are connected with each other, and are inserted underground. The steel pipe type sheet piles serving as piles constituting the temporary structure may be welded to each other to form long steel pipe type sheet piles depending on applications, and are inserted deep underground.

More specifically, in a case where the depth of the steel pipe type sheet piles inserted underground is large, the long steel pipe type sheet piles are inserted underground such that a lower end of an upper steel pipe type sheet pile is welded sequentially to an upper end of a lower steel pipe type sheet pile that has been already inserted underground.
[0004]

When the temporary long steel pipe type sheet piles that have been inserted underground are drawn and removed, the vicinity of the welded portions are cut off and sequentially removed using the reverse procedure by which the steel pipe type sheet piles were inserted underground. Therefore, removing the sheet piles requires enormous cost as well. Although steel pipe type sheet piles are simply drawn and removed when the degree of insertion thereof is shallow, the frictional resistance with the surrounding ground increases as the degree of insertion deepens, making drawing of the sheet piles difficult.
[0005]

With conventional construction, in order to reduce the cost required for constructing a building or civil engineering structure, a long steel pipe type sheet pile inserted deep underground and thus difficult to withdraw and remove was cut at a shallow portion, and a portion was left in the ground. For example, as a joint connection structure of a steel pipe type sheet pile used as described above, a joint connection structure formed by steel pipe type sheet piles 40-42 as illustrated in FIGS. 27A through 29E is known. The joint connection structure of steel pipe type sheet piles 40-42 will be described briefly below.

[0006]

As illustrated in FIG. 27A, the steel pipe type sheet pile 40 used in the first example of the conventional joint connection structure has a male joint 36 made of a steel

member having a T-shaped cross-section and is fixed on the outer side of one end of a steel pipe type sheet pile body 1 in a radial direction. More specifically, the steel pipe type sheet pile 40 has: the male joint 36 formed by welding a leg 35 of the steel member having the T-shaped cross-section to the steel pipe type sheet pile body 1 formed by a steel pipe; and, a female joint 34 in which a pair of female-joints constituting pieces 38 made of steel having an L-shaped cross-section are arranged on the outer side of the other end of the steel pipe type sheet pile body 1 so as to face each other at an interval, and are welded to the steel pipe type sheet pile body 1.

In the steel pipe type sheet pile 40, the leg 35 having the T-shaped cross-section is formed of a single steel sheet. The male joint 36 is a cantilever type, and is welded at a base portion of the leg 35. Therefore, the male joint 36 has low bending rigidity and is difficult to strengthen the bending rigidity.

In the joint connection structure having the steel pipe type sheet piles 40 connected with each other, the male joint 36 having the T-shaped cross-section is interlocked and disposed into the female joint 34 having the pair of female-joint constituting pieces 38 having the L-shaped cross-section, as illustrated in FIG. 27A.

In the steel pipe type sheet pile 40, a space between the leg 35 of the male joint 36 and the female-joint constituting pieces 38 is narrow as illustrated in FIG. 27A, and hence, there is a possibility that the steel pipe type sheet pile is displaced from a desired position at the time of drawing the steel pipe type sheet pile from the temporary earth-retaining wall for retaining the earth that has been inserted underground such that the steel pipe type sheet piles are connected with each other (central lines of the joints 36, 37 are indicated by the single dot chain line in FIGS. 27B and 27D). In this case, as illustrated in FIGS. 27B through 27D, a base end side of the male joint 36 may be brought into contact with the female-joint constituting pieces 38, possibly damaging the joint 36 and/or the female-joint constituting pieces 38.

[0007]

As illustrated in FIG. 28A, a steel pipe type sheet pile 41 used in the second example of the conventional joint connection structure has a male joint 36 formed by

welding a leg 35 of the steel member having the T-shaped cross-section to the steel pipe type sheet pile body 1 on the outer side of one end of a steel pipe type sheet pile body 1 in a radial direction; and, a female joint 34 in which a steel member having a tubular shape with a slit is fixed to the steel pipe type sheet pile 1 on the outer side of the other end of the steel pipe type sheet pile body 1.

In this case, as the male joint 36 has a similar structure to that of the first example, the male joint 36 has low bending rigidity and it is difficult to strengthen the bending rigidity. Further, as illustrated in FIG. 28A, a space between the leg 35 of the male joint 36 and the slit of the female joint 34 is narrow and the length of the leg 35 is short, and hence there is a possibility that the steel pipe type sheet pile is displaced from a desired position at the time of drawing the the steel pipe type sheet pile from the ground (central lines of the joints 36, 37 are indicated by the single dot chain line in FIGS. 28B and 28D). In this case, as illustrated in FIGS. 28B through 28D, a base end side of the male joint 36 may be brought into contact with the female-joint constituting pieces 33, possibly damaging the joint 36 and/or the female-joint constituting pieces 33.

[0008]

As illustrated in FIG. 29A, a steel pipe type sheet pile 42 used in the third example of the conventional joint connection structure has a male-female joint 37 in which a steel joint member having a tubular shape with a slit is welded to the steel pipe type sheet pile body 1 on the outer side of one end of the steel pipe type sheet pile body 1 in a radial direction; and a male-female joint 37 in which a steel joint member having a tubular shape with a slit is fixed to the steel pipe type sheet pile body 1 on the outer side of the other end of the steel pipe type sheet pile body 1.

A base portion of the steel male-female joint 37 having a tubular shape with the slit is welded to the sheet pile body 1. The male-female joint 37 is of cantilever type in which a joint piece circularly extending from the welding portion on the base portion side extends circularly, and hence, the bending rigidity thereof is low. Further, as illustrated in FIG. 29A, the width G of the slit is narrow, there is a possibility that the steel pipe type sheet pile is displaced from the desired position at the time of drawing the steel pipe type

sheet pile (central lines of the joints 37 are indicated by the single dot chain line). As illustrated in FIGS. 29B through Fig. 29E, both of the steel male-female joints 37 having the tubular shape with the slit may be brought into contact with each other, possibly damaging the steel male-female joint 37 having the tubular shape with the slit.

[0009]

In general, in a case where the steel pipe type sheet pile is used as a temporary member by inserting it deep underground, enormous cost is required not only for drawing the steel pipe type sheet pile, and but also for repairing the large amount of joints of the steel pipe type sheet pile, which have been deformed at the time of drawing operations, to reuse them. Therefore, in order to reduce the total cost including the construction, inexpensive steel pipe type sheet piles economically designed are used as the temporary member, and then only the unwanted upper portion thereof is cut out and removed without drawing the entire length of the steel pipe type sheet pile.

[0010]

Recently, with the increase in the cost of steel materials and environmental awareness, there is a demand for the steel pipe type sheet pile to be recycled, and be used repeatedly, which is a need that did not exist previously. However, the conventional joint did not have sufficient strength and rigidity, possibly being damaged at the time of drawing. Therefore, in addition to the workability at the time of insertion and water-shutting performance of the steel pipe type sheet pile, there is a demand for a joint or a steel pipe type sheet pile having a steel pipe that is not damaged at the time of drawing the steel pipe type sheet pile.

[0011]

Note that, in addition to the conventional techniques, the following techniques (1) to (4) are known.

- (1) A joint structure capable of preventing the deformation of the joint portion by filling cement milk in the joint or around the joint from the inner side of the steel pipe of the steel pipe type sheet pile (see, for example, Patent Document 1).
- (2) A steel pipe type sheet pile having an H-shaped joint on a steel pipe (see, for

example, Patent Document 2).

(3) A steel pipe member in which a through-hole is provided in the steel pipe type sheet pile body formed by a steel pipe to supply a back-fill material from the inner side of the steel pipe type sheet pile body into the joint, and a communicating hole is provided to discharge the filling material from the joint to the outside of the steel tube in a direction away from the outer surface of the steel pipe (see, for example, Patent Document 3).

(4) A technique in which an inlet hole is provided only on one surface side of one joint to fill a hollow portion between one side of a joint and the ground with a filling material such as cement or mortar, a double packer is disposed in the joint, and an inlet hole is provided between the packers (see, for example, Patent Document 4).

All of the techniques (1) to (4) described above are used mainly for the steel pipe type sheet pile for a permanent structure, and none of the techniques (1) to (4) described above disclose or suggest a technological idea of reducing the frictional resistance between the steel pipe type sheet pile and the surrounding ground.

Related Art Documents

Patent Documents

[0012]

Patent Document 1: Japanese Unexamined Patent Application, First Publication No. 2007-224640

Patent Document 2: Japanese Unexamined Patent Application, First Publication No. 2008-19608

Patent Document 3: Japanese Unexamined Patent Application, First Publication No. 2002-70473

Patent Document 4: Japanese Unexamined Patent Application, First Publication No. 2000-204544

Disclosure of the Invention

Problems to be Solved by the Invention

[0013]

As described above, there is a problem in that it is difficult for the conventional steel pipe type sheet pile inserted deep underground to be drawn after being used, and be recycled.

An object of the present invention is to provide a joint structure of a steel pipe type sheet pile and a steel pipe type sheet pile that can be easily drawn and recycled without damaging it even if the steel pipe type sheet pile is used as a temporary member and is inserted deep underground, and a method of drawing the steel pipe type sheet pile.

Means for Solving the Problems

[0014]

(1) A steel pipe type sheet pile, which is an aspect according to the present invention, includes a sheet pile body formed by a steel pipe; a first joint provided on an outer surface of the sheet pile body along a longitudinal direction of the sheet pile body; and, a second joint provided on a surface opposite the outer surface of the sheet pile body of the first joint along a longitudinal direction of the sheet pile body, in which each of the first joint and the second joint has a joint body, a first leg disposed on a front surface side of the sheet pile, and a second leg disposed on a rear surface side of the sheet pile so as to be distanced from the first leg, and supporting the joint body along with the first leg, the first leg and the second leg are fixed to the sheet pile body, the first joint is provided with a first hollow portion extending along a longitudinal direction of the sheet pile body, one end in the longitudinal direction of which is closed, the second joint is provided with a second hollow portion extending along a longitudinal direction of the sheet pile, one end in the longitudinal direction of which is closed, and a first discharging hole for discharging pressurized water from the first hollow portion and the second hollow portion toward the outside direction is provided at the first leg and the second leg of the first joint sectioning the first hollow portion and at the first leg and the second leg of the second joint sectioning the second hollow portion.

(2) In the steel pipe type sheet pile according to (1), it may be possible that the first

hollow portion is surrounded by the first joint including the joint body, the first leg and the second leg, and the sheet pile body, and the second hollow portion is surrounded by the second joint including the joint body, the first leg and the second leg, and the sheet pile body.

(3) In the steel pipe type sheet pile according to (1), it may be possible that the first hollow portion is surrounded by the first joint including the joint body, the first leg and the second leg, and connection section of the first leg and the second leg included in the first joint portion, and the second hollow portion is surrounded by the first joint including the joint body, the first leg and the second leg, and connection section of the first leg and the second leg included in the second joint portion.

(4) In the steel pipe type sheet pile according to (1), it may be possible that the first discharging hole is provided with a nozzle.

(5) In the steel pipe type sheet pile according to (1), it may be possible that the leg portion has a plurality of the first discharging holes at intervals in the longitudinal direction of the joint.

(6) In the steel pipe type sheet pile according to (1), it may be possible that the first discharging hole is obliquely provided such that, an exit thereof is positioned closer to the outer surface of the sheet pile body on the outer side than an inlet thereof in the leg.

(7) In the steel pipe type sheet pile according to (1), it may be possible that a positioning engagement section formed by a recess or protrusion continuing in the longitudinal direction is provided on the inner circumferential surface of each of the first hollow portion and the second hollow portion.

(8) In the steel pipe type sheet pile according to (1), it may be possible that each of the first joint and the second joint is a joint having an H-shaped cross-section.

(9) A joint structure of a steel pipe type sheet pile, which is a second aspect of the present invention, is characterized in that a plurality of the steel pipe type sheet piles according to (1) are arranged such that the first joint of one steel pipe type sheet pile and the second joint of the other steel pipe type sheet pile are fitted to each other; and, the size between outer surfaces of first protrusion provided on an outer side of the joint

interlocking portion of the first joint is smaller than a size between inner sides of second protrusion provided so as to face an inner side of each side plate of the second joint.

(10) In the joint structure of a steel pipe type sheet pile according to (9), it may be possible that the second protrusion provided so as to face the inner side of each of the side plates of the second joint is disposed on a base end side of the side plate, the first protrusion provided on the outer side of the joint interlocking portion of the first joint is disposed so as to be displaced toward the center portion of a flange of the first joint; and, the second protrusion on the second joint and the first protrusion on the first protrusion of the first joint are distanced from each other so as not to be engaged with each other.

(11) In the joint structure of a steel pipe type sheet pile according to (9), it may be possible that the first protrusion of the first joint and the second protrusion of the second joint are provided continuously in the longitudinal direction of the joint in a staggered manner.

(12) In the steel pipe type sheet pile according to (1), it may be possible that the joint body of each of the first joint and the second joint is a pipe-shaped joint body having a slit provided along the longitudinal direction of the joint.

(13) In the steel pipe type sheet pile according to (1), it may be possible that the joint body has a second discharging hole for discharging highly pressurized water into a joint interlocking portion.

(14) A wall structure, which is an aspect of the present invention, is formed by interlocking a plurality of the steel pipe type sheet piles according to (1).

(15) In the steel pipe type sheet pile according to (1), it may be possible that a friction-reducing material is provided on a surface of the steel pipe type sheet pile.

(16) In the steel pipe type sheet pile according to (1), it may be possible that the leg is provided on both of the joint body and the sheet pile body, and is a reinforcing leg for reinforcing the joint.

(17) A method of drawing a steel pipe type sheet pile, which is a first aspect of the present invention, is a method of drawing the steel pipe type sheet pile according to (1) from the ground, which includes: supplying pressurized water to the first hollow portion

and the second hollow portion; discharging the pressurized water through the first discharging hole toward the outer side of the first hollow portion and the second hollow portion; and, drawing the steel pipe type sheet pile upward after friction between the steel pipe type sheet pile and the ground is reduced by the pressurized water.

(18) A method of drawing a steel pipe type sheet pile, which is a second aspect of the present invention, is a method of drawing the steel pipe type sheet pile (1) from the ground, which includes: inserting a pressurized-water supplying pipe into the first hollow portion and the second hollow portion; positioning the first discharging hole to a nozzle of the pressurized-water supplying pipe; discharging pressurized water supplied to the pressurized-water supplying pipe through the nozzle and the first discharging hole toward the outer side of the first hollow portion and the second hollow portion; and, drawing the steel pipe type sheet pile upward after friction between the steel pipe type sheet pile and the ground is reduced by discharging the pressurized water.

Effects of the Invention

[0015]

According to the present invention, each of the joints of the steel pipe type sheet pile is provided with the leg on the front side and the leg on the rear side with a space, and the joint is fixed to the sheet pile body by welding the base end of each the leg to the sheet pile body. Therefore, compared with the conventional joint structure, it is possible to significantly strengthen rigidity such as tensile strength of the joint in the vertical direction and shearing strength of the joint in the lateral direction (horizontal direction). Further, the steel pipe type sheet pile according to the present invention is provided with a hollow portion; the hollow portion is closed on the top end side of the joint in the longitudinal direction; and, each leg is provided with the first discharging hole for discharging the highly pressurized water toward the outer surface side of the steel pipe type sheet pile body. Therefore, it is possible to draw and retrieve the steel pipe type sheet pile, by discharging the highly pressurized water from the first discharging hole to reduce the friction between the outer surface of the steel pipe type sheet pile and the ground even

when the steel pipe type sheet pile is inserted deep underground for temporary use. Yet further, the joints of the steel pipe type sheet pile are formed by a simple joint structure having high rigidity, whereby it is possible to prevent the sheet pile body and the joint from being damaged and recycle the steel pipe type sheet pile.

Further, plural first discharging holes are provided in the longitudinal direction of the joint at intervals, whereby it is possible to reduce the friction between the ground and the steel pipe type sheet pile over the entire length of the steel pipe type sheet pile.

Yet further, the first discharging hole is obliquely provided such that an exit thereof is positioned closer to the outer surface of the steel pipe type sheet pile body on the outer side than an inlet thereof in the leg, whereby it is possible to loosen the ground around the outer surface of the steel pipe type sheet pile to reduce the friction between the steel pipe type sheet pile and the surrounding ground and reduce the friction at the time of drawing operation. Accordingly, the excess deforming force is not applied to the joint at the time of drawing the steel pipe type sheet pile.

Yet further, the joint has the leg on the base end side and the joint body is provided to be supported by the legs. Therefore, it is possible to form the hollow portion by the joint and the outer surface of the sheet pile body, and form the hollow portion by the legs and the joint body or the connection section between the legs by effectively utilizing the leg. Yet further, since the joint body and the hollow portion are separated away from each other, the hollow portion can be formed without affecting the joint body, and it is possible to form the first discharging hole at the legs with ease.

Yet further, by providing an engagement portion for positioning formed by the recess or protrusion continuing in the longitudinal direction on the inner circumferential surface of the hollow portion of the steel pipe type sheet pile, it is possible to lower the highly-pressurized-water supplying pipe while positioning it in the horizontal direction only by providing the engagement portion to the highly-pressurized-water supplying pipe placed within the hollow portion.

Yet further, by providing each of the joints with the leg and the joint body integrally provided to the leg, it is possible to form the joint structure of the steel pipe type

sheet pile having high rigidity such as tensile strength of the joint in the vertical direction and shearing strength of the joint in the lateral direction by using the joint with the simple structure. Also, the joint can be manufactured by hot extrusion molding at low cost.

Yet further, by forming the joint so as to have the H-shaped cross-section, it is possible to obtain the simple joint structure of the steel pipe type sheet pile having the high rigidity such as tensile strength of the joint in the vertical direction and shearing strength of the joint in the lateral direction by utilizing the commercial H-shaped steel or assembling type H-shaped steel.

Yet further, by making the size between outer surfaces of the protrusion provided on an outer side of the joint interlocking portion of the first joint smaller than the size between inner sides of the protrusion provided so as to face an inner side of each side plate of the second joint, it is possible to secure a degree of freedom at the time of drawing the steel pipe type sheet pile because the allowance for moving the steel pipe type sheet pile in the right and the left directions or the front and the rear directions at the time of drawing the steel pipe type sheet pile can be obtained.

Yet further, the protrusion provided so as to face the inner side of each of the side plates of the second joint is disposed on a base end side of the side plate; the protrusion provided on the outer side of the joint interlocking portion of the first joint is disposed so as to be displaced toward the center portion of a flange of the first joint; and, the protrusion on the second joint and the protrusion on the first protrusion of the first joint are distanced from each other so as not to be engaged with each other. With this configuration, the protrusion on the second joint and the protrusion on the first joint are not brought into contact with each other, which makes it possible to avoid the difficulty at the time of drawing operation caused by mutual interference between the protrusions. Additionally, the degree of freedom at the time of drawing the steel pipe type sheet pile is significantly improved, while the drawing operation becomes easy.

Yet further, the protrusion on the side plate of the second joint and the protrusion of the first joint are provided intermittently in the longitudinal direction of the joint in a staggered manner. With this configuration, it is possible to reduce a possibility that the

protrusion on the second joint side is engaged with the protrusion on the first joint side, and the drawing operation becomes easy because the protrusion of the second joint and the protrusion of the first joint are not engaged with each other at the beginning of drawing operation.

Yet further, by forming the joints so as to have the reinforcing leg on both sides of the pipe-shaped joint body with the slit, it is possible to provide the steel pipe type sheet pile having the joint structure with high rigidity such as tensile strength of the joint in the vertical direction and shearing strength of the joint in the lateral direction only by welding the steel plate serving as the leg and having the first discharging hole to the commercial steel pipe having the pipe-shaped joint with the slit.

Yet further, by forming the joint body so as to have the second discharging hole for discharging the highly pressurized water into the joint interlocking portion, it is possible to reduce the friction of the joint interlocking section and reduce the friction between the joint and the surrounding ground. Therefore, the drawing the steel pipe type sheet pile become further easy, and the load caused by the friction of the joint is reduced, thereby reducing the damage of the joint.

According to the wall structure of the present invention, it is possible to easily draw and retrieve the steel pipe type sheet pile, which is inserted deep underground for temporary use, without damaging the joint in the state where the frictional resistance with the surrounding ground is reduced. Therefore, it is possible to largely reduce the deformation of joint of the steel tube body after being drawn, and largely reduce the hand-repair operation of the joint, which is required for the conventional steel pipe type sheet pile, whereby the steel pipe type sheet pile can be economically recycled and is reused.

Yet further, by providing the friction-reducing material on the surface of the steel pipe type sheet pile, it is possible to reduce the frictional resistance between the steel pipe type sheet pile and the surrounding ground, whereby the steel pipe type sheet pile can be further easily drawn.

Yet further, it is possible to form the hollow portion to the reinforcing leg

provided on both of the joint body and the steel pipe type sheet pile body while further enhancing the rigidity of the joint. Also, by discharging the highly pressurized water from the first discharging hole provided to the reinforcing leg, it is possible to significantly reduce the friction between the steel pipe type sheet pile and the surrounding ground.

According to the method of drawing the steel pipe type sheet pile, which is the first aspect of the present invention, at the time of drawing the steel pipe type sheet pile from the ground, the highly pressurized water is supplied to the hollow portion provided to the steel pipe type sheet pile; the highly pressurized water is discharged from the first discharging hole toward the outer surface side of the sheet pile body; the friction between the steel pipe type sheet pile and the ground is reduced; and, then the steel pipe type sheet pile is drawn. Therefore, by reducing the friction between the steel pipe type sheet pile and the ground to reduce the drawing resistance, it is possible to easily draw even the steel pipe type sheet pile inserted deep underground without damaging the steel pipe type sheet pile.

Further, according to the method of drawing the steel pipe type sheet pile, which is the second aspect of the present invention, at the time of drawing the steel pipe type sheet pile from the ground, the highly-pressurized-water supplying pipe is inserted and placed into the hollow portion provided to the steel pipe type sheet pile; the nozzle of the highly-pressurized-water supplying pipe is positioned to the first discharging hole provided to the leg; the highly pressurized water discharged from the nozzle of the highly-pressurized-water supplying pipe is made pass through the first discharging hole provided to the leg, and is discharged toward the outer surface side of the steel pipe type sheet pile body; the friction between the steel pipe type sheet pile and the ground is reduced; and then, the steel pipe type sheet pile is drawn. Therefore, by reducing the friction between the steel pipe type sheet pile and the ground to reduce the drawing resistance, it is possible to easily draw even the steel pipe type sheet pile inserted deep underground without damaging the steel pipe sheet pile.

Brief Description of the Drawings

[0016]

FIG. 1 is a transverse cross-sectional view illustrating an expanded joint interlocking portion in a temporary earth-retaining wall using a steel pipe type sheet pile according to a first embodiment of the present invention;

FIG. 2 is a side view illustrating a steel pipe type sheet pile according to the first embodiment of the present invention;

FIG. 3 is a vertical cross-sectional view illustrating a front side of the steel pipe type sheet piles 2 according to the first embodiment of the present invention that is inserted underground to form the temporary earth-retaining wall;

FIG. 4 is an expanded plan view illustrating a part of FIG. 3;

FIG. 5 is an expanded transverse cross-section illustrating a discharging state from discharging holes of joints to reduce friction;

FIG. 6 is an expanded transverse cross-section illustrating a mode of discharging from discharging nozzles of a highly-pressurized-water supplying pipe provided within joints through discharging holes of the joint;

FIG. 7 is a side view illustrating a state where a steel pipe type sheet pile is drawn by using a method according to the present invention.

FIG. 8 is a side view illustrating a state where a steel pipe type sheet pile is drawn by using another method according to the present invention.

FIG. 9 is an expanded plan view illustrating the vicinity of a joint in a joint connection structure in which steel pipe type sheet piles according to the second embodiment of the present invention are connected with each other;

FIG. 10A is a plan view illustrating a male joint used in the joint connection structure illustrated in FIG. 9;

FIG. 10B is a plan view illustrating a female joint used in the joint connection structure illustrated in FIG. 9;

FIG. 11 is a plan view illustrating the steel pipe type sheet piles according to the second embodiment of the present invention that are connected with each other;

FIG. 12 is an expanded plan view illustrating a joint interlocking portion in which steel pipe type sheet piles according to a third embodiment of the present invention are connected with each other;

FIG. 13A is a plan view illustrating a male joint used in the joint connection structure illustrated in FIG. 12;

FIG. 13B is a plan view illustrating a female joint used in the joint connection structure illustrated in FIG. 12;

FIG. 14 is a plan view illustrating the steel pipe type sheet piles according to the third embodiment of the present invention that are connected with each other;

FIG. 15 is an expanded plan view illustrating a joint interlocking portion in which steel pipe type sheet piles according to a fourth embodiment of the present invention are connected with each other;

FIG. 16A is a plan view illustrating a male joint used in the joint connection structure illustrated in FIG. 15;

FIG. 16B is a plan view illustrating a female joint used in the joint connection structure illustrated in FIG. 15;

FIG. 17 is a plan view illustrating the steel pipe type sheet piles according to the fourth embodiment of the present invention that are connected with each other;

FIG. 18 is a plan view illustrating the steel pipe type sheet piles according to a fifth embodiment of the present invention that have been connected with each other;

FIG. 19 is an expanded plan view illustrating the vicinity of a joint interlocking portion of FIG. 18;

FIG. 20 is an expanded plan view illustrating the vicinity of a joint interlocking portion using a steel pipe type sheet pile according to a sixth embodiment of the present invention;

FIG. 21 is a vertical cross-section illustrating an expanded side view of the vicinity of a joint interlocking portion using a steel pipe type sheet pile according to a variation example of the sixth embodiment of the present invention;

FIG. 22 is an expanded transverse cross-section illustrating joints according to a

seventh embodiment of the present invention having a reinforcing leg, and a joint connection structure in which the joints are connected with each other.

FIG. 23 is a vertical cross-section illustrating a side view of an example of an earth-retaining wall with a steel pipe type sheet pile having check valves provided to holes in a lower portion of the joint at intervals in the vertical direction;

FIG. 24A is a vertical cross-section illustrating a side view of one example of a mode of a hole provided to a joint;

FIG. 24B is a vertical cross-section illustrating a side view of a mode in which a check valve is provided to the hole of the joint;

FIG. 24C is a vertical cross-section illustrating a side view of a mode of the hole in which an inner surface on one side of the hole is inclined so as to intersect an hole axis, and an inner surface on the other side of the hole is parallel;

FIG. 25 is a transverse cross-section illustrating a state where a highly-pressurized-water supplying pipe is inserted into a joint in a joint connection structure in which steel pipe type sheet piles according to an eighth embodiment of the present invention are connected with each other;

FIG. 26 is a transverse cross-section illustrating an expanded joint interlocking portion in a temporary earth-retaining wall, which uses a steel pipe type sheet pile according to a ninth embodiment;

FIG. 27A is a transverse cross-section illustrating a first example of a conventional joint connection structure;

FIG. 27B is a transverse cross-section illustrating a state where a steel pipe type sheet pile of the conventional joint connection structure illustrated in FIG. 27A is positionally changed;

FIG. 27C is a transverse cross-section illustrating a state where a steel pipe type sheet pile of the conventional joint connection structure illustrated in FIG. 27A is positionally changed;

FIG. 27D is a transverse cross-section illustrating a state where a steel pipe type sheet pile of the conventional joint connection structure illustrated in FIG. 27A is

positionally changed;

FIG. 28A is a transverse cross-section illustrating a second example of a conventional joint connection structure;

FIG. 28B is a transverse cross-section illustrating a state where a steel pipe type sheet pile of the conventional joint connection structure illustrated in FIG. 28A is positionally changed;

FIG. 28C is a transverse cross-section illustrating a state where a steel pipe type sheet pile of the conventional joint connection structure illustrated in FIG. 28A is positionally changed;

FIG. 28D is a transverse cross-section illustrating a state where a steel pipe type sheet pile of the conventional joint connection structure illustrated in FIG. 28A is positionally changed;

FIG. 29A is a transverse cross-section illustrating a third example of a conventional joint connection structure;

FIG. 29B is a transverse cross-section illustrating a state where a steel pipe sheet pile of the conventional joint connection structure illustrated in FIG. 29A is positionally changed;

FIG. 29C is a transverse cross-section illustrating a state where a steel pipe type sheet pile of the conventional joint connection structure illustrated in FIG. 29A is positionally changed;

FIG. 29D is a transverse cross-section illustrating a state where a steel pipe type sheet pile of the conventional joint connection structure illustrated in FIG. 29A is positionally changed; and,

FIG. 29E is a transverse cross-section illustrating a state where a steel pipe type sheet pile of the conventional joint connection structure illustrated in FIG. 29A is positionally changed.

Embodiments of the Invention

[0017]

Next, the present invention will be described in detail on the basis of embodiments illustrated in the drawings. Note that, in a second embodiment and embodiments thereafter, the same reference characters as those in the first embodiment are applied to the same constituent members and the constituent members having similar functions to those in the first embodiment, and explanation thereof is omitted or simplified.

[0018]

FIG. 1 is an expanded view illustrating a joint interlocking portion in a temporary earth-retaining wall using a steel pipe type sheet pile according to the first embodiment of the present invention. FIG. 2 is a side view illustrating a steel pipe type sheet pile 2 according to the first embodiment of the present invention.

[0019]

As illustrated in FIGS. 1 and 2, the steel pipe type sheet pile 2 has a sheet pile body 1 formed by a pipe-shaped steel, a male joint (first joint) 3, and a female joint (second joint) 4. The male joint 3 is disposed on the left side of the sheet pile body 1 standing in a vertical direction in FIG. 2 and along a longitudinal direction of the sheet pile body 1. The female joint 4 is disposed on the right side of the sheet pile body 1 in FIG. 2 and along the longitudinal direction of the sheet pile body 1. The male joint 3 and the female joint 4 each protrude from an outer surface 14 of the sheet pile body 1.

[0020]

Each of the joints 3, 4 is provided with two legs 5 on the front side and on the rear side. A base end portion of the leg 5 is welded to the steel pipe type sheet pile body 1 along its longitudinal direction.

The female joint 4 is formed such that the leg (first leg) 5 on the front side and the leg (second leg) 5 on the rear side are inclined with each other so as to be made closer to each other toward the male joint side, which is adjacent to said female joint, of the steel pipe type sheet pile 2 to be inserted underground (that is, toward the top end side of the female joint 4) while the space between the legs 5 increases toward the base end side thereof. At a top end portion of the leg 5 of the female joint 4, a female joint interlocking

portion 6A serving as a female joint body and having a pair of side plates 7 and a groove bottom plate 8 are integrally provided such that each of the side plates 7 is coplanar with a sloped surface of each leg 5 on the front side and the leg 5 on the rear side.

In this mode, the female joint interlocking portion 6A serving as the female joint body has a groove-shaped cross-section. Further, the base end portion of each of the side plates 7 is integrally connected with each leg 5 by way of the groove bottom plate 8. At a top end portion of each of the side plates 7 facing each other at an interval, a lip 9 protruding so as to come closer to each other is provided to prevent the male joint from departing from the female joint. An inner side surface of each of the side plates 7 of the female joint interlocking portion 6A serving as the female joint body is perpendicular to the groove bottom plate 8 such that the interlocking space is not narrow regardless of the inclination of the side plates.

[0021]

The male joint 3 is formed such that the leg 5 on the front side and the leg 5 on the rear side are inclined with each other so as to be made closer to each other toward the female joint side, which is adjacent to said male joint, of the steel pipe type sheet pile 2 to be inserted underground (that is, toward the top end side of the male joint 3) while the space between the leg 5 increases toward the base end side thereof. At a top end portion of the leg 5 of the male joint 3, a male joint interlocking portion 6B having a flange 10, a bottom plate 11 and a web 12 and serving as a male joint body is integrally provided. In this mode, a top end portion of the male joint interlocking portion 6B serving as the male joint body has a T-shaped cross-section and is provided with the flange 10 and the web 12, which are integrally connected with the bottom plate 11.

A space between a side surface of the web 12 at the T-shaped cross-section portion and a top end of the lip 9 of the female joint 4 is made larger than a space between an end portion of the flange 10 of the male joint 3 and an inner side surface of the side plate 7 of the female joint 4 to make allowance of joint fitting larger, while the male joint 3 is prevented from departing from the female joint 4. Further, the inner side sizes of the bottom plate 11 of the male joint 3 and the lip 9 of the female joint 4 are formed such that

thicknesses thereof are 2-3 times thicker than a thickness of the flange 10, so that the joint-fitting allowance in the longitudinal direction of the wall body can be made larger.

[0022]

The flange 10 of the male joint 3 or the groove bottom plate 8 of the female joint 4 is provided with a water-expanding water-stop material (water swelling water stop material) 13 depending on applications to stop water between the joints. Note that FIG. 1 illustrates that the water-expanding water-stop material 13 is expanded.

[0023]

It should be noted that, as the water-expanding water-stop material, it is preferable to use a fluid water stopping material in which a synthetic resin elastomer is used as a base for the water stopping material and containing super absorbent polymers, filling material, solvent and the like; and the material becomes a hard, elastic film after applied and air dried. Further, it is preferable that, when dipped into water, the thus obtained hard film expand 20 times in fresh water, 6 times in seawater, after 24 hours. Yet further, it may be possible to use water-expandable polyurethane as the water-expanding water-stop material 13.

[0024]

The female joint 4 and the male joint 3 can be manufactured inexpensively by hot extrusion molding of the steel material.

[0025]

In the first embodiment, each of the joints 3 and 4 is provided with the leg 5 on the front side and the leg 5 on the rear side at intervals, and the base end portion of each leg 5, 5 is welded to the steel pipe type sheet pile body 1, whereby the joints 3 and 4 are fixed to the steel pipe type sheet pile body 1.

[0026]

As described above, it is possible to strongly fix the joints 3 and 4 to the steel pipe type sheet pile body 1 while increasing the bending rigidity at the portion where the joints 3 and 4 are attached to the steel pipe type sheet pile body 1, by welding the base end portions of the leg 5 on the front and the rear sides of the joints 3 and 4 to the steel pipe

type sheet pile body 1.

[0027]

Additionally, a hollow portion (first or second hollow portion) 15 is formed so as to be surrounded by the female joint interlocking portion 6A or the male joint interlocking portion 6B serving as the joint body, the leg 5 and the outer surface 14 of the steel pipe type sheet pile body 1. The hollow portion 15 is closed by a closing plate 18 (see FIG. 2) on the top end side in the longitudinal direction of the joint, and holes (first discharging hole) 16 are provided to each leg 5, 5 in a symmetric manner so as to face the outer surface side of the steel pipe type sheet pile body 1. The respective holes 16 penetrate through the leg 5 and communicate the hollow portion 15 with the outside of the steel pipe type sheet pile 2, so as to discharge pressurized water from the hollow portion 15 toward the outside. The holes 16 may be used directly to discharge highly pressurized water. Alternatively, by disposing a highly-pressurized-water supplying pipe 17 (see FIG. 6) in the hollow portion 15, the highly pressurized water may be discharged toward the outer surface side of the steel pipe type sheet pile body 1 through the nozzle provided to the highly-pressurized-water supplying pipe 17, and the holes 16 provided to the joint. Note that it may be possible to provide a nozzle for controlling the direction or strength of discharging the highly pressurized water.

[0028]

The holes 16 are obliquely provided such that, an exit thereof is positioned closer to the outer surface side 14 of the steel pipe sheet type pile body 1 on the outer side than the an inlet thereof in the leg 5. This makes it possible to discharge the highly pressurized water toward the outer surface side of the steel pipe type sheet pile body 1 on the outer side than the leg 5.

[0029]

Further, according to the present invention, each of the joints 3 and 4 has the leg 5 on the base end side, and the joint interlocking portion (the female joint interlocking portion 6A, the male joint interlocking portion 6B) is formed so as to be supported by the leg 5. The hollow portion 15 is formed on the base end side of the joint 3, 4, while no

hollow portion is formed on the joint interlocking portion on the top end side of the joint 3, 4, and hence, the size of the joint interlocking portion is reduced, whereby the joints 3 and 4 can be structured in a compact size and an easy manner.

[0030]

As illustrated in FIG. 2, the holes 16 formed in the joints 3 and 4 are arranged at intervals at a lower portion of or over the entire portion of the steel pipe type sheet pile 2. In a case of deep insertion, plural steel pipe type sheet pile units are arranged in the vertical direction, and the steel pipe type sheet piles welded to each other are driven and inserted underground. On the the steel pipe type sheet pile unit located on the lower position, the holes 16 are provided at intervals over the entire length thereof. For the steel pipe type sheet pile unit located on the upper end side, on the other hand, it may be possible to form the holes 16 at intervals only at the lower portion of the steel pipe type sheet pile 2, or at intervals over the entire length of the steel pipe type sheet pile 2.

[0031]

As illustrated in FIG. 2, in this embodiment, the closing plate 18 is provided on the top end portion in the longitudinal direction of the leg 5 to close the hollow portion 15. The closing plate 18 is welded to the steel pipe type sheet pile body 1, the leg 5 and the base end portion of the joint interlocking portion. This makes it possible to prevent water and earth from entering from the top end side in the longitudinal direction of the joint (that is, the lower end side when the steel pipe type sheet pile 2 stands in the vertical direction) into the hollow portion 15 formed by the steel pipe sheet type pile body 1, the leg 5 and the base end portion of the joint interlocking portion.

[0032]

FIG. 3 is a view illustrating the steel pipe type sheet piles 2 according to the first embodiment of the present invention that is inserted underground to form the temporary earth-retaining wall 19 (wall structure), and FIG. 4 is a view illustrating its cross-section.

In this state, in general, a wale 46 and a brace 47 located between the wales 46 to support the wale 46 are provided on the side of the earth-retaining wall 19 as illustrated in FIG. 23; one side is excavated in the dried state; and the structure such as a road and

tunnel is constructed.

[0033]

As described above, the earth-retaining wall 19 is installed for temporary use, and hence, is removed after the structured is constructed. In the present invention, as illustrated in FIGS. 5 and 7 (especially FIG. 7), on the upper end portion of the hollow portion 15 of the male joint 4 or the male joint 3, a coupler 20 is provided as needed, and a highly-pressurized-water supplying pipe (or highly-pressurized-water supplying hose) 17 is connected to the coupler 20. Highly pressurized water is supplied from the highly-pressurized-water supplying pipe 17 into the hollow portion 15, so that the highly pressurized water is discharged from the holes 16 toward the outer surface 14 of the steel pipe type sheet pile body 1. This make it possible to loosen the ground in the vicinity of the steel pipe type sheet pile body 1 and the joints 3 and 4 to reduce the frictional resistance of the steel pipe type sheet pile body 1 (and the joints 3 and 4) with respect to the surrounding ground 21, so that the steel pipe type sheet pile 2 can be drawn in a direction as indicated by the arrow.

As described above, by discharging the highly pressurized water toward the outer surface 14 of the steel pipe type sheet pile body 1, the highly pressurized water actively advances along the outer surface 14 of the steel pipe type sheet pile body 1, whereby the friction between the surrounding ground 21 and the outer surface 14 of the steel pipe sheet pile body 1 can be efficiently reduced.

[0034]

Further, in the present invention, as illustrated in FIG. 6 and 8 (especially FIG. 8), it may be possible to dispose the highly-pressurized-water supplying pipe 17 within the joint body. The highly-pressurized-water supplying pipe 17 is provided with nozzles at the same intervals as the intervals of the holes 16 provided to the joint. The highly pressurized water supplied from a highly-pressurized-water supplying source (not shown) to the highly-pressurized-water supplying pipe 17 passes through the nozzles of the highly-pressurized-water supplying pipe 17 and the holes 16 of the joint, and is discharged toward the outer surface 14 of the steel pipe type sheet pile body 1. This make it possible

to loosen the ground in the vicinity of the steel pipe type sheet pile body 1 and the joints 3 and 4 to reduce the frictional resistance of the steel pipe type sheet pile body 1 (and the joints 3 and 4) with respect to the surrounding ground 21, so that the steel pipe type sheet pile 2 can be drawn in a direction as indicated by the arrow.

[0035]

[Second Embodiment]

FIG. 9 through FIG. 11 illustrate a steel pipe type sheet pile 2 according to a second embodiment of the present invention and the vicinity of a joint in a joint connection structure in which the steel pipe type sheet piles are connected with each other. FIG. 9 is an expanded plan view illustrating the joint connection structure; FIGS. 10A and 10B are plan views illustrating a male joint and a female joint used in the joint connection structure illustrated in FIG. 9; and FIG. 11 is a plan view illustrating the steel pipe type sheet piles according to the second embodiment of the present invention that are connected with each other.

[0036]

In this embodiment, a recess 27 is provided on a top end portion of a flange 10 of the male joint 3, and a water-expanding water-stop material 13 is provided to the recess 27. By forming the recess 27, a required amount of the water-expanding water-stop material 13 can be securely applied before installation of the steel pipe type sheet pile, and the material can be prevented from departing and falling at the time of installation of the steel pipe type sheet pile, whereby it is possible to improve the effect of stopping the water by the water-expanding water-stop material 13.

Other constituent members are equal to the embodiment described above.

[0037]

[Third Embodiment]

FIG. 12 through FIG. 14 illustrate a steel pipe type sheet pile 2 according to a third embodiment of the present invention and the vicinity of a joint in a joint connection structure in which the steel pipe type sheet piles are connected with each other. FIG. 12 is an expanded plan view illustrating the joint connection structure; FIGS. 13A and 13B

are plan views illustrating a male joint and a female joint used in the joint connection structure illustrated in FIG. 12; and FIG. 14 is a plan view illustrating the steel pipe type sheet piles according to the third embodiment of the present invention that are connected with each other.

[0038]

In this embodiment, a distance between legs 5 of a male joint 3 and a female joint 4 is made wider than that in the first embodiment. This makes it possible to improve tensile strength in the vertical direction of the standing steel pipe type sheet pile 2, shearing strength in the horizontal direction of the standing steel pipe type sheet pile 2, and bending rigidity. Further, on a top end portion of a flange 10 of the male joint 3, there is provided a recess 27 that is deeper than that in the second embodiment, and a water-expanding water-stop material 13 is provided to the recess 27. Yet further, on a surface of a groove bottom plate 8 of the female joint 4 on the male joint 3 side, a protrusion 30 having a semi-circle-shaped cross-section that protrudes toward the male joint 3 side is provided along the longitudinal direction of the female joint 4. This makes it possible to further improve the effect of stopping the water by the water-expanding water-stop material. In this embodiment, the protrusion 30 protruding toward the recess 27 is provided, whereby it is possible to improve the effect of stopping the water by the water-expanding water-stop material 13. Other constituent members are equal to the embodiment described above.

[0039]

[Fourth Embodiment]

FIG. 15 through FIG. 17 illustrate a steel pipe type sheet pile 2 according to a fourth embodiment of the present invention and the vicinity of a joint in a joint connection structure in which the steel pipe type sheet piles are connected with each other. FIG. 15 is an expanded plan view illustrating the joint connection structure; FIGS. 16A and 16B are plan views illustrating a male joint and a female joint used in the joint connection structure illustrated in FIG. 15; and FIG. 17 is a plan view illustrating the steel pipe type sheet piles according to the fourth embodiment of the present invention that are connected

with each other.

[0040]

In this embodiment, part of leg 5 of a female joint 4 and a male joint 3 are formed in a circular shape, and the legs 5 are integrally connected by way of a connection section 24. For the female joint 4 and the male joint 3, a hollow portion 15 having the circular cross-section is formed between the legs 5 by a joint body (female joint interlocking portion 6A, male joint interlocking portion 6B), the legs 5 and the connection section 24.

Further, a bottom plate 11 of the male joint 3 is formed in a circular shape.

Yet further, an inner side of a side plate 7 of the female joint 4 is formed in a circular shape, and an inner circumferential surface on the hollow portion 15 side of a groove bottom plate 8 is formed in a circular shape.

With a mode having the hollow portion 15 having the circular cross-section, a highly-pressurized-water supplying pipe can be easily disposed in the hollow portion 15 having the circular cross-section by hanging it from the ground surface.

[0041]

[Fifth Embodiment]

FIG. 18 and FIG. 19 illustrate a steel pipe type sheet pile 2 according to a fifth embodiment of the present invention and the vicinity of a joint in a joint connection structure in which the steel pipe type sheet piles are connected with each other. FIG. 18 is a plan view illustrating the steel pipe type sheet piles according to the fifth embodiment of the present invention that are connected with each other, and FIG. 19 is an expanded plan view illustrating the joint connection structure.

[0042]

In this embodiment, a steel material having an H-shaped cross-section such as an H-shaped steel is used as a female joint 4 and a male joint 3. A half portion of each flange of the steel material having the H-shaped cross-section is used as a leg 5 of the female joint 4, and is welded to the steel pipe type sheet pile body 1. The remaining half portion of the flange of the steel material having the H-shaped cross-section is used as a side plate 7 of the female joint 4. A web of the steel material having the H-shaped

cross-section is used as a groove bottom plate 8 of the female joint 4.

On an top end portion of the side plate 7 of the female joint 4, a continuous or discrete steel plate is welded to form an inner protrusion (second protrusion) 28. A shape of the inner protrusion 28 is not specifically limited, and may be a square cross-section, rectangle cross-section or circular cross-section.

[0043]

Further, a half portion of each flange of the steel material having the H-shaped cross-section is used as a leg 5 of the male joint 3, and is welded to the steel pipe type sheet pile body 1. The remaining half portion of the flange of the steel material having the H-shaped cross-section is used as a flange 10 of a male joint interlocking portion 6B. A web of the steel material having the H-shaped cross-section is used as a bottom plate 11 of the male joint 3. On a top end portion (or its outer side) of the flange 10 of the male joint interlocking portion 6B of the male joint 3, a continuous or discrete steel plate is welded to form an outer protrusion (first protrusion) 29.

A top end of the outer protrusion 29 protrudes outwardly in a wall thick direction of a wall body than the flange 10, and is located on the center side of an earth-retaining wall 19 in the wall thickness direction than the inner protrusion 28. Further, a distance between the respective top end portions of the outer protrusions 29 is shorter than a inner side dimension between the respective side plates 7 of the female joint 4, so that a fitting structure having high fitting tolerance can be formed.

According to this embodiment, it is possible to freely move the steel pipe type sheet pile 2 in a normal direction (a direction in which a wall body is constructed), which is a line connecting a center of each of the joints and a center of the steel pipe, at the time of drawing the steel pipe type sheet pile, so that a degree of freedom at the time of drawing the steel pipe type sheet pile can be made high and the drawing operation can be easily done.

[0044]

In this embodiment, it may be possible to dispose a water-expanding water-stop material 13 on the surface of the male joint 3 outer than the outer protrusion 29 of the

male joint 3. Alternatively, it may be possible to dispose the water-expanding water-stop material 13 on the surface on the base portion side inner than the inner protrusion 28 of the female joint 4. With the water-expanding water-stop material 13, water can be stopped between the male joint 3 and the female joint 4.

In a mode illustrated in the drawings, a distance t between outer sides of the respective outer protrusions 29 of the male joint 3 is made shorter than a distance T between inner sides of the respective inner protrusions 28 of the female joint 4, so that the male joint 3 can be loosely fitted to the female joint 4.

By making the distance t between outer surfaces of the respective outer protrusions 29 disposed on the outer side of the joint fitting portion of the male joint 3 smaller than the distance T between inner sides of the respective inner protrusions 28 disposed so as to face the inner side of the respective side plates 7 of the female joint 4, it is possible to generate sufficient allowance for moving the steel pipe type sheet pile 2 in the right and left directions or in the forward and backward directions at the joint fitting portion of the steel pipe type sheet pile 2 at the time of drawing the steel pipe type sheet pile 2, so that sufficient degree of freedom can be secured at the time of drawing the steel pipe type sheet pile 2.

[0045]

It should be noted that, although not shown, it may be possible to make the distance t between the respective outer protrusions 29 of the male joint 3 longer than the distance T between the respective inner protrusions 28 of the female joint 4. In this case, the outer protrusion 29 and the inner protrusion 28 can be engaged with each other in a manner that cannot be disengaged, so that sufficient strength for fitting the male joint 3 in the direction of the female joint 4 can be obtained and the water-expanding water-stop material 13 can stop water between the male joint 3 and the female joint 4.

[0046]

[Sixth Embodiment]

FIG. 20 illustrates a steel pipe type sheet pile 2 according to a sixth embodiment of the present invention. In this embodiment, an inner protrusion 28 of a female joint 4

and an outer protrusion 29 of a male joint 3 are positionally displaced toward respective base end sides from those in the fifth embodiment illustrated in FIG. 19. More specifically, the inner protrusion 28 is welded to the vicinity of the central portion of each of the side plates 7 of the female joint 4, and the outer protrusion 29 is welded to each flange 10 of the male joint 3 so as to be shifted toward a bottom plate 11.

[0047]

In this embodiment, the male joint 3 is fitted with the female joint 4 such that the outer protrusion 29 of the male joint 3 is shifted toward the front side (that is, toward the base end side of the male joint 3) than the inner protrusion 28 of the female joint 4, rather than toward the rear side (that is, toward the base end side of the female joint 4) than the inner protrusion 28 of the female joint 4. In this mode, the joints connected with each other can be easily drawn. Further, the water-expanding water-stop material 13 is provided on a top end side of the female joint 4 than the inner protrusion 28 as well as on a top end side of the outer surface than the outer protrusion 29.

As described above, in this embodiment, the protrusions 28 are provided on the base end side of the respective side plates 7 of the female joint 4 so as to face the inner side of the respective side plates 7, and the protrusions 29 are provided on the outer side of the joint fitting portion so as to be shifted toward the center portion of a flange 10 of the male joint 3, so that the protrusion 28 on the female joint side and the protrusion 29 on the male joint 3 side are distanced from each other so as not to be engaged with each other. In this case, the protrusion 28 on the female joint 4 side and the protrusion 29 on the male joint 3 side are not brought into contact with each other, which makes it possible to avoid the difficulty at the time of drawing operation caused by mutual interference between the protrusions 28 and 29. Additionally, the degree of freedom at the time of drawing the steel pipe type sheet pile 2 is significantly improved, while the drawing operation becomes easy.

[0048]

FIG. 21 illustrates the vicinity of a joint fitting portion using a steel pipe type sheet pile according to a variation example of this embodiment. In this variation

example, the outer protrusion 29 or the inner protrusion 28 is intermittently provided.

In this variation example, the inner protrusion 28 and the outer protrusion 29 are arranged in a staggered manner at intervals in the vertical direction. By arranging the outer protrusion 29 in the staggered manner at intervals in the vertical direction with respect to the inner protrusion 28, it is possible to reduce a possibility that the inner protrusion 28 is engaged with the outer protrusion 29 at the time of drawing the steel pipe type sheet pile 2, and the drawing operation becomes easy because the inner protrusion 28 and the outer protrusion 29 are not engaged with each other at the beginning of drawing operation.

[0049]

[Seventh Embodiment]

FIG. 22 is a transverse cross-section illustrating joints according to a seventh embodiment of the present invention having a reinforcing leg, and a joint connection structure in which the joints are connected with each other.

In this embodiment, a pipe-shaped steel tube joint 33 having a slit along a longitudinal direction thereof is welded to a steel pipe type sheet pile body 1. Further, there is provided a reinforcing leg 5 formed by a band-shaped steel plate in which an outer surface of a center portion of a short circular-shaped piece 32 in the pipe-shaped steel tube joint 33 with the slit is connected with an outer surface of the steel pipe type sheet pile body 1. One end of the reinforcing leg 5 is welded to a short or long circular-shaped piece, and the other end thereof is welded to the outer surface of the steel pipe type sheet pile body 1. This makes the leg 5 function as an angle brace. Further, a hollow portion 15 is formed by the reinforcing leg 5, the short circular-shaped piece 32 (or long circular-shaped piece 31, which will be described later), and the outer surface of the steel pipe type sheet pile body 1. In this embodiment, the steel pipe joint 33 serves as a joint interlocking portion as the joint body.

[0050]

In this embodiment, the vicinity of the center portion of the long circular-shaped piece 31 and the vicinity of the top end portion of the short circular-shaped piece 32 are

each connected to the reinforcing leg 5. As a result, a protruding length of the long circular-shaped piece 31 on the top end side is made shorter, so that rigidity of the respective circular-shaped pieces can be strengthened. Further, the reinforcing leg 5 is disposed on the base end side of each of the circular-shaped pieces, so that the top end side of each of the circular-shaped pieces can be reinforced. In particular, in this embodiment, a substantially triangle shape is formed by the reinforcing leg 5, the base end side of the circular-shaped piece, and a portion of the steel pipe type sheet pile body 1 surrounded thereby, so that rigidity of this portion can be increased.

Further, in this embodiment, holes 16 for discharging highly pressurized water toward the outer circumferential surface of the steel pipe type sheet pile body 1 are provided to each leg 5 at intervals in the vertical direction.

In this embodiment, a water-expanding water-stop material 13 is provided in the opposing inner surfaces of the top end portions of the respective long circular-shaped pieces, whereby water stopping function is realized by expanding the water-expanding water-stop material 13.

[0051]

Next, with reference to FIG. 23, the holes 16 formed in the leg 5 in the respective embodiments will be described in detail.

In a case where the steel pipe type sheet pile 2 is inserted deep underground to construct the temporary earth-retaining wall 19 for retaining the earth, the steel pipe type sheet pile 2 is subjected to frictional force between the steel pipe type sheet pile 2 and the surrounding ground 21, self weight of the steel pipe type sheet pile 2 or adhesive force via the water-expanding water-stop material between the joints and the like as drawing resistance of the steel pipe type sheet pile 2 at the time of drawing the steel pipe type sheet pile 2 from the upper side. Assuming that the steel pipe type sheet pile has a diameter of 1000 mm and a thickness of 12 mm for example, the self weight of the steel pipe type sheet pile 2 is about 3 kN per meter of the steel pipe type sheet pile. On the other hand, in a case where the adhesive force is 20 kN/m² assuming the general soft clay ground, the frictional resistance with the surrounding ground is about 60 kN per meter of length of the

steel pipe type sheet pile, which is 20 times as large as the self weight of the steel pipe type sheet pile. As can be understood from an example of combination between the steel pipe type sheet pile and the ground, the frictional force with the surrounding ground accounts for a large portion of the drawing resistance of the steel pipe type sheet pile. Therefore, in order to reduce the damage of the joint of the steel pipe type sheet pile and make it possible to be recycled, it is important to prevent force that causes the joint to excessively deform, and it is essential to reduce the drawing force.

[0052]

Of the resistances described above, by reducing the frictional force between the steel pipe type sheet pile 2 and the surrounding ground 21, it is possible to largely reduce the force required for drawing the steel pipe type sheet pile 2. The holes 16 are provided to the leg 5 at intervals in the vertical direction, and highly pressurized water is discharged from the holes 16 toward the outer surface of the steel pipe type sheet pile 2, whereby the ground of the surrounding ground 21 around the outer surface of the steel pipe type sheet pile 2 is loosened to reduce the frictional force between the outer surface of the steel pipe type sheet pile 2 and the surrounding ground 21.

When the highly pressurized water is supplied to the hollow portion 15, a discharging force of the highly pressurized water discharged from the holes 16 at the lower position in a state where the sheet pile 2 stands vertically is larger than a discharging force of the highly pressurized water discharged from the holes 16 at the upper position in a state where the sheet pile 2 stands vertically. Therefore, it is necessary to set the discharging force of the highly pressurized water discharged from the holes 16 at the upper position at a predetermined value or higher, to sufficiently loosen the ground around the outer surface of the steel pipe type sheet pile 2. To this end, as illustrated in FIG. 24B, it may be possible to dispose a check valve 22 to holes 16 at the lower position to adjust the discharging force such that the discharging force of the highly pressurized water discharged from the holes 16 at the upper position is equal to the discharging force of the highly pressurized water discharged from the holes 16 at the lower position.

[0053]

The check valve 22 may be, for example, a rubber check valve 22a having a slit 22b or a general check valve having a ball-shaped metal valve body pressed against a valve seat by application of spring pressure. The check valve 22 can be installed to the leg 5 of the joint 3, 4 before the leg 5 of the joint 3 or 4 is attached to the sheet pile body 1. The highly pressurized water can be discharged from all of the holes 16 in the vertical direction at the same time, by setting valve-opening pressure of the check valve 22 such that the valve-opening pressure increases as the position of the check valve 22 becomes lower in the vertical direction (that is, vertical direction at the time when the sheet pile 2 stands vertically). By setting the valve-opening pressure of all of the check valve in the vertical direction to be equal, the lower the positions of the holes 16 are, the higher the discharging pressure of the highly pressurized water is.

[0054]

FIG. 25 illustrates a state where a highly-pressurized-water supplying pipe is inserted into a joint in a joint connection structure in which steel pipe type sheet piles according to the sixth embodiment of the present invention are connected with each other.

Difference between the joint connection structure of this embodiment and the joint connection structure illustrated in FIG. 15 is that, in the embodiment illustrated in FIG. 25, a positioning engagement section 23 formed by a recessed groove 25 continuing in the vertical direction is symmetrically provided continuously in the vertical direction on the inner surface of each of the circular-shaped leg 5 of the male joint 3.

[0055]

The positioning engagement section 23 may be continuous protrusion. In this case, a recessed groove is formed on the highly-pressurized-water supplying pipe to be engaged with the joint.

More specifically, in this embodiment, the positioning engagement section 23 comprising the continuous recess or protrusion in the longitudinal direction is provided on the inner circumferential surface of the hollow portion 15 surrounded by the joint interlocking portion 6A or 6B serving as the joint body, the legs 5 and the connection section 24 connecting the respective leg.

The number of the recessed groove 25 serving as the positioning engagement section 23 can be one or more, and three grooves or four grooves may be possible. The shape of the cross-section of the recessed groove 25 serving as the positioning engagement section 23 is not specifically limited, and it may be possible to form the cross-section of the recessed groove 25 into a semi-circular shape or rectangular shape.

[0056]

As indicated by the double dot chain line corresponding to a recessed groove 25 in FIG. 25, a protrusion 26 is symmetrically provided on the outer surface of the highly-pressurized-water supplying pipe 17 to be inserted into the hollow portion 15. By fitting the protrusion 26 to the recessed groove 25, and inserting and positioning the highly-pressurized-water supplying pipe 17 into the hollow portion, it is possible to match the nozzles provided within the highly-pressurized-water supplying pipe 17 with the holes provided to the leg 5 without shifting in the circumferential direction of the pipe 17. Therefore, only by positioning the pipe 17 correctly in the vertical direction at the time of inserting the pipe 17, it is possible to match the nozzles provided to the highly-pressurized-water supplying pipe 17 with the holes provided to the leg 5 at a predetermined position.

Further, the positions of the holes 16 provided to the leg 5 on the steel pipe type sheet pile side can be correctly obtained by measuring them before inserted underground. By measuring the distance of lowering the highly-pressurized-water supplying pipe 17, it is possible to correctly match the positions of the nozzles of the highly-pressurized-water supplying pipe 17 with the positions of the holes on the leg 5 side.

[0057]

It should be noted that, although not shown, in the first to fifth embodiments, one or preferably two positioning engagement sections 23 formed by the recessed groove or protrusion continuing in the vertical direction may be provided on the inner circumferential surface of the hollow portion 15 surrounded by the female joint interlocking portion 6A or male joint interlocking portion 6B serving as the joint body, the leg 5 and the steel pipe type sheet pile body 1. In this case, the highly-pressurized-water

supplying pipe 17 can be lowered from the ground surface, and water pressure is not applied to the hollow portion 15, whereby quality required for welding the leg 5 can be reduced.

[0058]

In a case where the highly pressurized water (water jet) is continuously discharged from the holes 16 or nozzles provided to the highly-pressurized-water supplying pipe 17 at a pressure of 14.7 MPa for one minute with a volume of 300 liter, it is possible to obtain a cutting depth of about 700 mm in an extremely hard ground having an N value of 50 in the surrounding ground.

[0059]

It should be noted that, in general, a pipe diameter of the steel pipe type sheet pile body 1 is about 700 mm to 16000 mm in diameter. It is sufficient for the discharged water to reach about 550 to 1250 mm, because an area that requires reduced adhesive between the steel pipe type sheet pile 2 and the ground by using the highly pressurized water discharged from the holes 16 arranged in a line is 1/4 of the circumferential length of the steel pipe type sheet pile body 1. In a case of about 900 mm for example, 1/4 of the circumferential length of the steel pipe type sheet pile body 1 is about 700 mm, and hence, the highly pressurized water reaches about the central portion of the outer surface of the steel pipe type sheet pile body 1 with a cutting depth of about 700 mm. Therefore, the ground around the outer peripheral surface of the steel pipe type sheet pile body 1 is loosened; the adhesive between the steel pipe type sheet pile 2 and the ground is reduced; and the frictional resistance at the time of drawing operation is significantly reduced, whereby it is possible to easily draw the steel pipe type sheet pile 2. Further, by reducing the force required for drawing operation, the steel tube body is less deformed, and the deformation force acting on the joint can be significantly reduced, so that it is possible to reduce the deformation of the joint and significantly decrease the repair operation. As a result, cost required for drawing operation and repair operation after the drawing operation can be reduced, and the steel pipe type sheet pile 2 can be recycled economically.

Note that the discharging pressure can be appropriately set through designing

operation in accordance with the strength of the ground. Further, the inclined angle of the holes 16 with respect to the steel pipe type sheet pile body 1 is appropriately set by taking the pipe diameter of the steel pipe type sheet pile body 1 into consideration.

[0060]

Further, by applying and forming the water-expanding water-stop material on the steel pipe type sheet pile 2 in advance, the material absorbs water in the surrounding ground and expands; the frictional resistance with the ground is reduced, so that the drawing operation can be easily performed.

[0061]

By applying the water-expanding water-stop material on the steel pipe type sheet pile, the water-expanding water-stop material is made function as a friction-reducing material. Then, by discharging the highly pressurized water from the joint toward the outer surface of the steel pipe type sheet pile body as is the case with the present invention, the water-expanding water-stop material applied on the surface of the sheet pile is made expand, and can be made securely function as the friction-reducing material.

In particular, in the present invention, the holes 16 are provided to the leg 5 on the front surface side and the leg 5 on the rear surface side of the steel pipe type sheet pile 2, and hence, it is possible to loosen the ground on both the front surface side and the rear surface side of the steel pipe type sheet pile 2, and significantly reduce the frictional resistance of the ground with respect to both the front and the rear surface sides of the steel pipe type sheet pile.

[0062]

Next, description will be made of a case where the steel pipe type sheet pile 2 according to the respective embodiments described above is inserted underground; the temporary earth-retaining wall 19 for retaining the earth is constructed; and then, the steel pipe type sheet pile 2 for temporary use is drawn. In a case where the highly pressurized water is supplied to the hollow portion 15, a coupler 20 is provided at the upper end portion of the hollow portion 15 of the female joint 4 or the male joint 3 depending on applications. The coupler 20 is a connection member for supplying the highly

pressurized water, and also functions as a lid for preventing the pressure from leaking out of the upper portion at the time of supplying the highly pressurized water. As illustrated in FIG. 7, a steel-type coupler may be welded, or it may be possible to use a coupler formed by combining a steel tube with a pressurizing-type rubber packer, which is not shown. The highly-pressurized-water supplying pipe 17 is connected with the coupler 20. The drawing operation is performed in a state where the highly pressurized water is supplied from the highly-pressurized-water supplying pipe 17 to the hollow portion 15; the highly pressurized water is discharged from the holes 16 toward the outer surface of the steel pipe type sheet pile body 1; the ground around the steel pipe type sheet pile body 1 and the joints 3, 4 is loosened; and, the frictional resistance of the surrounding ground 21 with respect to the steel pipe type sheet pile body 1 (and the joints 3, 4) is reduced.

[0063]

In the case described above, it should be noted that, at the time of drawing the steel pipe type sheet pile 2, all the steel pipe type sheet piles are removed by sequentially repeating the operation in which the steel pipe type sheet pile located at the upper portion is cut and removed as needed, and the coupler and the highly-pressurized-water supplying pipe are jointed again at the upper end portion of the space of the joint of the remaining steel pipe type sheet pile.

Note that the operation described above is not required in a case where a large crane or the like that can draw the steel pipe type sheet pile at one time is used.

[0064]

At the time of inserting the highly-pressurized-water supplying pipe 17 into the hollow portion 15, the nozzles provided to the highly-pressurized-water supplying pipe 17 are matched with the positions of the holes 16 provided to the leg 5, so that the highly pressurized water discharged out of the nozzles of the highly-pressurized-water supplying pipe 17 is made pass through the holes 16 provided to the leg 5 to discharge the water toward the outer surface side of the steel pipe type sheet pile body 1. This makes it possible to reduce the friction between the steel pipe type sheet pile 2 and the ground to drawn the steel pipe type sheet pile 2 as similar manner to the operation described above.

[0065]

In the case described above, it should be noted that, at the time of drawing the steel pipe type sheet pile 2, the steel pipe type sheet pile located at the upper portion is cut and removed as needed. Further, the highly-pressurized-water supplying pipe is configured by jointing plural highly-pressurized-water supplying pipes as needed. Therefore, all the steel pipe type sheet piles are removed by sequentially repeating the operation in which the upper side of the highly-pressurized-water supplying pipe is removed while the lower side thereof is supported, and the highly-pressurized-water supplying pipe is jointed again after the upper steel pipe type sheet pile is removed.

[0066]

The drawing operation may be performed by providing plural clamps to the steel pipe type sheet pile body, holding the steel pipe type sheet pile by means of the clamp, and drawing the steel pipe type sheet pile as well as the clamps by the crane. Further, the steel pipe type sheet pile may be drawn by applying vibration to the steel pipe type sheet pile body by vibrator at the time of drawing, in a state where the plural clamps and a three-point-supported pile driver having a leader are used, and a hydraulic jack is installed into the leader in a positionally adjustable manner.

[0067]

It should be noted that, in the embodiment above, explanation has been made of a case where the friction between the outer surface of the steel pipe type sheet pile body 1 and the surrounding ground 21 is reduced by discharging the highly pressurized water (water jet). In addition to this, it may be possible to reduce the friction of the interlocking portion between the male joint 3 and the female joint 4 adjacent to each other at the time of drawing the steel pipe type sheet pile 2 by discharging the highly pressurized water, or to reduce the friction between the male joint 3 or the female joint 4 and the surrounding ground. In this case, the steel pipe type sheet pile 2 can be further easily drawn and the load caused by the friction of the joint portion can also be reduced, thereby reducing the damage at the joint. Such a mode described above will be described in detail with reference to FIG. 26.

[0068]

[Ninth Embodiment]

FIG. 26 is an expanded view illustrating a joint interlocking portion in a temporary earth-retaining wall for retaining the earth, which uses a steel pipe type sheet pile 2 according to a ninth embodiment. A groove bottom section 8 of a female joint 4 is provided with a hole (second discharging hole) 44 making a hollow portion 15 of the female joint communicate with a female joint interlocking portion 6A. This is a mode in which the highly pressurized water is discharged into the joint to reduce the friction at the time of drawing operation.

Further, two holes (second discharging hole) 45 are provided at a bottom plate 11 of the male joint 3 on both sides of a web 12 to make the hollow portion 15 of the male joint 3 communicate with a surrounding space of the web 12 of a male joint interlocking portion 6B. This is a mode in which the highly pressurized water is discharged in the joint interlocking portion or the vicinity thereof to reduce the friction at the time of drawing operation.

[0069]

In these case, similar to the embodiments described above, the highly pressurized water supplied to the hollow portion 15 of the female joint 4 or male joint 3, or the highly pressurized water supplied to the highly-pressurized-water supplying pipe disposed in the hollow portion 15 of the female joint 4 or male joint 3 is discharged from the hole 44 or holes 45.

By providing the hole 44 to the female joint 4 or the holes 45 to the male joint, it is possible to reduce the friction of the interlocking portion of the male joint 3 and the female joint 4 adjacent to each other in a case where the plural steel pipe type sheet piles are arranged adjacent to each other, and reduce the friction between the steel pipe type sheet pile and the surrounding ground in a case where the steel pipe type sheet piles are not arranged adjacent to each other.

[0070]

Intervals of the holes 44 provided to the female joint 4 in the vertical direction

and intervals of the holes 45 provided to the male joint 3 in the vertical direction may be set at the same intervals as the holes 16 provided to the leg 5 of the female joint 4 or male joint 3 in the vertical direction. However, it is desirable for the holes to be positionally displaced in the vertical direction in order to reduce the loss of cross-section of the joint portion in the same horizontal position.

It should be noted that the discharging directions of the holes 16 provided to the leg 5 of the female joint 4 or male joint 3 and the discharging directions of the holes 44, 45 provided to the female joint 4 or male joint 3 may be set in any direction of the horizontal direction, the upward direction, and the downward direction.

[0071]

At the time of carrying out the present invention, water used as the highly pressurized water may be tap water, or liquid having the friction-reducing material combined therewith. Further, the steel pipe type sheet pile body 1 may be a steel pipe having circular-shaped cross-section or steel tube having square-shaped cross-section.

Industrial Applicability

[0072]

According to the steel pipe type sheet pile of the present invention, it is possible to significantly strengthen rigidity such as tensile strength of a joint in the vertical direction and shearing strength of a joint in the lateral direction (horizontal direction). Further, according to the steel pipe type sheet pile of the present invention, it is possible to draw and recycle a steel pipe type sheet pile by discharging highly pressurized water from the first discharging hole to reduce the friction between the outer surface of the steel pipe type sheet pile and the ground, even when the steel pipe type sheet pile is inserted deep underground for temporary use. Further, it is possible to prevent a sheet pile and joint from being damaged, and recycle the steel pipe type sheet pile using a joint having a simple structure.

Reference Numerals

[0073]

- 1 Steel pipe type sheet pile body
- 2 Steel pipe type sheet pile
- 3 Male joint
- 4 Female joint
- 5 Leg
- 6A Female joint interlocking portion (female joint body)
- 6B Male joint interlocking portion (male joint body)
- 7 Side plate
- 8 Groove bottom plate
- 9 Lip
- 10 Flange
- 11 Bottom plate
- 12 Web
- 13 Water-expanding water-stop material
- 14 Outer surface of steel pipe
- 15 Hollow portion
- 16 Hole
- 17 Highly-pressurized-water supplying pipe
- 18 Closing plate
- 19 Earth-retaining wall
- 20 Coupler
- 21 Surrounding ground
- 22 Check valve
- 22a Rubber check valve
- 22b Slit
- 23 Positioning engagement section
- 24 Connection section
- 25 Recessed groove

26	Protrusion
27	Recess
28	Inner protrusion
29	Outer protrusion
30	Protrusion having a semi-circle-shaped cross-section
31	Long -shaped piece
32	Short circular-shaped piece
33	Pipe-shaped steel tube joint with slit
34	Female joint
35	Leg
36	Male joint
37	Male-female joint
38	Steel-female-joint constituting pieces
40	Steel pipe type sheet pile
41	Steel pipe type sheet pile
42	Steel pipe type sheet pile
43	Ground
44	Hole
45	Hole
46	Wale
47	Brace

CLAIMS

1. A steel pipe type sheet pile comprising:
 - a sheet pile body formed of a steel pipe;
 - a first joint provided on an outer surface of the sheet pile body along a longitudinal direction of the sheet pile body; and,
 - a second joint provided on a surface of the sheet pile body of the first joint opposite the first joint along a longitudinal direction of the sheet pile body, wherein each of the first joint and the second joint has a joint body, a first leg disposed on a front surface side of the sheet pile, and a second leg disposed on a rear surface side of the sheet pile body so as to be distanced from the first leg and to support the joint body along with the first leg,
 - the first leg and the second leg are fixed to the sheet pile body,
 - the first joint is provided with a first hollow portion extending along a longitudinal direction of the sheet pile body, one end in the longitudinal direction of which is closed,
 - the second joint is provided with a second hollow portion extending along a longitudinal direction of the sheet pile body, one end in the longitudinal direction of which is closed, and
 - a first discharging hole for discharging pressurized water from the first hollow portion and the second hollow portion toward the outside direction is provided at the first leg and the second leg of the first joint sectioning the first hollow portion and at the first leg and the second leg of the second joint sectioning the second hollow portion.
2. The steel pipe type sheet pile according to claim 1, wherein
 - the first hollow portion is surrounded by the first joint including the joint body, the first leg and the second leg, and the sheet pile body, and
 - the second hollow portion is surrounded by the second joint including the joint body, the first leg and the second leg, and the sheet pile body.

3. The steel pipe type sheet pile according to claim 1 or 2, wherein
the first hollow portion is surrounded by the first joint including the joint body,
the first leg and the second leg, and connection section of the first leg and the second leg
being included in the first joint portion, and
the second hollow portion is surrounded by the second joint including the joint body, the
first leg and the second leg, and connection section of the first leg and the second leg being
included in the second joint portion.
4. The steel pipe type sheet pile according to one of claims 1-3, wherein
the first discharging hole is provided with a nozzle.
5. The steel pipe type sheet pile according to one of claims 1-4, wherein
the leg portion has a plurality of the first discharging holes at intervals in the
longitudinal direction of the joint.
6. The steel pipe type sheet pile according to one of claims 1-5, wherein
the first discharging hole is obliquely provided such that, an exit thereof is
positioned closer to the outer surface of the sheet pile body on the outer side than an inlet
thereof in the leg.
7. The steel pipe type sheet pile according to one of claims 1-6, wherein
a positioning engagement section formed by a recess or protrusion continuing in
the longitudinal direction is provided on the inner circumferential surface of each of the
first hollow portion and the second hollow portion.
8. The steel pipe type sheet pile according to one of claims 1-7, wherein
each of the first joint and the second joint is a joint having an H-shaped
cross-section.

9. A joint structure of a steel pipe type sheet pile, wherein
a plurality of the steel pipe type sheet piles according to claim 1 are arranged such that the first joint of one steel pipe type sheet pile and the second joint of the other steel pipe type sheet pile are fitted to each other; and,
the size between outer surfaces of a first protrusion provided on an outer side of the joint interlocking portion of the first joint is smaller than the size between inner sides of second protrusion provided so as to face an inner side of each side plate of the second joint.
10. The joint structure of a steel pipe type sheet pile according to claim 9, wherein
the second protrusion provided so as to face the inner side of each of the side plates of the second joint is disposed on a base end side of the side plate;
the first protrusion provided on the outer side of the joint interlocking portion of the first joint is disposed so as to be displaced toward the center portion of a flange of the first joint; and,
the second protrusion on the second joint and the first protrusion on the first protrusion of the first joint are distanced from each other so as not to be engaged with each other.
11. The joint structure of a steel pipe type sheet pile according to claim 9 or 10, wherein
the first protrusion of the first joint and the second protrusion of the second joint are provided continuously in the longitudinal direction of the joint in a staggered manner.
12. The steel pipe type sheet pile according to one of claims 1-8, wherein
the joint body of each of the first joint and the second joint is a pipe-shaped joint body having a slit provided along the longitudinal direction of the joint.
13. The steel pipe type sheet pile according to one of claims 1-8 and 12, wherein

the joint body has a second discharging hole for discharging highly pressurized water into a joint interlocking portion.

14. A wall structure formed by interlocking a plurality of the steel pipe type sheet piles according to one of claims 1-8, 12, and 13.
15. The steel pipe type sheet pile according to one of claims 1-8, and 12-14, wherein a friction-reducing material is provided on a surface of the steel pipe type sheet pile.
16. The steel pipe type sheet pile according to one of claims 1-8, and 12-15, wherein the leg is provided on both of the joint body and the sheet pile body, and is a reinforcing leg for reinforcing the joint.
17. A method for drawing the steel pipe type sheet pile according to claim 1 from the ground, the method including:
 - supplying pressurized water to the first hollow portion and the second hollow portion;
 - discharging the pressurized water through the first discharging hole toward the outer side of the first hollow portion and the second hollow portion; and,
 - drawing the steel pipe type sheet pile upward after friction between the steel pipe type sheet pile and the ground is reduced by the pressurized water.
18. A method for drawing the steel pipe type sheet pile according to claim 1 from the ground, the method including:
 - inserting a pressurized-water supplying pipe into the first hollow portion and the second hollow portion;
 - positioning the first discharging hole to a nozzle of the pressurized-water supplying pipe;

discharging pressurized water supplied to the pressurized-water supplying pipe through the nozzle and the first discharging hole toward the outer side of the first hollow portion and the second hollow portion; and,

drawing the steel pipe type sheet pile upward after friction between the steel pipe type sheet pile and the ground is reduced by discharging the pressurized water.