

DESCRIPTION

STEEL WALL AND CONSTRUCTION METHOD FOR STEEL WALL

Technical Field

[0001]

The present invention relates to a steel wall which is used in earth retaining works, cofferdam, bank protection, land reclamation, a bank, or the like and a construction method for the steel wall.

Background Art

[0002]

Conventionally, a steel sheet pile or a steel pipe sheet pile has been used in various construction works such as earth retaining works, cofferdam, bank protection, land reclamation, and a bank. The steel sheet pile and the steel pipe sheet pile are selectively used according to required rigidity. In general, the steel sheet pile is used in a situation where rigidity may be low, and the steel pipe sheet pile is used in a situation where high rigidity is required.

[0003]

Here, the steel pipe sheet pile has a larger amount of joint margin, compared to the steel sheet pile. Therefore, in a case where water stopping performance is required when constructing cofferdam, bank protection, or the like, in general, a method in which a joint space is filled with packed cement mortar is adopted. In this method, in a case where it

is used in a waterfront environment such as rivers and harbors, if a bag in which mortar is packed is broken, there is a possibility that the mortar may flow out. Further, since the gap between the bags can become a water channel, it is not necessarily suitable for a use where strict water stopping performance is required.

[0004]

Therefore, as a measure in a case where prevention of leakage of water in the inside of a disposal site is strictly required, as in water shielding bank protection or the like of a sea-level waste disposal site or the like, there is proposed a structure in which measures to prevent leakage are carried out in a joint space of a steel pipe sheet pile and the joint space is directly filled with a filler such as mortar (refer to Patent Literature 1, for example). In a case where filling of mortar is performed in this manner, it is disadvantageous in that there is a need to perform work, in which after the steel pipe sheet pile is driven into the ground, earth and sand in the inside of a joint are discharged by a water jet or the like and the inside of the joint is then filled with mortar, so that labor and time are required for field work.

[0005]

In contrast to this, in the steel sheet pile, rigidity becomes low compared to the steel pipe sheet pile. However, water stopping performance is excellent, an expansion gap of a joint is small, and, even in a state where no measures are performed, water stopping performance is high compared to the

steel pipe sheet pile. Further, by painting a swellable water-stop material on the joint in advance, it is also possible to further enhance the water stopping performance of the steel sheet pile. According to this method, it is possible to provide water stopping performance equal to or greater than that of the steel pipe sheet pile subjected to the above-described measures, and omission of labor of field work becomes possible.

[0006]

Therefore, as a technique to enhance the rigidity of the steel sheet pile, there is proposed a technique to use a combination steel sheet pile stiffened by integrating an H-shaped steel with a U-shaped (hat-shaped) steel sheet pile constituting a wall body (refer to Patent Literature 2, for example). The combination steel sheet pile having such a structure is usually constructed by a vibratory hammer construction method and a portion thereof is driven by a press-in method. However, in the condition in which regulation of vibration and noise is strict, in an urban area or the like, a case in which there is capability for using the vibratory hammer construction method is limited. In particular, since the combination steel sheet pile having such a shape has a large cross-sectional area, so that resistance at the time of driving becomes large, even if performing driving by the press-in method is attempted, in hard ground, it is considered that construction becomes difficult.

[0007]

Therefore, for driving in hard ground, it is conceivable

to apply a construction method using an earth auger (a drilling device) which drills the ground. However, since the cross-sectional shape of the combination steel sheet pile extends over a wide range, a device is needed. As an example of the device, using the following construction method has been proposed in a case of building up a combination steel sheet pile having a structure similar to that of the combination steel sheet pile in Patent Literature 2 (refer to Patent Literature 3, for example). That is, a construction method has been proposed in which the combination steel sheet pile is driven so as to extend over a range that is drilled by the earth auger at the time of driving of the combination steel sheet pile and a range that is drilled by the earth auger at the time of built-up of a combination steel sheet pile driven ahead of the above combination steel sheet pile.

Citation List

Patent Literature

[0008]

Patent Literature 1: Japanese Patent No. 3756755

Patent Literature 2: Japanese Patent Application
Laid-Open (JP-A) No. 2002-212943

Patent Literature 3: Japanese Patent No. 4074241

Summary of Invention

Technical Problem

[0009]

As described above, rigidity in a steel wall is higher

in a steel pipe sheet pile wall than in a steel sheet pile wall. On the other hand, water stopping performance in a joint can be enhanced more easily in the steel sheet pile wall than in the steel pipe sheet pile wall.

Therefore, as illustrated in Patent Literature 2, by combining shaped steel with a steel sheet pile wall in which it is easy to enhance water stopping performance, it is possible to construct a steel wall having both rigidity and high water stopping performance.

[0010]

However, a cross-sectional area becomes large by combining a steel sheet pile and shaped steel. Therefore, as described above, there is a limit in driving the combination steel sheet pile by the press-in method, and a need to adopt the vibratory hammer construction method occurs. However, in the vibratory hammer construction method, vibration or noise at the time of driving becomes a problem.

[0011]

In a case of adopting a construction method as illustrated in Patent Literature 3, a casing needs to be disposed outside an auger screw (a drilling shaft having a screw blade). With respect to the casing, there is a need to apply the casing having a length according to a steel material placing length. Therefore, if the placing length is changed, the length of the casing also needs to be changed. Further, with respect to a steel material which is driven at the beginning, since a steel material which has been driven previously is not present, there

is a need to perform preliminary boring of a preceding drilling range by an earth auger without driving a steel material. From the above, it takes time to perform construction.

[0012]

The present invention has been made in view of the above-described circumstances and has an object to provide a steel wall having both high rigidity and high water stopping performance.

Further, the present invention has an object to provide a construction method for a steel wall which allows a construction method which reduces vibration or noise that is not easily reduced in combination steel sheet piles in the related art, to be easily applied.

Solution to Problem

[0013]

In order to solve the above problem, a steel wall according to claim 1 is characterized by including: a plurality of steel sheet piles which are connected by joints so as to provide a wall body; and steel pipes which are in contact with all or some of the steel sheet piles of the wall body with a longitudinal direction of each steel pipe following a longitudinal direction of the steel sheet pile.

[0014]

According to claim 1 of the invention, the steel wall includes the wall body (a steel sheet pile wall) made by connecting the plurality of steel sheet piles by the joints,

and the steel pipe which comes into contact with the steel sheet pile of the wall body with a longitudinal direction thereof following a longitudinal direction of the steel sheet pile. Therefore, it becomes possible to obtain a steel wall having higher water stopping performance than in a steel pipe sheet pile wall by the steel sheet pile wall made by connecting the joints of the steel sheet piles.

[0015]

In addition, when constructing the steel wall, for example, the steel sheet pile and the steel pipe may also be driven into the ground as a combination steel sheet pile in which the steel sheet pile and the steel pipe are joined and integrated. Further, the steel sheet pile and the steel pipe may also be separately driven into the ground.

When driving the steel pipe or the combination steel sheet pile into the ground, it is possible to press the steel pipe into the ground while drilling the ground on the lower side of the steel pipe with a drilling shaft of a drilling device inserted into the steel pipe. Therefore, even in hard ground, construction with low noise can be performed.

When drilling the ground by the drilling device, by drilling a range wider than the outer diameter of the steel pipe, a state is created where at least a portion of the section where the steel sheet pile is driven, of the ground, is drilled. In this way, it becomes possible to reduce resistance of the ground even during driving of the steel sheet pile.

When driving the steel pipe or the combination steel sheet

pile by using the drilling device, drilling by the drilling device is performed for each driving of the steel pipe or the combination steel sheet pile. Therefore, preliminary boring is not required at the time of the start of construction. Further, the drilling shaft is in a state where it is inserted into the steel pipe, so that a cylindrical casing, into which the drilling shaft is inserted, is not required. Therefore, when constructing the steel wall, there is no need to prepare a casing having a length corresponding to an embedded length of the steel pipe.

[0016]

In the invention according to claim 1, the steel wall of claim 2 is characterized in that positional shift in the longitudinal direction between the steel sheet pile and the steel pipe is regulated at a portion where the steel sheet pile and the steel pipe are in contact with each other.

[0017]

According to claim 2 of the invention, at a portion where the steel sheet pile and the steel pipe are in contact with each other, positional shift in the longitudinal direction between the steel sheet pile and the steel pipe is regulated, for example, by the steel sheet pile and the steel pipe being fixed to each other by welding over the entire length, or the like. In this way, the steel sheet pile and the steel pipe function as an integral beam structure in which the steel sheet pile and the steel pipe are integrated, so that it is possible to obtain higher rigidity than the summed rigidity of the rigidity of the

steel pipe and the rigidity of the steel sheet pile.

[0018]

In the invention according to claim 1, the steel wall of claim 3 is characterized in that positional shift in the longitudinal direction between the steel sheet pile and the steel pipe is allowed at a portion where the steel sheet pile and the steel pipe are in contact with each other.

[0019]

According to claim 3 of the invention, positional shift between the steel sheet pile and the steel pipe is allowed at a portion where the steel sheet pile and the steel pipe are in contact with each other. In this case, an overlap beam structure, in which the deflection behavior of the steel sheet pile and the deflection behavior of the steel pipe are the same, is provided, so that the summed rigidity of the rigidity of the steel pipe and the rigidity of the steel sheet pile is obtained.

In this structure, joining of the steel pipe and the steel sheet pile is not required, so that processing labor for joining work is eliminated and a reduction in cost can be attained. Further, since the steel sheet pile and the steel pipe can be transported in a state of being separated, transport efficiency can be increased compared to a state where the steel sheet pile and the steel pipe are joined to each other. In addition, by separately constructing the steel pipe and the steel sheet pile, it becomes possible to perform rotational press-in of the steel pipe.

[0020]

In the invention according to claim 3, the steel wall of claim 4 is characterized in that the steel sheet pile and the steel pipe are joined to each other at an upper end portion of the wall body.

[0021]

In the invention according to claim 4, the steel wall of claim 5 is characterized in that the joining is jointing by coping, welding, bolts, or a drill screw.

[0022]

According to claims 4 and 5 of the invention, the steel sheet pile and the steel pipe are joined to each other, so that rigidity can be increased. Further, joining of an upper end portion of the wall body can be easily performed after driving.

[0023]

In the invention according to any one of claims 1 to 5, the steel wall of claim 6 is characterized in that the steel pipe is disposed on the face on one side or both of the faces of the wall body.

[0024]

According to claim 6 of the invention, the steel wall in a normal usage environment is subjected to great pressure (earth pressure) from the face on one side. Therefore, disposing the steel pipe on one face side that is the opposite side to the side which is subjected to great pressure of the wall body, is reasonable. In particular, in the case of the overlap beam structure, earth pressure acts on the wall body composed of the steel sheet piles and the earth pressure also acts on the steel

pipe through the wall body. Accordingly, a structure that is reasonably subjected to earth pressure becomes possible.

[0025]

On the other hand, for example, when strength is required in the case of the integral beam structure, it is possible to enhance the rigidity of the steel wall by disposing the steel pipes on both the faces of the wall body. Further, in a case where the steel pipes are respectively disposed on both of the faces of the wall body, with respect to the steel pipe which is disposed on the face that is subjected to great pressure, the integral beam structure is made by regulating positional shift in the longitudinal direction between the steel pipe and the steel sheet pile. Further, with respect to the steel pipe which is disposed on the face on the opposite side to the face that is subjected to great pressure, the overlap beam structure is made by allowing positional shift in the longitudinal direction between the steel pipe and the steel sheet pile. In this manner, it is also possible to dispose the steel pipe on each face of the wall body. Further, in a case where the steel pipes are disposed on both the faces of the wall body, it is also possible to use the steel pipes having different sizes according to the faces where the steel pipes are disposed.

[0026]

In the invention according to any one of claims 1 to 6, the steel wall of claim 7 is characterized in that the wall body is formed approximately in a wavelike fashion in which a peak and a valley are repeated, and the steel pipe enters a valley

portion of the wall body and is in contact with the steel sheet pile.

[0027]

According to claim 7 of the invention, since the steel pipe enters the valley portion of the wall body, it is possible to narrow the width of the steel wall along a direction perpendicular to the longitudinal direction of the wall body. Therefore, space-saving is attained and space efficiency is excellent. Further, for example, when driving the steel sheet pile and the steel pipe as the integral beam structure, in a case where drilling is performed at the same time, it is possible to narrow a drilling range.

[0028]

In the invention according to claim 7, the steel wall of claim 8 is characterized in that the steel pipes are continuously or discretely provided in a plurality of valley portions which are continuously formed side by side in the face on one side of the wall body.

[0029]

According to claim 8 of the invention, in a case where the steel pipes are continuously provided in the plurality of valley portions of the wall body, that is, in a case where the steel pipes are basically provided in all the valley portions of the wall body, the distance between the steel pipes is constant and the steel pipes come close to each other. Therefore, it is possible to make the steel wall be a stable structure and to enhance strength.

[0030]

On the other hand, in a case where pressure on the steel wall is relatively low or a case where the rigidity of the steel sheet pile or the steel pipe which is used is high (for example, the diameter of the steel pipe is large), the steel pipe is disposed in every other or every second valley portion. In this manner, the steel pipes can also be disposed in some of the valley portions rather than all the valley portions of the wall body. That is, a configuration is also acceptable in which the steel pipes are disposed discretely with respect to the valley portions. In this case, a reduction in cost can be attained by reducing the used amount of the steel pipe.

[0031]

In the invention according to any one of claims 1 to 6, the steel wall of claim 9 is characterized in that the wall body is formed approximately in a wavelike fashion in which a peak and a valley are repeated, and the steel pipe is in contact with the steel sheet pile on the peak portion side of the wall body.

[0032]

According to claim 9 of the invention, more installation space is required than in the case of claim 8 of the invention. However, since a steel pipe diameter is not regulated to the size of the valley portion and it becomes possible to use a steel pipe having a larger steel pipe diameter, it is advantageous in a case where high rigidity is required.

[0033]

In the invention according to claim 9, the steel wall of

claim 10 is characterized in that the steel pipes are continuously or discretely provided at a plurality of peak portions which are continuously formed side by side in the face on one side of the wall body.

[0034]

According to claim 10 of the invention, in a case where the steel pipes are continuously provided at the plurality of peak portions of the wall body in approximately the same way as the case of claim 8 of the invention, it is possible to make the steel wall be a stable structure. Accordingly, it is possible to enhance the strength of the steel wall.

On the other hand, in a case where pressure on the steel wall is relatively low or a case where the rigidity of the steel sheet pile or the steel pipe which is used is high, the steel pipes are discretely disposed at the peak portions. In this way, the used amount of the steel pipe of the steel wall can be reduced, so that a reduction in cost can be attained.

[0035]

In the invention according to any one of claims 1 to 10, the steel wall of claim 11 is characterized in that the lengths in the longitudinal directions of the steel sheet pile and the steel pipe are different from each other.

[0036]

According to claim 11 of the invention, for example, by making the length (the length from the top to the bottom) in the longitudinal direction of the steel sheet pile short with respect to the length (the length from the top to the bottom)

in the longitudinal direction of the steel pipe, rational design such as being capable of making the length of an embedded portion shorter than when the steel sheet pile and the steel pipe are made to have the same length becomes possible.

On the other hand, the length in the longitudinal direction of the wall body may also be made longer than the length in the longitudinal direction of the steel pipe. The length from the top to the bottom of the steel pipe is determined from the viewpoint of the rigidity of the steel wall. At this time, in a case where boiling, heaving, or circular slip is a concern when the length from the top to the bottom of the wall body is the same extent as the length of the steel pipe, the length from the top to the bottom of the wall body may be made long with respect to the steel pipe.

[0037]

In the invention according to any one of claims 1 to 11, the steel wall of claim 12 is characterized by including: at least two steel wall divided sections, each of which includes the wall body and the steel pipe that comes into contact with the wall body and in which extending directions are different from each other, wherein end portions of the two steel wall divided sections confront each other, so that a corner portion is provided, a joint is provided at the steel pipe which is disposed at an end portion on the corner portion side of the steel wall divided section on one side among the two steel wall divided sections, and the joint of the steel pipe and a joint of the steel sheet pile of an end portion on the corner portion

side of the steel wall divided section on the other side are connected to each other.

[0038]

In the invention according to any one of claims 1 to 11, the steel wall of claim 13 is characterized by including: at least two steel wall divided sections, each of which includes the wall body and the steel pipe that comes into contact with the wall body and in which extending directions are different from each other, wherein each of the two steel wall divided sections includes the wall body and the steel pipe that comes into contact with the wall body end portions of the two steel wall divided sections confront each other, so that a corner portion is provided, joints are provided at the steel pipes which are respectively disposed at end portions on the corner portion sides of the two steel wall divided sections, and the joints are connected to each other.

[0039]

According to claims 12 and 13 of the invention, the two steel wall divided sections are connected by the joint at corner portions of both of the steel walls. In this way, shift does not occur in a direction in which each steel wall divided section should be directed. Further, the steel pipe can be disposed at the corner portion. In addition, it becomes possible to make a configuration in which the steel pipe of the corner portion and the steel pipe adjoining the above steel pipe are closely disposed in two directions intersecting each other. With these factors, it is possible to secure rigidity even at the corner

portion.

[0040]

A construction method for a steel wall according to claim 14 is a method in which a plurality of steel sheet piles are connected by joints, so that a wall body is provided, and steel pipes are in contact with all or some of the steel sheet piles of the wall body with a longitudinal direction of each steel pipe following a longitudinal direction of the steel sheet pile, and the construction method is characterized by including: making a combination steel sheet pile by joining the steel pipe and the steel sheet pile with which the steel pipe comes into contact, over the entire length of a mutual contact portion or joining the steel pipe and the steel sheet pile at a portion of the contact portion, before driving; and inserting a drilling shaft of a drilling device into the steel pipe of the combination steel sheet pile and then driving the combination steel sheet pile while drilling the ground in a range wider than the diameter of the steel pipe under the steel pipe by the drilling device.

[0041]

According to claim 14 of the invention, by making a combination steel sheet pile in which the steel pipes and the steel sheet pile are combined, it is possible to obtain a steel wall having both high water stopping performance and high rigidity.

In addition to that, since the combination steel sheet pile is driven into the ground while drilling the ground, even if the cross-sectional area of the combination steel sheet pile

is wide and the ground is hard, it becomes possible to drive the combination steel sheet pile into the ground by a center bored piling method in which noise and vibration are low. Further, the drilling shaft of the drilling device is in a state where it is inserted into the steel pipe, so that a cylindrical casing, into which the drilling shaft of the drilling device is inserted, is not required.

[0042]

The construction method for a steel wall according to claim 15 is a method in which a plurality of steel sheet piles are connected by joints, so that a wall body is provided, and steel pipes are in contact with all or some of the steel sheet piles of the wall body with a longitudinal direction of each steel pipe following a longitudinal direction of the steel sheet pile, the construction method is characterized by including: inserting a drilling shaft of a drilling device into the steel pipe and then driving the steel pipe while drilling the ground in a range wider than the diameter of the steel pipe under the steel pipe by the drilling device; and subsequently, driving the steel sheet pile which comes into contact with the steel pipe.

[0043]

According to claim 15 of the invention, after the steel pipe is driven, the steel sheet pile is driven.

At this time, the steel pipe is driven into the ground while drilling the ground over a diameter wider than the steel pipe, and after the steel pipe is driven, the steel sheet pile

which comes into contact with the steel pipe is driven. In this way, driving of not only the steel pipe, but also the steel sheet pile which is driven to overlap at least a portion of a drilled section around the steel pipe becomes easy. Further, similarly to claim 14 of the invention, there is no need to use a casing.

[0044]

The construction method for a steel wall according to claim 16 is a method in which a plurality of steel sheet piles are connected by joints, so that a wall body is provided, and steel pipes are in contact with all or some of the steel sheet piles of the wall body with a longitudinal direction of each steel pipe following a longitudinal direction of the steel sheet pile, and the construction method is characterized by including: drilling the ground in a range wider than the diameter of the steel pipe by a drilling device; and driving the steel sheet pile and the steel pipe in the drilled range.

[0045]

According to claim 16 of the invention, the steel sheet pile and the steel pipe which comes into contact with the steel sheet pile are driven in the range drilled by the drilling device. Further, the steel wall is constructed by connecting the steel sheet piles by the joints. Therefore, it becomes possible to drive the steel wall having high rigidity and water stopping performance, with reduced noise or vibration even in hard ground.

[0046]

The construction method for a steel wall according to

claim 17 is a method in which a plurality of steel sheet piles are connected by joints, so that a wall body is provided, and steel pipes are in contact with all or some of the steel sheet piles of the wall body with a longitudinal direction of each steel pipe following a longitudinal direction of the steel sheet pile, and the construction method is characterized by including: driving the steel pipe while making the steel pipe follow the wall body installed already.

[0047]

According to claim 17 of the invention, for example, in a case where an existing steel sheet pile wall is installed, since a steel wall having high rigidity is constructed by using the existing steel sheet pile wall as it is, rather than removing the existing steel sheet pile wall, it is very reasonable.

[0048]

The construction method for a steel wall according to claim 18 is a method in which a plurality of steel sheet piles are connected by joints, so that an approximately wavelike wall body in which a peak and a valley are repeated is provided, the steel pipes are provided at a plurality of valley portions or peak portions formed on the face on one side of the wall body, and the steel pipe is in contact with the steel sheet pile with a longitudinal direction thereof following a longitudinal direction of the steel sheet pile, and the construction method is characterized by including: driving the steel pipe by using a press-in method or a rotary press-in construction method.

[0049]

According to claim 18 of the invention, by driving the steel pipe by the press-in method or the rotary press-in construction method to take a reactive force from the previously pressed-in steel pipe or the like, it is possible to keep vibration or noise at the time of construction relatively low. Therefore, it is possible to construct a steel wall having the effects as described above, in a state where noise or vibration is reduced.

In addition, if the steel pipe is driven by the rotary press-in construction method, since a bend in a longitudinal direction is not easily generated at the time of construction, it is easy to perform straight construction in a vertical direction, and in addition, it is possible to perform construction with relatively small reactive force.

Advantageous Effects of Invention

[0050]

According to the invention, high water stopping performance which is the same as that of steel sheet pile walls in the related art can be obtained and high rigidity can also be obtained. Further, according to the invention, it becomes possible to perform construction with a construction method in which noise and vibration are reduced.

Brief Description of Drawings

[0051]

Fig. 1 is a schematic plan view of a main section

illustrating a steel wall related to an embodiment of the invention.

Fig. 2 is a schematic perspective view of a main section illustrating the steel wall.

Fig. 3 is a side view illustrating an example of a construction apparatus using an earth auger which is used in a construction method for the steel wall.

Fig. 4 is a diagram for describing a drilling range by the earth auger in the construction method for the steel wall.

Fig. 5 is a diagram for describing a construction method which drives a steel pipe along an existing steel sheet pile wall, as a modified example of the construction method for the steel wall related to the embodiment.

Fig. 6 is a schematic plan view of a main section of the steel wall, illustrating a modified example of the steel wall related to the embodiment and also illustrating a drilling range of the earth auger.

Fig. 7 is a schematic plan view of a main section of the steel wall, illustrating another modified example of the steel wall related to the embodiment and also illustrating a drilling range of the earth auger.

Fig. 8 is a schematic plan view of a main section of the steel wall, illustrating another modified example of the steel wall related to the embodiment and also illustrating a drilling range of the earth auger.

Fig. 9 is a schematic plan view of a main section illustrating another modified example of the steel wall related

to the embodiment.

Fig. 10 is a diagram for describing a drilling range by the earth auger in a construction method for the steel wall illustrated in Fig. 9.

Fig. 11 is a schematic plan view of a main section illustrating another modified example of the steel wall related to the embodiment.

Fig. 12 is a diagram for describing a drilling range by the earth auger in a construction method for the steel wall illustrated in Fig. 11.

Fig. 13 is a diagram for describing an example in which a steel pipe is made longer than a steel sheet pile (a wall body) in the steel wall related to the embodiment.

Fig. 14 is a diagram for describing an example in which a steel sheet pile (a wall body) is made longer than a steel pipe in the steel wall related to the embodiment.

Fig. 15 is a diagram for describing a case where a corner portion is present in the steel wall related to the embodiment.

Fig. 16 is a diagram for describing a case where a corner portion is present in the steel wall related to the embodiment.

Fig. 17 is a diagram for describing an example in which a joint is provided at a steel pipe in a case where a corner portion is present in the steel wall related to the embodiment.

Fig. 18 is a diagram for describing another example in which a joint is provided at a steel pipe in a case where a corner portion is present in the steel wall related to the embodiment.

Fig. 19 is a diagram for describing still another example

in which a joint is provided at a steel pipe in a case where a corner portion is present in the steel wall related to the embodiment.

Description of Embodiments

[0052]

Hereinafter, an embodiment of the invention will be described with reference to the drawings.

As illustrated in Figs. 1 and 2, a steel wall 3 related to this embodiment is constituted by combining a hat-shaped steel sheet pile 1 as a steel sheet pile and a steel pipe 2. The steel pipe 2 is in contact with the hat-shaped steel sheet pile 1 with the longitudinal direction thereof following the longitudinal direction of the hat-shaped steel sheet pile 1. Here, the longitudinal directions of the hat-shaped steel sheet pile 1 and the steel pipe 2 are parallel to each other and also the longitudinal directions are made to be in a vertical direction.

[0053]

The hat-shaped steel sheet pile 1 includes a web 1a, a pair of flanges 1b which respectively extends obliquely from both side edges of the web 1a so as to spread each other, a pair of arms 1c which extends parallel to the web 1a to the left and right from leading ends of the left and right flanges 1b, and joints 1d provided at leading ends of the arms 1c. The diameter of the steel pipe 2 is made narrower than the width of the hat-shaped steel sheet pile 1 and the steel pipe 2 is in contact

with the web 1a in a state where the outer circumferential surface thereof has entered the face on the valley side of the hat-shaped steel sheet pile 1. In addition, the steel pipe 2 may also be made to come into contact with the left and right flanges 1b. Further, the steel pipe 2 may also be made to come into contact with one or both of the left and right flanges 1b and the web 1a. However, it is preferable that the steel pipe 2 comes into contact with both the left and right flanges 1b. Further, as will be described later, the steel pipe 2 may also be made to come into contact with the face on the peak side of the hat-shaped steel sheet pile 1.

[0054]

A plurality of hat-shaped steel sheet piles 1 are in a state where the hat-shaped steel sheet piles 1 are arranged in a row with the joints 1d thereof connected to each other, thereby constructing a steel sheet pile wall. Further, the hat-shaped steel sheet pile 1 and the steel pipe 2 are driven into the ground.

[0055]

In the steel wall 3, there is a case where the hat-shaped steel sheet pile 1 and the steel pipe 2 are joined by welding, bolts, or the like, thereby being integrated to each other, and a cross section is maintained as an integral beam structure. Further, there is a case where the hat-shaped steel sheet pile 1 and the steel pipe 2 are made to be in a state of being only in contact with each other without being joined to each other. That is, there is a case where the hat-shaped steel sheet pile

1 and the steel pipe 2 are disposed so as to overlap with the longitudinal directions thereof parallel to each other, thereby forming an overlap beam structure made such that the deflection behavior of the two becomes the same. When high rigidity is required, it is preferable to make an integral beam structure by joining the steel pipe 2 and the hat-shaped steel sheet pile 1 over the entire length in the longitudinal direction or the partial length or intermittently joining the steel pipe 2 and the hat-shaped steel sheet pile 1 at plural places.

[0056]

On the other hand, in a case where for the rigidity of the steel wall 3, high rigidity is not required so much, the overlap beam structure is also acceptable in consideration of processing labor and cost for integration by welding, bolts, or the like. In the overlap beam structure, positional shift in the longitudinal direction between the steel pipe 2 and the hat-shaped steel sheet pile 1 is allowed at a portion where the steel pipe 2 and the hat-shaped steel sheet pile 1 are in contact with each other. Further, in the case of the overlap beam structure, a structure is adopted in which the hat-shaped steel sheet pile 1 side (the opposite side to the face coming into contact with the steel pipe 2) is subjected to earth pressure. By doing so, it is possible to make earth pressure not act in a direction separating the hat-shaped steel sheet pile 1 and the steel pipe 2. Further, in a case where the steel pipe 2 and the hat-shaped steel sheet pile 1 are driven into the ground at the same time, the steel pipe 2 and the hat-shaped steel sheet

pile 1 may also be provisionally joined partially. In addition, if the hat-shaped steel sheet pile 1 and the steel pipe 2 are joined to each other by coping, welding, bolts, a drill screw, or the like at an upper end portion of the steel wall 3, it is possible to increase rigidity.

[0057]

In Fig. 1, a structure is adopted in which the steel pipes 2 respectively come into contact with all the hat-shaped steel sheet piles 1. However, provided that rigidity is in an allowable range, it is also possible to thin out the steel pipes 2 by alternately combining the steel pipes 2 with respect to the hat-shaped steel sheet piles 1, or the like (that is, it is also possible to discretely dispose the steel pipes).

[0058]

In the steel wall 3, as described above, a sheet pile wall is formed from steel sheet piles (the hat-shaped steel sheet piles 1). In addition to this, a state is created where the sheet pile wall is stiffened by the steel pipes 2 which come into contact with the steel sheet piles. Therefore, the steel wall 3 can obtain higher water stopping performance than in a steel pipe sheet pile at joint portions of the steel sheet pile wall composed of the steel sheet piles. Further, the steel wall 3 can obtain high rigidity due to the steel pipes 2.

[0059]

Further, as described above, in a case where higher rigidity is required, it is possible to obtain high rigidity by forming an integral beam structure by joining and integrating

the steel sheet pile and the steel pipe 2. In a case where required rigidity is lower than in the above-described case, the overlap beam structure in a state where the steel sheet pile and the steel pipe 2 are in contact with each other without being joined to each other is adopted. In this way, it is possible to attain a reduction in processing labor or costs for joining the steel sheet pile and the steel pipes 2.

[0060]

Here, in the case of the steel wall having the overlap beam structure, for example, even if clearance of several cm is formed between the steel sheet pile (the hat-shaped steel sheet pile 1) and the steel pipe 2, the steel sheet pile and the steel pipe 2 function as the overlap beam structure through earth and sand entering the clearance. That is, in fact, a state where the steel sheet pile and the steel pipe 2 are in contact with each other also includes a case where a clearance is formed to a slight extent between the steel sheet pile and the steel pipe 2, and it is acceptable if it is state where a wall body composed of the steel sheet piles and the steel pipe 2 can fulfill a function as the overlap beam structure.

[0061]

Next, a construction method for the steel wall 3 will be described.

In construction of the steel wall 3, even in hard ground, it is preferable to be able to drive the hat-shaped steel sheet pile 1 and the steel pipe 2 into the ground by using a construction method in which noise or vibration is low. For

example, it is preferable to drive the steel pipe 2 or a combination steel sheet pile of the steel pipe 2 and the hat-shaped steel sheet pile 1 into the ground by using a construction apparatus using an earth auger as a drilling device.

[0062]

In Fig. 3, an example of a construction apparatus 11 using an earth auger is illustrated. The construction apparatus 11 includes a leader mast 12 which is vertically supported on a heavy machine 20 such as a crawler so as to be able to rise and fall, and an auger drive section 13 provided at the leader mast 12 so as to be able to move up and down. Further, the construction apparatus 11 includes an auger screw (a spiral auger) 14 as a drilling shaft which is connected to the auger drive section 13, thereby being rotationally driven, and a steel pipe setting section 15 for setting the steel pipe 2 on the lower side of the auger drive section 13. In addition, the construction apparatus 11 includes a steel material gripping section 17 for setting the hat-shaped steel sheet pile 1 in a case of driving the steel pipe 2 and the hat-shaped steel sheet pile 1 into the ground together, a hydraulic cylinder 18 for pressing the steel pipe 2 and the hat-shaped steel sheet pile 1 into the ground, and an attachment 21 which has an auger bit and is also joined to a leading end of the auger screw 14.

[0063]

In a case of constructing the steel wall having the integral beam structure, a combination steel sheet pile in which

the steel pipe 2 and the hat-shaped steel sheet pile 1 are integrated is driven while fitting the joint 1d of the combination steel sheet pile to the joint 1d of a previously driven combination steel sheet pile.

[0064]

First, a state is created where an upper end portion of the steel pipe 2 is supported on the steel pipe setting section 15 and also the auger screw 14 is inserted into the steel pipe 2. In addition to this, the hat-shaped steel sheet pile 1 may also be gripped by the steel material gripping section 17.

[0065]

Thereafter, the steel pipe 2 and the auger screw 14 are pressed down by the hydraulic cylinder 18. At this time, the auger screw 14 and the attachment 21 which is mounted on the leading end of the auger screw 14 and has the auger bit are rotated by the auger drive section 13, thereby drilling the ground. Further, as illustrated in Fig. 4, a drilling range 5 is set so as to be slightly wider than the outer diameter of the steel pipe 2 and reach the vicinity of the joints 1d of the hat-shaped steel sheet pile 1. By doing so, since a large portion of the combination steel sheet pile is driven into the drilled ground, even if the ground is hard, the steel pipe and the steel sheet pile can be easily driven.

[0066]

Also in the case of the overlap beam structure, if the steel pipe 2 and the hat-shaped steel sheet pile 1 are partially joined by bolting, welding, or the like to the extent that the

steel pipe 2 and the hat-shaped steel sheet pile 1 are not separated during driving, the same method as the case of the above-described integral beam structure can be used.

[0067]

Further, the hat-shaped steel sheet pile 1 and the steel pipe 2 may also be separately driven. In this case, first, only the steel pipe 2 is set on the construction apparatus 11 and the steel pipe 2 is first driven while drilling the above-described drilling range 5 by the construction apparatus 11. Thereafter, the hat-shaped steel sheet pile 1 is driven. Also at this time, the drilling range 5 becomes a range which overlaps the driving position of the hat-shaped steel sheet pile 1. Further, in a case where two or more steel pipes 2 are previously driven against the hat-shaped steel sheet pile 1, the drilling range 5 may also be somewhat broadened such that the entirety of the driving position of the hat-shaped steel sheet pile 1 is included in the drilling range 5.

[0068]

Further, as another method, a method is also acceptable in which after the drilling range 5 is first drilled by the construction apparatus 11 on which the steel pipe 2 is not set, the steel pipe 2 and the hat-shaped steel sheet pile 1 are separately driven. Since the ground is drilled before driving, a resisting force at the time of driving becomes small, and also in this case, it is possible to perform driving by using a press-in method or the like in which vibration is low. In this case, the drilling range 5 may also be somewhat broadened such

that the entirety of the driving position of the hat-shaped steel sheet pile 1 is included in the drilling range 5. Also in this case, since the face on the valley side of the hat-shaped steel sheet pile 1 is in contact with the outer surface of the steel pipe 2, the drilling range 5 becomes relatively small.

[0069]

In the construction method for the steel wall 3, since it is enough if a range slightly wider than the outer diameter of the steel pipe 2 is drilled as the drilling range 5, it is possible to suppress an increase in power required for drilling. Therefore, there is no need to drill a considerably wide range away from a steel sheet pile wall, as in the method of, for example, Patent Literature 3.

[0070]

Further, in a case where the steel sheet pile 1 and the steel pipe 2 are separately driven, if a pitch of the steel pipe is set to be a pitch capable of being constructed by using an existing hydraulic press-in machine, it is possible to drive each of the steel sheet pile 1 and the steel pipe 2 by using the existing hydraulic press-in machine. In this case, when driving the steel sheet pile 1 and the steel pipe 2, it becomes possible to continuously perform driving in the direction of a wall with a previously driven steel pipe or the like grasped.

In a case where the steel sheet pile 1 and the steel pipe 2 are separately driven, the steel pipe 2 may also be driven with a rotary press-in method. According to the rotary press-in method, a reactive force of driving is relatively small and it

is possible to accurately drive the steel pipe 2.

[0071]

In contrast to this, in a construction method of a conventional structure in which each of a steel sheet pile and an H-shaped steel is driven without integrating the steel sheet pile and the H-shaped steel, thereby constituting a wall body having an overlap beam structure, there is a problem in construction accuracy when driving the H-shaped steel, and an adoptable construction method is limited. For example, in the driving of the H-shaped steel, a reactive force stand is required, or, when the ground is hard, deformation of the H-shaped steel itself easily occurs, and there is a need to drill the ground in advance with an auger or the like.

[0072]

In addition, it is preferable to join the steel sheet pile and the steel pipe 2 at upper end portions thereof by coping, welding, bolts, a drill screw, or the like after driving.

[0073]

Further, in a case where higher rigidity is required, it is possible to obtain high rigidity by joining and integrating the steel sheet pile and the steel pipe 2, thereby making the integral beam structure. In a case where required rigidity is lower than in the above-described case, by making the overlap beam structure in a state where the steel sheet pile and the steel pipe 2 come into contact with each other without being joined to each other, it is possible to attain a reduction in processing labor or cost for joining the steel sheet pile and

the steel pipe 2 to each other.

Further, in a state where the auger screw 14 that is a drilling shaft of the construction apparatus 11 using the earth auger as the drilling device has been inserted into the steel pipe 2, the ground below the steel pipe 2 or the steel pipe 2 and the steel sheet pile is drilled over a range wider than the outer diameter of the steel pipe 2. The steel pipe 2 or the steel pipe 2 and the steel sheet pile are pressed into the ground while performing drilling in this manner. Therefore, even in hard ground, it is possible to construct the steel wall 3 with low noise and vibration.

[0074]

Further, as still another method, as illustrated in Fig. 5, a steel wall 83 may also be constructed by driving the steel pipe 2 while making the steel pipe 2 follow an existing steel sheet pile wall 6. In this case, by driving the steel pipe 2 while making the steel pipe 2 follow the face on the opposite side to the side being mainly subjected to earth pressure, of the steel sheet pile wall 6, it is possible to make an overlap beam structure in which the steel sheet pile (the hat-shaped steel sheet pile 1) side is subjected to earth pressure. Since the existing steel sheet pile wall 6 is used as it is, rather than being removed, it is very reasonable.

[0075]

In driving the steel pipe 2 while making the steel pipe 2 follow the existing steel sheet pile wall 6, if an upper portion on the side where the steel pipe 2 is driven, of the steel sheet

pile wall 6, is exposed, it is relatively easy to make the steel pipe 2 follow the steel sheet pile wall 6. On the other hand, in a case where coping concrete or the like is installed on the side where the steel pipe 2 is driven, of the steel sheet pile wall 6, driving the steel pipe 2 after an upper portion of the steel sheet pile wall 6 is exposed to some extent by removing the coping concrete makes it easy to make the steel pipe 2 follow the steel sheet pile wall 6.

[0076]

As a method of driving the steel pipe 2, it is preferable to drive the steel pipe 2 by using a press-in method, if possible. However, in a case where the soil is hard, so that driving is difficult in the press-in method, it is possible to perform driving by using a well-known rotary press-in construction method. As described above, in a case where makeup is performed by concrete, or the like, driving may also be performed by rotationally pressing-in the steel pipe 2 having a cutting bit at a leading end thereof, thereby making the steel pipe 2 follow the steel sheet pile 1 while punching the concrete on the front. If it is a rotary press-in construction method, even if it is not the same extent as in the press-in method, vibration is much smaller than in at least a vibratory hammer construction method.

[0077]

After the steel wall 83 is constructed by driving the steel pipe 2, in a case where the steel pipe 2 is exposed, so that it is not preferable in appearance, the steel wall 83 may also be subjected to makeup with concrete.

[0078]

Next, a steel wall 33 that is a modified example of the steel wall 3 will be described with reference to Fig. 6. The steel wall 33 uses a Z-shaped steel sheet pile 31 as a steel sheet pile constituting a steel sheet pile wall.

The Z-shaped steel sheet pile 31 includes a web 31a, a pair of flanges 31b which extends obliquely in opposite directions from both side edges of the web 31a, and joints 31d provided at leading ends of the flanges 31b. Therefore, the Z-shaped steel sheet pile 31 has an approximate shape of half the hat-shaped steel sheet pile 1. A steel sheet pile wall formed by connecting the Z-shaped steel sheet piles 31 has approximately the same shape as that of the steel sheet pile wall formed by connecting the hat-shaped steel sheet piles 1 except the position of the joint 31d is different. That is, this steel sheet pile wall has a shape in which a peak and a valley are repeated alternately.

[0079]

The steel pipe 2 is disposed in a valley portion on one face side of the steel sheet pile wall composed of the Z-shaped steel sheet piles 31 and is also in a state where a portion of the steel pipe 2 enters the valley portion. The outer circumferential surface of the steel pipe 2 is in contact with the webs 31a of the two Z-shaped steel sheet piles 31.

[0080]

In the steel wall 33, an overlap beam structure in which the Z-shaped steel sheet pile 31 and the steel pipe 2 are not

joined to each other is suitable, and in construction thereof, a construction method at the time of the overlap beam structure among the above-described construction methods for the steel wall 3 can be suitably used. For example, it is possible to use a method in which after the ground is first drilled by the construction apparatus 11, the steel pipe 2 and the Z-shaped steel sheet pile 31 are separately pressed into the ground. A drilling range 35 by the construction apparatus 11 at this time is a range which includes almost the entirety of the Z-shaped steel sheet pile 31 except the vicinity of every other joint 31 which interferes with the drilling range 35. However, as described above, in a case where the joint 31d portion of the previously driven Z-shaped steel sheet pile 31 does not interfere with drilling by performing drilling in advance, the drilling range may also be set slightly larger such that the entirety of the Z-shaped steel sheet pile 31 is included therein.

[0081]

Further, the Z-shaped steel sheet piles 31 may also be driven one by one, and the two Z-shaped steel sheet piles 31 in which the joints 31d are fitted and swaged may also be driven as a set. In a case where the two Z-shaped steel sheet piles 31 constitute a set, it is possible to carry out basically the same construction method as that for the above-described hat-shaped steel sheet pile 1. Further, also in a case where the Z-shaped steel sheet piles 31 are driven one by one, a method is also acceptable in which after the steel pipe 2 is driven

with a center bored piling method by using the construction apparatus 11, the Z-shaped steel sheet pile 31 is pressed in.

In a case where the hat-shaped steel sheet pile or the Z-shaped steel sheet pile is applied to the steel sheet pile, compared to a case where a U-shaped steel sheet pile which will be described later is applied, since there is no need to take into account positional shift between the steel sheet piles, it can be regarded as an overlap beam structure in which intact rigidity of the steel sheet pile and rigidity of the steel pipe are summed.

[0082]

Next, a steel wall 43 that is a modified example of the steel wall 3 will be described with reference to Fig. 7. The steel wall 43 uses a U-shaped steel sheet pile 41 as a steel sheet pile constituting a steel sheet pile wall.

The U-shaped steel sheet pile 41 includes a web 41a, a pair of flanges 41b which extends obliquely from both side edges of the web 41a so as to spread each other, and joints 41d provided at leading ends of the flanges 41b. A steel sheet pile wall formed by connecting the U-shaped steel sheet piles 41 has approximately the same shape as that of the steel sheet pile wall formed by connecting the hat-shaped steel sheet piles 1 except the position of the joint 41d is different, and has a shape in which a peak and a valley are repeated alternately.

[0083]

The steel pipe 2 is disposed in a valley portion on one face side of the steel sheet pile wall composed of the U-shaped

steel sheet piles 41 and is also in a state where a portion of the steel pipe 2 enters the valley portion. In the case of the U-shaped steel sheet pile 41, since when viewed from a face on one side, a state is created where a valley and a peak are formed by different U-shaped steel sheet piles 41, the steel pipe 2 is disposed at every other U-shaped steel sheet pile 41. The outer circumferential surface of the steel pipe 2 is in contact with the left and right joints 41d in a state where it has entered the valley portion of a single U-shaped steel sheet pile 41. Further, the flange 41b on one side of each of the U-shaped steel sheet piles 41 adjoining the left and right sides of the U-shaped steel sheet pile 41 with a portion of the steel pipe 2 entering the valley side is in contact with the outer circumference of the steel pipe 2. The diameter of the steel pipe 2 is set wider than the width of the U-shaped steel sheet pile 41. In addition, the steel pipe 2 may also be made to come into contact with the web 41a of the U-shaped steel sheet pile 41 by making the diameter of the steel pipe 2 narrower than the width of the U-shaped steel sheet pile 41.

[0084]

Also in the steel wall 43, an overlap beam structure is suitable, and in construction thereof, a construction method which is used for the overlap beam structure, among the above-described construction methods for the steel wall 3, can be suitably used. For example, it is possible to use a method in which after the ground is first drilled by the construction apparatus 11, the steel pipe 2 and the U-shaped steel sheet pile

41 are pressed into the ground. It is possible to set a drilling range 45 by the construction apparatus 11 at this time such that the U-shaped steel sheet pile 41 in which the steel pipe 2 is not disposed on the valley side is disposed astride the two drilling ranges 45. Therefore, even if the drilling range 45 is set relatively narrow, since the entirety of all the U-shaped steel sheet piles 41 falls within the drilling range 45, press-in of the U-shaped steel sheet pile 41 becomes easy. Or, a method is also acceptable in which after the steel pipe 2 is driven with the center bored piling method by using the construction apparatus 11, the U-shaped steel sheet pile 41 is pressed in.

[0085]

Next, a steel wall 53 that is a modified example of the steel wall 3 will be described with reference to Fig. 8. The steel wall 53 uses the U-shaped steel sheet pile 41 as a steel sheet pile constituting a steel sheet pile wall, similarly to the steel wall 43 illustrated in Fig. 7. However, the diameter of the steel pipe 2 is made narrower than the width of the U-shaped steel sheet pile 41, so that a state is created where a portion of the steel pipe 2 enters the valley side of the U-shaped steel sheet pile 41, thereby coming into contact with the web 41a of the U-shaped steel sheet pile 41.

Further, the steel pipes 2 are disposed at each U-shaped steel sheet pile 41 rather than every other U-shaped steel sheet pile 41. In this case, since disposition of the peak side and the valley side of the U-shaped steel sheet piles 41 is reversed

alternately, the steel pipes 2 are alternately disposed on two faces of a steel sheet pile wall composed of the U-shaped steel sheet piles 41.

[0086]

In the steel wall 43, any case of the integral beam structure and the overlap beam structure can be considered, and in construction thereof, it is acceptable if an appropriate construction method among the above-described construction methods for the steel wall 3 is adopted. Further, a drilling range 55 has a larger diameter than the diameter of the steel pipe 2 and becomes a range which includes a portion except the joints 41d of the U-shaped steel sheet pile 41.

[0087]

Next, a steel wall 63 that is a modified example of the steel wall 3 will be described with reference to Figs. 9 and 10. In the steel wall 3, the steel pipe 2 is in contact with the web 1a on the valley side of the hat-shaped steel sheet pile 1, whereas the steel wall 63 is made such that the steel pipe 2 comes into contact with the web 1a on the peak side of the hat-shaped steel sheet pile 1. That is, the steel pipe 2 is in contact with a peak portion of the face on one side of a steel sheet pile wall.

[0088]

In the steel wall 63, it is possible to make the above-described integral beam structure by joining and integrating the steel pipe 2 and the hat-shaped steel sheet pile 1. In this case, it is possible to obtain higher rigidity than

in the steel wall 3. Therefore, a structure is made which is effective for a case where higher rigidity than in the steel wall 3 is required. Further, in the steel wall 63, it is possible to make the above-described overlap beam structure without joining the steel pipe 2 and the hat-shaped steel sheet pile 1. In this case, the same rigidity as that in a case where the steel wall 3 is made to be the overlap beam structure is obtained. In addition, an installation range (a width perpendicular to an arrangement direction of the hat-shaped steel sheet piles 1) of the steel wall 63 becomes wider than in the steel wall 3. In this way, since space efficiency deteriorates, in the case of the overlap beam structure, it is advantageous to use the steel wall 3.

[0089]

In construction of the steel wall 63 having the integral beam structure, a construction method for the integral beam structure among the construction methods for the steel wall 3 can be suitably used. Therefore, in construction of the steel wall 63, in a state where the steel pipe 2 is joined to the hat-shaped steel sheet pile 1, as described above, press-in is performed while performing drilling by using the construction apparatus 11. However, when drilling a portion where the hat-shaped steel sheet pile 1 is driven, except the vicinity of the joint 1d, there is a need to make a drilling range 65 wider than in the case of the steel wall 3.

[0090]

Next, a steel wall 73 that is a modified example of the

steel wall 3 will be described with reference to Figs. 11 and 12. The steel wall 73 is a steel wall in which the diameter of the steel pipe 2 is made large with respect to the effective width of the hat-shaped steel sheet pile 1, and the steel pipe 2 has high rigidity by making the steel pipe 2 have a large cross section. Therefore, in a case where high rigidity is required for the steel wall 73, it becomes a suitable structure.

[0091]

The steel pipe 2 is in a state where a portion thereof enters a valley portion of the hat-shaped steel sheet pile 1 and the steel pipe 2 comes into contact with the flange 1b or a corner portion between the flange 1b and the arm 1c of the hat-shaped steel sheet pile 1.

Further, the steel pipe 2 is disposed at every other hat-shaped steel sheet pile 1 rather than being disposed at each hat-shaped steel sheet pile 1. In addition, the steel pipes 2 may also be disposed so as to be spaced apart from each other at an interval wider than an interval when the steel pipes 2 are disposed at every other hat-shaped steel sheet pile 1, such as an interval when the steel pipes 2 are disposed at every two hat-shaped steel sheet piles 1 or the like.

[0092]

In the steel wall 73, even if the integral beam structure in which the hat-shaped steel sheet pile 1 and the steel pipe 2 are joined to each other, as described above, is not made, high rigidity is obtained simply with the steel pipes 2. Since the steel pipes are disposed being spaced at an interval

corresponding to one or more hat-shaped steel sheet piles 1, it is preferable to adopt the overlap beam structure.

[0093]

In the case of the overlap beam structure, it becomes possible to separately drive the steel pipe 2 and the hat-shaped steel sheet pile 1 into the ground, as described above. At this time, for example, press-in is performed while performing drilling by using the construction apparatus 11 with the auger screw 14 inserted into the steel pipe 2. In this case, as illustrated in Fig. 12, the driving position of every other hat-shaped steel sheet pile 1 with which the steel pipe 2 does not come into contact is set to be included in adjacent drilling ranges 75. In this way, the driving position of the hat-shaped steel sheet pile 1 enters a state of being drilled to include even the portions of the joints 1d of the hat-shaped steel sheet pile 1. In this way, it becomes possible to more easily press the hat-shaped steel sheet pile 1 into the ground. In addition, in the case of the overlap beam structure, the ground may also be drilled by the construction apparatus 11 in which the steel pipe 2 is not set, before the steel pipe 2 and the hat-shaped steel sheet pile 1 are driven. In this case, the steel pipe 2 and the hat-shaped steel sheet pile 1 may also be driven into the ground which has been drilled and softened.

[0094]

In any of the steel walls 33, 43, 53, 63, and 73 illustrated in Figs. 6 to 12, similarly to the case where the steel wall 3 of Fig. 1 has been described with reference to Fig. 5 by using

an existing steel sheet pile wall, it is possible to make a steel wall having the overlap beam structure by driving the steel pipe 2 while making the steel pipe 2 follow the steel sheet pile wall. [0095]

In the steel walls 3, 33, 43, 53, 63, 73, and 83, the length from the top to the bottom of the steel sheet pile (a wall body) and the length of the steel pipe 2 may also be different from each other, if necessary.

For example, as illustrated in Fig. 13, the length (the length from the top to the bottom) in the longitudinal direction of a steel sheet pile wall (a wall body 9) composed of steel sheet piles may also be made short with respect to the length (the length from the top to the bottom) in the longitudinal direction of the steel pipe 2. By shortening the length of the steel sheet pile, a rational design such as being capable of making the length of an embedded portion shorter than when the steel sheet pile and the steel pipe are made to have the same length becomes possible.

On the other hand, as illustrated in Fig. 14, it is also possible to make the length from the top to the bottom of the steel sheet pile wall (the wall body 9) longer than the length of the steel pipe 2. The length from the top to the bottom of the steel pipe 2 can be determined from the viewpoint of the rigidity of the steel walls 3, 33, 43, 53, 63, and 73. At this time, in a case where boiling, heaving, or circular slip is a concern when the length from the top to the bottom of the wall body 9 is the same extent as the length of the steel pipe 2,

the length from the top to the bottom of the wall body 9 may be set long with respect to the steel pipe 2.

[0096]

In the steel walls 3, 33, 43, 53, 63, and 73, when using the steel wall in, for example, cofferdam or the like, corner portions are formed at the steel walls 3, 33, 43, 53, 63, and 73.

Here, in a case of forming a corner portion in which the face on the side where the steel pipe 2 is disposed becomes the inside, the following problem arises.

[0097]

A description will be performed taking the steel wall 3 as an example. As illustrated in Fig. 15, if disposing the steel pipe 2 at each of the valley portions adjoining each other at a corner portion is attempted, the positions of portions of the steel pipes 2 overlap each other, so that it is not possible to dispose the steel pipes 2. Therefore, as illustrated in Fig. 16, a configuration is made in which the steel pipe 2 is disposed at only one of the valley portions adjoining each other across a corner. However, in this case, depending on the rigidity of the steel pipe 2 or the steel sheet pile 1, lack of rigidity is a concern. In addition, in Fig. 15 or the like, steel wall divided sections are made in which the respective portions of the steel walls 3 that are disposed approximately perpendicular to each other so as to interpose a corner portion therebetween are disposed in different directions. A state is created where these steel wall divided sections are connected to each other

at the corner portion.

[0098]

Therefore, for example, as illustrated in Fig. 17, a configuration may also be made in which a joint for steel pipe sheet pile 7 is provided at the steel pipe 2 of a corner portion and the joint 1d of the hat-shaped steel sheet pile 1 as a steel sheet pile is connected to the joint for steel pipe sheet pile 7.

The steel pipe 2, at which the steel sheet pile joint 7 is provided, is disposed in a valley portion of an end on the corner side of a constituent wall divided section on one side among two steel wall divided sections orthogonal to each other with a corner portion of a corner interposed therebetween. The hat-shaped steel sheet pile 1 in which the joint 1c is engaged with the steel sheet pile joint 7 of the steel pipe 2 is the hat-shaped steel sheet pile 1 on the side nearest the corner of the steel wall divided section on the other side.

By passing the portion on the arm 1c side of the joint 1d of the hat-shaped steel sheet pile 1 up and down through a slit of the joint for steel pipe sheet pile 7 of the steel pipe 2, a state is created where the joint for steel pipe sheet pile 7 of the steel pipe 2 and the hat-shaped steel sheet pile 1 are connected.

[0099]

Further, as another configuration of the corner portion, for example, as illustrated in Fig. 18, a structure may also be used in which a joint section 8 composed of the arm 1c of

the hat-shaped steel sheet pile 1 and the joint 1d of a leading end of the arm 1c is welded to the steel pipe 2 which is disposed in a valley portion of an end on the corner side of a wall body section on one side.

A configuration is made in which the joint 1d of the hat-shaped steel sheet pile 1 of an end on the corner side of the wall body section on the other side orthogonal to the above-described wall body section on one side is connected to the joint section 8 of the steel pipe 2.

The joint section 8 may also be made, for example, by cutting a portion (the arm 1c and the joint 1d) of the hat-shaped steel sheet pile 1 and welding the portion to the steel pipe 2. Further, it is preferable that a configuration be made in which the joint section 8 of the steel pipe 2 and the arm 1c and the joint 1d of the hat-shaped steel sheet pile 1 which is connected to the joint section 8 are disposed approximately linearly.

[0100]

Further, as still another configuration of the corner portion, for example, as illustrated in Fig. 19, joint pipes 7 (tubular joints) are provided at both the steel pipes 2, each of which is disposed in a valley portion on the side nearest the corner of each of two wall body sections constituting a corner portion. Then, a configuration may also be such that the joint pipes 7 are connected to each other.

In the above-described three configurations of the corner portion, the corner portions of all the constituent walls 3 are

connected by a joint and also shift does not occur in a normal direction. Further, the steel pipe 2 is disposed at the corner portion. In addition to this, since the steel pipes 2 adjoining the steel pipe 2 are respectively disposed closely in two directions perpendicular to each other, it is possible to secure rigidity even at the corner portion.

[0101]

In a case of using the joint pipe 7, by filling the inside sides of the joint pipes 7 with mortar after connection, it is possible to secure water stopping performance. In this case, since the filling of mortar is performed only at the corner portion, even if the filling of mortar is performed, an increase in labor or costs can be suppressed.

In addition, the joint which is provided at the steel pipe 2 is not limited to the annular joint for steel pipe 7, and as described above, the joint of the steel sheet pile may also be used, or joints having other joint structures may also be used, and in short, it is acceptable if a structure is made in which the steel pipes 2 or the steel pipe 2 and the steel sheet pile can be connected to each other by the joint.

Reference Signs List

[0102]

- 1: hat-shaped steel sheet pile (steel sheet pile)
- 2: steel pipe
- 3: steel wall
- 5: drilling range
- 6: existing steel sheet pile wall

11: construction apparatus using an earth auger
14: auger screw (drilling shaft)
31: Z-shaped steel sheet pile (steel sheet pile)
33: steel wall
35: drilling range
41: U-shaped steel sheet pile (steel sheet pile)
43: steel wall
45: drilling range
53: steel wall
55: drilling range
63: steel wall
65: drilling range
73: steel wall
75: drilling range
83: steel wall

CLAIMS

1. A steel wall comprising:
a plurality of steel sheet piles which is connected by joints so as to provide a wall body; and
steel pipes which are in contact with all or some of the steel sheet piles of the wall body with a longitudinal direction of each steel pipe following a longitudinal direction of the steel sheet pile,
wherein the wall body is formed approximately in a wavelike fashion in which a peak and a valley are repeated; and
the steel pipe enters a valley portion of the wall body and is in contact with the steel sheet pile.
2. The steel wall according to claim 1, wherein positional shift in the longitudinal direction between the steel sheet pile and the steel pipe is regulated at a portion where the steel sheet pile and the steel pipe are in contact with each other.
3. The steel wall according to claim 1, wherein positional shift in the longitudinal direction between the steel sheet pile and the steel pipe is allowed at a portion where the steel sheet pile and the steel pipe are in contact with each other.
4. The steel wall according to any one of claims 1 to 3, wherein the steel pipe is disposed on the face on one side or both of the faces of the wall body.
5. The steel wall according to any one of claims 1 to 4, wherein the steel pipes are continuously or discretely provided in a plurality of valley portions which are continuously formed side by side in the face on one side of the wall body.

6. A steel wall comprising:

a plurality of steel sheet piles which is connected by joints so as to provide a wall body; and

steel pipes which are in contact with all or some of the steel sheet piles of the wall body with a longitudinal direction of each steel pipe following a longitudinal direction of the steel sheet pile,

wherein the wall body is formed approximately in a wavelike fashion in which a peak and a valley are repeated, and

the steel pipe is in contact with the steel sheet pile on the peak portion side of the wall body.

7. The steel wall according to claim 6, wherein the steel pipes are continuously or discretely provided at a plurality of peak portions which are continuously formed side by side in the face on one side of the wall body.

8. The steel wall according to any one of claims 1 to 7, wherein the lengths in the longitudinal directions of the steel sheet pile and the steel pipe are different from each other.

9. The steel wall according to any one of claims 1 to 8, comprising:

at least two steel wall divided sections, each of which includes the wall body and the steel pipe that comes into contact with the wall body and in which extending directions are different from each other,

wherein end portions of the two steel wall divided sections confront each other, so that a corner portion is provided,

a joint is provided at the steel pipe which is disposed at an end portion on the corner portion side of the steel wall divided section on one side among the two steel wall divided sections, and

the joint of the steel pipe and a joint of the steel sheet pile of an end portion on the corner portion side of the steel wall divided section on the other side are connected to each other.

10. The steel wall according to any one of claims 1 to 8, comprising:

at least two steel wall divided sections, each of which includes the wall body and the steel pipe that comes into contact with the wall body and in which extending directions are different from each other,

wherein end portions of the two steel wall divided sections confront each other, so that a corner portion is provided,

joints are provided at the steel pipes which are respectively disposed at end portions on the corner portion sides of the two steel wall divided sections, and

the joints are connected to each other.

11. A construction method for a steel wall in which a plurality of steel sheet piles is connected by joints, so that an approximately wavelike wall body in which a peak and a valley are repeated is provided, and steel pipes are in contact with all or some of the steel sheet piles of the wall body with a longitudinal direction of each steel pipe following a

longitudinal direction of the steel sheet pile, the construction method comprising:

making a combination steel sheet pile by joining the steel pipe and the steel sheet pile with which the steel pipe comes into contact, over the entire length of a mutual contact portion or joining the steel pipe and the steel sheet pile at a portion of the contact portion, before driving; and

inserting a drilling shaft of a drilling device into the steel pipe of the combination steel sheet pile and then driving the combination steel sheet pile while drilling the ground in a range wider than the diameter of the steel pipe under the steel pipe by the drilling device,

wherein the steel pipe of the combination steel sheet pile enters a valley portion of the wall body and is in contact with the steel sheet pile or the steel pipe is in contact with the steel sheet pile on the peak portion side of the wall body.

12. A construction method for a steel wall in which a plurality of steel sheet piles is connected by joints, so that a wall body is provided, and steel pipes are in contact with all or some of the steel sheet piles of the wall body with a longitudinal direction of each steel pipe following a longitudinal direction of the steel sheet pile, the construction method comprising:

inserting a drilling shaft of a drilling device into the steel pipe and then driving the steel pipe while drilling the ground in a range wider than the diameter of the steel pipe under the steel pipe by the drilling device; and subsequently, driving the steel sheet pile which comes into contact with the steel

pipe.

13. A construction method for a steel wall in which a plurality of steel sheet piles is connected by joints, so that an approximately wavelike wall body in which a peak and a valley are repeated is provided, steel pipes are in contact with all or some of the steel sheet piles of the wall body with a longitudinal direction of each steel pipe following a longitudinal direction of the steel sheet pile, and the steel pipe enters a valley portion of the wall body and is in contact with the steel sheet pile or the steel pipe is in contact with the steel sheet pile on the peak portion side of the wall body the construction method comprising:

drilling the ground in a range wider than the diameter of the steel pipe by a drilling device; and driving the steel sheet pile and the steel pipe in the drilled range.

14. A construction method for a steel wall in which a plurality of steel sheet piles is connected by joints, so that a wall body is provided, and steel pipes are in contact with all or some of the steel sheet piles of the wall body with a longitudinal direction of each steel pipe following a longitudinal direction of the steel sheet pile, the construction method comprising:

driving the steel pipe while making the steel pipe follow the wall body installed already.

15. A construction method for a steel wall in which a plurality of steel sheet piles is connected by joints, so that an approximately wavelike wall body in which a peak and a valley are repeated is provided, the steel pipes are provided at a

plurality of valley portions or peak portions formed on the face on one side of the wall body, and the steel pipe is in contact with the steel sheet pile with a longitudinal direction thereof following a longitudinal direction of the steel sheet pile, the construction method comprising:

driving the steel pipe by using a hydraulic press-in construction method or a rotary press-in construction method.