

DESCRIPTION

5 **Title of the Invention:**
JOINT MECHANISM AND CONNECTION METHOD FOR STEEL
PIPE

Technical Field

10 [0001]

The present invention relates to a joint mechanism and a connection method for a steel pipe.

Background Art

15 [0002]

For forming a foundation pipe, a soil retaining sheet pile for a structure, an anti-landslide pile, a pier post, etc., a steel pipe pile is employed as an example of a steel pipe. In order to reach an inside of a support layer which is a solid ground present under a soft ground, a long steel pipe is required. However, for the sake of convenience of manufacture, transport etc., it has been practiced to carry a steel pipe pile manufactured in a factory and having a length ranging from a few meters to a few tens of meters to a site of its installment and to connect a plurality of such steel pipe piles vertically to each other one after another on the site to form an assembly having a required length.

25 [0003]

As a mechanism for connecting steel pipe piles as above, Patent Document 1 proposes a machine-based joint mechanism.

[0004]

30 With this joint mechanism, an inward circumferential groove of an outer fitting member and an outward circumferential groove of an inner fitting member are formed in advance to have a same groove width. Then, the inward circumferential groove and the outward circumferential groove are brought into opposition to each other when the outer fitting member and the inner fitting member are fitted to each other, and then a key member incorporated within the inward

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circumferential groove is pushed out toward the outward circumferential groove to realize fitting across and between the inward circumferential groove and the outward circumferential groove. As a result, a pair of steel pipe piles are connected not to be movable relative to each other along a longitudinal direction of these steel pipe piles.

Background Art Document

[Patent Document]

[0005]

10 [Patent Document 1] Japanese Patent No. 3158081

Summary of the Invention

Problem to be Solved by Invention

[0006]

15 However, the above-described arrangement wherein a key member is incorporated in advance within the inward circumferential groove to be pushed out toward the outward circumferential groove at the time of connection tends to be complicated. Further, as the inward circumferential groove needs to be formed with a groove width capable of accommodating the key member entirely, the thickness of the outward fitting member is increased correspondingly.

[0007]

20 The present invention has been made in view of the above-described state of the art and its object is to simplify an arrangement for connecting a pair of steel pipes and to achieve cost reduction also.

[Solution]

[0008]

30 According to a first characterizing feature of a joint mechanism relating to the present invention, a joint mechanism for a steel pipe comprises:

- a first inner joint provided at one end of one steel pipe;
- a second inner joint provided at the other end of the other steel pipe;
- 35 an outer joint disposed circumferentially between and across the

first inner joint and the second inner joint for connecting a pair of the steel pipes to each other when the first inner joint of one steel pipe is placed adjacent the second inner joint of the other steel pipe;

5 a key member for engaging the first inner joint with the outer joint and also engaging the second inner joint with the outer joint, thereby to prevent relative movement between the pair of steel pipes in a longitudinal direction of these steel pipes;

10 an outward circumferential groove provided respectively in an outer circumference of the first inner joint and an outer circumference of the second inner joint;

an inward circumferential groove provided in an inner circumference of the outer joint in opposition to the outward circumferential grooves provided in the outer circumferences of the first inner joint and the second inner joint respectively; and

15 the outer joint includes an opening portion for inserting the key member from an outer circumference of the outer joint into a key groove constituted of the outward circumferential groove and the inward circumferential groove.

[0009]

20 When the first inner joint provided at one end of one steel pipe and the second inner joint provided at the other end of the other steel pipe are placed adjacent each other and the outer joint is placed circumferentially across and between these first inner joint and second inner joint, through the opening portion formed in the outer joint, the key member can be disposed from the outer circumferential face of the outer joint into the key grove constituted of the outward circumferential groove and the inward circumferential groove.

25 Accordingly, there is no need for providing such arrangement provided by the conventional joint mechanism in which a key member is incorporated in advance within the inward circumferential groove. Consequently, the thickness of the outer joint can be reduced and material cost can be reduced correspondingly. Moreover, as the first inner joint and the second inner joint can be provided with an identical shape, reduction of processing cost can be realized also.

35 [0010]

According to a second characterizing feature of the present

invention, the key member comprises a plurality of split key members each constituting a portion of a circle, and a closing member having a function of the split key member and a function of closing the opening portion.

5 [0011]

At the opening portion, there is disposed the closing member having a function similar to the split key member of preventing relative movement between the pair of steel pipes in the longitudinal direction of these steel pipes. With this, it is possible to removal of the split key members disposed in the key groove through the opening portion to the outside.

[0012]

According to a third characterizing feature of the present invention, the outer joint comprises a plurality of unit members disposed side by side around the first inner joint and the second inner joint.

[0013]

If the outer joint is comprised of a plurality of unit members of a size allowing hand pickup thereof by a worker, a lifting operation by a machine such as a crane can be omitted, so that work efficiency for steel pipe connection can be improved.

[0014]

According to a fourth characterizing feature of the present invention, the plurality of unit members include an opening unit member having the opening portion and a standard unit member not having the opening portion.

[0015]

With the above, the opening unit member having the opening portion allowing insertion of the key member can be disposed at a desired position. That is, working efficiency can be improved in the respect of the possibility of desired setting of the opening portion used for insertion of the key member into the key groove, in accordance with a situation of the work site, such as a working space.

[0016]

According to a fifth characterizing feature of the present invention, the plurality of unit members include a reference unit member to be disposed circumferentially across and between the first

inner joint and the second inner joint when the first inner joint and the second inner joint are placed in contact with each other and an extended unit member to be disposed circumferentially across and between the first inner joint and the second inner joint when the first inner joint and the second inner joint are placed apart from each other.

[0017]

By constituting one part of the outer joint disposed circumferentially across and between the first inner joint and the second inner joint of the reference unit member and constituting the other part thereof of the extended unit member, it is possible to tilt the axis of one steel pipe and the axis of the other steel pipe.

[0018]

Namely, when steel pipe piles are to be connected to each other and driven into the ground, if the posture of a steel pipe firstly driven into the ground is deviated from a predetermined posture, e.g. a perpendicular posture, the steel pipes can be connected to each other, with tilting the axes thereof in such a manner as to correct the posture of the subsequent steel pipe to be connected to the firstly driven steel pipe to a predetermined posture, e.g. to a posture near a perpendicular posture.

[0019]

According to a sixth characterizing feature of the present invention:

each of the first inner joint and the second inner joint includes a base portion and an inner fitting portion extending continuously from the base portion;

an annular engaging sunk portion is provided annularly in an end face of the base portion facing the inner fitting portion;

the outward circumferential groove is provided annularly in an outer circumference of the inner fitting portion;

at upper and lower end portions of the reference unit member and the extended unit member respectively, there are provided a pair of engaging projecting portions engageable with the engaging portion when the reference unit member and the extended unit member are disposed circumferentially across and around the first inner joint and the second inner joint;

in an inner circumference of the reference unit member and the extended unit member respectively, a pair of the inward circumferential grooves are provided in opposition to a pair of the outward circumferential grooves;

5 a distance between the pair of inward circumferential grooves of the reference unit member is set equal to a distance between the pair of outward circumferential grooves when the first inner joint and the second inner joint are placed in contact with each other; and

10 a distance between the pair of inward circumferential grooves of the extended unit member is set equal to a distance between the pair of outward circumferential grooves when the first inner joint and the second inner joint are placed apart from each other.

[0020]

15 When the reference unit member and the extended unit member are disposed circumferentially across and between the first inner joint and the second inner joint, engagement is established between the engaging projecting portion and the engaging sunk portion, thereby to prevent detachment of the reference unit member and the extended unit member to the outside. Even when the axis of one steel pipe and the axis of the other steel pipe are tilted, the key member can still be inserted into the key groove.

[0021]

20 According to a seventh characterizing feature of the present invention, at least the outer joint comprises a straight seam steel pipe; and

25 the bonding portion is disposed at a position not overlapped with the opening portion in the outer joint.

[0022]

30 A straight seam steel pipe is manufactured by a sheet rolling technique. The sheet rolling technique is inexpensive in comparison with other techniques such as ring forging technique employed for manufacturing a seamless steel pipe, with the cost thereof being much less than that of the latter techniques. By constituting the outer joint of a straight seam steel pipe respectively, the outer joint can be obtained

35 inexpensively.

On the other hand, the straight seam steel pipe has the bonding

portion along its longitudinal direction, so that uniformity in the circumferential direction cannot be obtained, thus suffering the disadvantage of lower rigidity at its circumferential portion, hence being less resistant against an inner pressure or a torsion.

5 Further, the circumferential portion of the outer joint where the opening portion is formed, due to the smaller amount of forming material at this portion, has lower rigidity than the other circumferential portion.

10 For this reason, the opening portion is provided in the outer joint in such a manner that the opening portion is disposed at a position different from the position across and between the bonding portion included in the straight seam steel pipe.

15 Therefore, by the arrangement of avoiding overlap between the circumferential portion formed with the opening portion and the bonding portion in the longitudinal direction of the straight seam steel pipe, it is possible to reduce the disadvantageous effect of reduced rigidity in one portion of the first inner joint and the second inner joint as compared with the other portion thereof.

20 **[0023]** According to an eighth characterizing feature of the present invention:

at least the outer joint comprises a straight seam steel pipe; and a bonding portion included in the straight seam steel pipe is disposed at a position not overlapped with a position of fixing the closing member in the inner joint.

25 **[0024]**

30 A straight seam steel pipe is manufactured by a sheet rolling technique. The sheet rolling technique is inexpensive in comparison with other techniques such as ring forging technique employed for manufacturing a seamless steel pipe, with the cost thereof being much less than that of the latter techniques. By constituting the outer joint of a straight seam steel pipe respectively, the outer joint can be obtained inexpensively.

35 On the other hand, the straight seam steel pipe has the bonding portion along its longitudinal direction, so that uniformity in the circumferential direction cannot be obtained, thus suffering the disadvantage of lower rigidity at its circumferential portion, hence

being less resistant against an inner pressure or a torsion.

Further, at the position of the inner joint for fixing the closing member, there is formed e.g. a bolt hole for fixing a bolt as a fixing arrangement, and the circumferential portion of this position, due to the less amount of material used, has lower rigidity as compared with the other circumferential portion.

Then, at the position in the inner joint for fixing the closing member is provided in this inner joint at a position not across the bonding portion included in the straight seamless steel pipe.

With the above arrangement of avoiding overlap between the position in the inner joint for fixing the closing member with the bonding portion in the longitudinal direction of the straight seam steel pipe, it becomes possible to avoid excessive reduction in the rigidity in a portion of the inner joint as compared with the remaining portion.

[0025]

According to a ninth characterizing feature of the present invention:

at least the outer joint comprises a straight seam steel pipe; and

a bonding portion included in the straight seam steel pipe is disposed at a position not overlapped with a counter bore portion formed in the inner joint or with a counter bore portion formed in the outer joint constituting a rotation preventing key groove.

[0026]

A straight seam steel pipe is manufactured by a sheet rolling technique. The sheet rolling technique is inexpensive in comparison with other techniques such as ring forging technique employed for manufacturing a seamless steel pipe, with the cost thereof being much less than that of the latter techniques. By constituting the outer joint of a straight seam steel pipe respectively, the outer joint can be obtained inexpensively.

On the other hand, the straight seam steel pipe has the bonding portion along its longitudinal direction, so that uniformity in the circumferential direction cannot be obtained, thus suffering the disadvantage of lower rigidity at its circumferential portion, hence being less resistant against an inner pressure or a torsion.

Further, the circumferential portion where a counter bore portion

is formed in the inner joint or a counter bore portion is formed in the outer joint constituting a rotation preventing key groove, due to the less amount of material used therein, has lower rigidity as compared with the other circumferential portion.

5 Then, the counter bore portion formed in the inner joint and the counter bore portion formed in the outer joint constituting the rotation preventing key groove are provided in the inner joint and the outer joint respectively at such positions not across the bonding portion included in the straight steam steel pipe.

10 With the above arrangement of avoiding overlap in the longitudinal direction of the straight seam steel pipe between the circumferential portion where a counter bore portion is formed in the inner joint or a counter bore portion is formed in the outer joint constituting the rotation preventing key groove and the bonding portion,
15 it becomes possible to avoid excessive reduction in the rigidity in a portion of the inner joint as compared with the remaining portion.

[0027]

 According to a first characterizing feature of a connection method of the present invention, the connection method connecting a pair of steel
20 pipes to each other with using the joint mechanism having any one of the first through seventh characterizing features described above, the method comprises the steps of:

 disposing an outer joint circumferentially of a first inner joint provided at one one end of one steel pipe;

25 disposing the first inner joint and a second inner joint provided at the other end of the other steel pipe adjacent each other to insert the second inner joint to an inner face of the outer joint, thereby to dispose the outer joint across and between the first inner joint and the second inner joint;

30 inserting a key member for engaging the first inner joint with the outer joint and engaging the second inner joint with the outer joint to prevent relative movement between the pair of steel pipes in the longitudinal direction of these steel pipes through an opening portion provided in the outer joint from an outer circumferential face of the outer
35 joint into a key groove including an outward circumferential groove provided in an outer circumference of the first inner joint and the second

inner joint respectively and an inward circumferential groove provided in an inner circumference of the outer joint in opposition to the outward circumferential groove and then sliding the key member inserted into the key groove along a circumferential direction within the key groove, so that the key member is disposed at a predetermined position within the key groove, except for a portion of the key groove corresponding to the opening portion; and

closing the opening portion with using a closing member having a function of the key member and having also a function of closing the opening portion.

[0028]

According to a second characterizing feature of a connection method of the present invention, the connection method connecting a pair of steel pipes to each other with using the joint mechanism having any one of the fifth through seventh characterizing features described above, the method comprises the steps of:

disposing an outer joint circumferentially of a first inner joint provided at one end of one steel pipe;

disposing the first inner joint and a second inner joint provided at the other end of the other steel pipe adjacent each other to insert the second inner joint to an inner face of the outer joint, thereby to dispose the outer joint across and between the first inner joint and the second inner joint;

inserting a key member for engaging the first inner joint with the outer joint and engaging the second inner joint with the outer joint to prevent relative movement between the pair of steel pipes in the longitudinal direction of these steel pipes through an opening portion provided in the outer joint from an outer circumferential face of the outer joint into a key groove including an outward circumferential groove provided in an outer circumference of the first inner joint and the second inner joint respectively and an inward circumferential groove provided in an inner circumference of the outer joint in opposition to the outward circumferential groove and then sliding the key member inserted into the key groove along a circumferential direction within the key groove, so that the key member is disposed at a predetermined position within the key groove, except for a portion of the key groove corresponding to the

opening portion; and

closing the opening portion with using a closing member having a function of the key member and having also a function of closing the opening portion;

5 wherein the step of disposing the outer joint circumferentially includes a step of tilting an axis of the one steel pipe and an axis of the other steel pipe by constituting the outer joint disposed across and between the first inner joint and the second inner joint of a plurality of unit members one or some of which constitute the reference unit
10 members and the other of which constitute the extended unit members.

[Brief Description of the Drawings]

[0029]

 [Fig. 1] Fig. 1 is an explanatory view of a steel pipe and a joint
15 mechanism,

 [Fig. 2] Fig. 2 is a perspective view of an outer joint,

 [Fig. 3] Fig. 3 is an explanatory view regarding inner joints and the outer joint,

 [Fig. 4] Fig. 4 is an explanatory view regarding the inner joints
20 and the outer joint,

 [Fig. 5] Fig. 5 is an explanatory view regarding the inner joints and the outer joint,

 [Fig. 6] Fig. 6 is a side view in section regarding the inner joints and the outer joint,

25 [Fig. 7] Fig. 7 is an explanatory view regarding engagement by a key member,

 [Fig. 8] Fig. 8 is a side view in section regarding engagement by the key member,

 [Fig. 9] Fig. 9 is a plane view in section regarding engagement by
30 the key member,

 [Fig. 10] Fig. 10 is an explanatory view regarding a closing member

 [Fig. 11] Fig. 11 is a side view in section regarding the closing member,

35 [Fig. 12] Fig. 12 is a plane view in section regarding the closing member,

[Fig. 13] Fig. 13 is an explanatory view of a using method of a joint mechanism,

[Fig. 14] Fig. 14 is a perspective view of an outer joint according to a further embodiment,

5 [Fig. 15] Fig. 15 is a perspective view of an outer joint according to a further embodiment,

[Fig. 16] Fig. 16 is a plane view in section of principal portions of an outer joint according to a further embodiment,

10 [Fig. 17] Fig. 17 is a plane view in section of principal portions of an outer joint according to a further embodiment,

[Fig. 18] Fig. 18 is a perspective view of an outer joint according to a further embodiment,

[Fig. 19] Fig. 19 is a side view in section of principal portions of an outer joint according to a further embodiment,

15 [Fig. 20] Fig. 20 is a side view in section of principal portions of an outer joint according to a further embodiment,

[Fig. 21] Fig. 21 is a side view in section of principal portions of an outer joint according to a further embodiment, and

20 [Fig. 22] Fig. 22 is an explanatory view of a steel pipe joint mechanism according to a further embodiment.

[Embodiments]

[0030]

25 Next, a steel pipe joint mechanism and connection method according to the present invention will be described in details with reference to the accompanying drawings.

30 Fig. 1 shows a steel pipe pile 1, as an example of a steel pipe, which has a cylindrically shaped outer circumferential face and which is to be driven into a ground by means of a hydraulic hammer, a jacking machine, a rotary jacking machine, etc. Fig. 1 also shows a joint mechanism for connecting a pair of steel pipe piles 1 to each other along the longitudinal direction of these steel pipe piles 1. Incidentally, although all of the steel pipe piles 1 are of an identical construction, where there arises a need for explaining one steel pipe pile 1 in
35 distinction from the other steel pipe pile 1, reference numerals provided to respective components of one steel pipe pile 1 will be provided with an

subscript A, whereas reference numerals provided to respective components of the other steel pipe pile 1 will be provided with an subscript B, respectively.

[0031]

5 Each steel pipe pile 1 (1A, 1B) comprises a tubular body 2 (2A, 2B) and inner joints 10 having a generally cylindrical shape, formed of cast iron and welded coaxially to opposed ends of the tubular body 2 (2A, 2B).

[0032]

10 As shown in Fig. 1, the inner joint 10 includes a base portion 11 having a slightly larger outside diameter than an outside diameter of the tubular body 2 and an inner fitting portion 12 having a smaller outside diameter than the base portion 11, the inner fitting portion 12 extending continuously from the base portion 11. In the instant embodiment, the
15 outside diameter of the base portion 11 is about 18 mm larger than the outside diameter of the tubular body 2.

 In the outer circumference of the inner fitting portion 12, there is defined a single line of outward circumferential groove 13 for engagement of an annular key member 30 which will be described later
20 herein. In an end face of the base portion 11 facing the inner fitting portion 12 side, there is provided, in the form of a circular ring, an engaging sunk portion 14 for engagement of an engaging projecting portion 24 provided at an end portion of an outer joint 20 to be described later.

25 [0033]

 Incidentally, the inner joints 10 welded to the opposed ends of the tubular body 2 are of an identical construction, yet, reference numerals provided to the respective components of the inner joint 10 which is to be disposed on the lower side when the steel pipe pile 1 is driven into the
30 ground are provided with the subscript A, whereas reference numerals provided to the respective components of the inner joint 10 which is to be disposed on the upper side then are provided with the subscript B, respectively. That is, one of the pair of inner joints 10A, 10B constitutes “a first inner joint”, and the other thereof constitutes “a second inner
35 joint”. As the first inner joint and the second inner joint have the identical construction, manufacturing cost reduction is made possible as

compared with a case of providing them with different constructions.

[0034]

As shown in Fig. 1 and Fig. 2, the outer joint 20 is comprised of eight unit members 21 which are formed by splitting a cylindrical body formed of cast iron and having an outside diameter slightly larger than the outside diameter of the tubular body 2 and an inside diameter allowing fitting/insertion of the inner joint 10, into eight equal parts. In the instant embodiment, the outside diameter of the outer joint 20 is about 18 mm larger than the outside diameter of the tubular body 2.

[0035]

Incidentally, the splitting into eight equal parts described above is only exemplary. The number of the unit members 21 obtained by splitting can be smaller than or greater than eight. But, it is preferred that the size of the unit member 21 obtained by such splitting be such a size as allows hand lifting of this member by a worker. Alternatively, the unit members 21 could be manufactured also by bending separate iron plates one by one. However, with use of the above-described simple manufacturing method of splitting a straight seam steel pipe, manufacturing cost can be reduced as compared with the case of manufacturing them one by one.

[0036]

In the inner circumference of the outer joint 20 constituted of the eight unit members 21, two parallel lines of annular inward circumferential grooves 23 (23A, 23B) having a depth substantially same as a depth of outward circumferential grooves 13 (13A, 13B) provided in the inner joint 10A and the inner joint 10B respectively are provided at positions where these grooves 23 may be in opposition to the outward circumferential grooves 13 (13A, 13B) when the outer joint 20 is disposed circumferentially around inner fitting portions 12 (12A, 12B) of the inner joints 10 (10A, 10B).

[0037]

An annular space constituted of the outward circumferential groove 13 and the inward circumferential groove 23 when the outer joint 20 is disposed circumferentially of the inner joint 10 constitutes a key groove for engaging the key member 30.

[0038]

When, the key member 30 is engaged with this key groove, i.e. across and between the inward circumferential groove 13 and the inward circumferential groove 23, the inner joint 10A and the outer joint 20 and also the inner joint 10B and the outer joint 20 are engaged respectively with each other, whereby the pair of steel pipe piles 1A, 1B are connected to each other along the longitudinal direction of these steel pipe piles 1.

[0039]

Each unit member 21 has engaging projecting portions 24 (24A, 24B) formed at its upper and lower end portions thereof as shown. When the unit member 21 is disposed circumferentially of the inner joint 10, the engaging projecting portions 24 (24A, 24B) come into engagement with engaging sunk portions 14 (14A, 14B) of the inner joint 10, thus preventing detachment of the unit member 21 to the outside.

[0040]

Of the eight unit members 21, four unit members 21 respectively include two opening portions 22 (22A, 22B) for allowing a longitudinal groove portion of the outward circumferential groove 13 (13A, 13B) to face outwards along the entire width of the outward circumferential groove 13 (13A, 13B) in order to allow the key member 30 to be disposed in the key groove constituted of the outward circumferential groove 13 and the inward circumferential groove 23, when the outer joint 20 is disposed circumferentially of the inner joint 10. These unit members 21 constitute "an opening unit member 21A".

[0041]

Each opening portion 22 (22A, 22B) is provided in the form of a cut along the portion forming each inward circumferential groove 23 (23A, 23B) along the entire width of this inward circumferential groove 23 (23A, 23B).

[0042]

The key member 30 consisting essentially of the outward circumferential groove 13 and the inward circumferential groove 23 is inserted via the opening portion 22 (22A, 22B) from the outer circumferential face of the outer joint 20.

[0043]

The other four unit members 21, except for the absence of the opening portions 22 (22A, 22B) therein, are identical to the opening unit

members 21A. These unit members 21 constitute “standard unit members 21B”.

[0044]

In the instant embodiment, the opening unit members 21A and the standard unit members 21B four of which respectively are provided are disposed side by side in alternation around the inner joints 10, thus together constituting the cylindrical outer joint 20. The opening unit member 21A, due to the present of the opening portions 22 formed therein, has lower rigidity than the standard unit member 21B. For this reason, by disposing the opening unit members 21A and the standard unit members 21B side by side in alternation, there is realized uniformity of rigidity of the outer joint 20 as a whole.

[0045]

As shown in Fig. 1 and Fig. 12, the key member 30 is formed of a plurality of arcuate pieces fitting within the key groove and obtained by e.g. splitting an annular body into 16 (sixteen) equal parts.

However, of these sixteen arcuate pieces, 12 (twelve) of them are split key members 31 to be fitted in the key groove and functioning as the key members 30, whereas the other four of them constitute closing members 32 having the function of the key member 20 and having also the function of closing the opening portion 22.

In each single key groove, the twelve split key members 21 and the four closing members 32 are fitted, thus together constituting the annular key member 30.

[0046]

Each split key member 31 has its size along the longitudinal direction of the steel pipe pile 1 which size is slightly smaller than the size of the opening portion 22 in this direction and has also its size along the circumferential direction of the steel pipe pile 1 which size is slightly smaller than the size of the opening portion 22 in this circumferential direction and has also its size along the radial direction of the steel pipe pile 1 which size is slightly smaller than the size of the key groove, that is, the outward circumferential groove 13 and the inward circumferential groove 23 along this radial direction.

[0047]

Each closing member 32 has its size along the longitudinal

direction of the steel pipe pile 1 which size is slightly smaller than the size of the opening portion 22 in this direction and has also its size along the circumferential direction of the steel pipe pile 1 which size is slightly smaller than the size of the opening portion 22 in this circumferential direction and has also its size along the radial direction of the steel pipe pile 1 which size is approximately equal to the size of the outward circumferential groove 13 from the bottom face to the surface of the opening portion 22.

[0048]

Further, the closing member 32 is configured to be fixable to the inner joint 10 with using the bolt 33, after its insertion into the opening portion 22. Alternatively, the closing member 32 can be configured to be fixable to the outer joint 20.

[0049]

Further, at boundary portions of the outer circumferences of the inner joint 10 and the outer joint 20 respectively, there are provided rotation preventing keys for preventing relative movement in the circumferential direction between the inner joint 10A and the inner joint 10B connected to each other via the outer joint 20.

[0050]

Though not shown, the rotation preventing key is disposed across a rotation preventing key groove consisting of a counter boring portion formed in an outer circumferential face of the base portion 11 of the inner joint 10 and a counter boring portion formed in an outer circumferential face of the outer joint 20 in opposition to the above-mentioned counter boring portion. Incidentally, the sizes and the numbers of the rotation prevention key and the counter boring portions described above will be appropriately set according to an installment method for the steel pipe piles 1. The rotation preventing key may be formed integral with one of the inner joint 10 and the outer joint 20. In such case, the counter boring portion will be formed only in the other of the joints 10, 20.

[0051]

The arrangement for preventing circumferential relative movement between the inner joint 10A and the inner joint 20B is not limited to the above arrangement using the rotation preventing key. Alternatively, for instance, the arrangement may be an arrangement of

making a length of the engaging projecting portion 24 of at least one of the eight unit members 21 in the longitudinal direction of the steel pipe piles 1 different from a length in the same direction of the engaging portions 24 of the other unit members 21. In such case, the unit members

5 21 will provide the similar function to the rotation preventing key.
[0052]

Next, with reference to Figs. 3 through 12, there will be explained a connection method of the present invention for connecting a subsequent steel pipe pile 1B to a foregoing steel pipe pile 1 which has been driven firstly, in construction method of driving into the ground with using e.g. a hydraulic hammer.

10 [0053]

In this connection method of connecting the pair of steel pipe piles 1A, 1B, the above-described joint mechanism is employed.

15 Firstly, as shown in Fig. 1 and Fig. 3, the four opening unit members 21A and the four standard unit members 21B will be disposed side by side in alternation with engaging the respective engaging projecting portions 24A (24) with the engaging sunk portion 14A (14) of the inner joint 10A provided at the upper end of the firstly driven one steel pipe pile 1A, whereby the cylindrical outer joint 20 will be formed around the inner joint 10A, as illustrated in Fig. 4.

20 [0054]

Next, as shown in Fig. 5 and Fig. 6, relative to the steel pipe pile 1A, the other steel pipe pile 1B will be suspended, and the engaging projecting portions 24B (24) of the opening unit members 21A and the standard unit members 21B constituting the outer joint 20 will be engaged with the engaging sunk portion 14B (14) of the inner joint 10B, whereby the inner joints 10A, 10B of the pair of steel pipe piles 1A, 1B will be disposed at predetermined positions inside the outer joint 20.

25 [0055]

30 Next, as shown in Figs. 7 through 9, the split key member 31 will be inserted into the opening portion 22 of the opening unit member 21A. Then, the split key member 31 inserted into the opening portion 22 will be slid along the longitudinal direction of the key groove. And, the next split key member 31 will be inserted into the opening portion 22.

35 [0056]

Upon completion of insertion of a predetermined number of split key members 31, as shown in Figs. 10 through 12, the closing member 32 inserted into the opening portion 22 will be fixed with using the bolt 33, thus closing this opening portion 22.

5 [0057]

As described above, the pair of steel pipe piles 1A, 1B can be connected to each other so as not to be movable relative to each other in the longitudinal direction of the steel pipe piles 1.

[0058]

10 Lastly, the rotation preventing key will be disposed across the rotation preventing groove consisting of the counter bore portion formed in the outer circumferential face of the base portion 1 of the inner joint 10 in opposition to the counter bore portion formed in the outer circumferential face of the outer joint 20, whereby the pair of steel pipe
15 piles 1A, 1B are connected to each other not to be movable relative to each other in the circumferential direction of the steel pipe piles 1A also.

[0059]

Incidentally, the arrangement of constituting the outer joint 20 in the inventive joint mechanism of the plurality of unit members 21 achieves the following advantage in addition to the advantage of
20 manufacture cost reduction described above.

[0060]

The unit members 21 together constituting the outer joint 20 are formed by splitting a cylindrical body formed of cast steel into eight
25 equal pieces.

This unit member 21 can also be formed of a cylindrical body whose height along the longitudinal direction of the steel pipe piles 1 has a reference distance to be disposed across and between the inner joint 10A and the inner joint 10B when the inner joint 10A and the inner joint
30 10B are placed in contact with each other, or of a cylindrical body having a distance slightly longer than the above reference distance, e.g. longer by 0.5 mm approximately or of a cylindrical body having a distance longer by 1.0 mm approximately than the same. Incidentally, the unit member 21 formed of the cylindrical body having the above-described
35 reference distance constitutes the “reference unit member 21C”, whereas the unit member 21 formed of a cylindrical body having such longer

distance than the reference distance constitutes the “extended unit member 21D”. Meanwhile, the reference unit member 21C and the extended unit member 21D, if provided with the opening portion 22, will constitute also “the opening unit member 21A and will constitute the “standard unit member 21B” if not provided with the opening portion 22.
[0061]

At the upper and lower end portions of the extended unit member 21D, like the reference unit member 21C, there are provided engaging projecting portions 24A, 24B to come into engagement with the engaging sunk portions 14A, 14B of the inner joints 10, when the unit member 21 is disposed circumferentially of the inner joints 10. In the inner circumference of the extended unit member 21D, like the reference unit member 21C, there are formed two lines of annular inward circumferential grooves 23 (23A, 23B).

[0062]

The distance between the pair of inward circumferential grooves 23 (23A, 23B) of the reference unit member 21C is set to be equal to the distance between the pair of outward circumferential grooves 13 (13A, 13B, when the inner joint 10A and the inner joint 10B are placed in contact with each other.

The distance between the pair of inward circumferential grooves 23 (23A, 23B) of the extended unit member 21D is set to be equal to the distance between the pair of outward circumferential grooves 13 (13A, 13B, when the inner joint 10A and the inner joint 10B are placed apart from each other.

The distance between the pair of inward circumferential grooves 23 (23A, 23B) of the extended unit member 21D is 0.5 mm or 1.0 mm longer than the reference distance.

Namely, the distance between the inward circumferential grooves 23 (23A, 23B) in the extended unit member 21D is set longer than the distance between the inward circumferential grooves 23 (23A, 23B) in the reference unit member 21C. Incidentally, above described 0.5 mm and 1.0 mm are only exemplary, and actually any appropriate value will be set based on e.g. the diameter of the steel pipe pile 1 or dimensional tolerance thereof.

[0063]

If the outer joint 20 is formed of the reference unit members 21C, mutually opposing faces of the inner joint 10A of the steel pipe pile 1A and the inner joint 10B of the steel pipe pile 1B to be connected to each other will come into contact with each other.

5 On the other hand, if the outer joint 20 is formed of the extended unit members 21D having the length which is 0.5 mm longer than the reference distance, a gap of 0.5 mm will be formed between mutually opposing faces of the inner joint 10A of the steel pipe pile 1A and the inner joint 10B of the steel pipe pile 1B. Similarly, if the outer joint 20
10 is formed of the extended unit members 21D having the length which is 1.0 mm longer than the reference distance, a gap of 1.0 mm will be formed between mutually opposing faces of the inner joint 10A of the steel pipe pile 1A and the inner joint 10B of the steel pipe pile 1B.

[0064]

15 Then, if a group of outer joints 20 having different lengths in the longitudinal direction of the steel pipe pile 1 are prepared in stock, then, when there arises a situation of the posture of the firstly driven steel pipe pile 1A being deviated from the posture along the perpendicular direction, by using the reference unit member 21C and the extended unit
20 member 21D in combination to dispose e.g. the reference unit member 21C on the left side in the drawing and dispose the extended unit member 21D on the right side, the subsequent steel pipe pile 1B can be driven with a posture along the perpendicular direction, so that the steel pipe piles 1A, 1B can be connected to each other with correcting the
25 postures thereof along the perpendicular direction. Since the inward circumferential groove 23 (23A, 23B) has such a width with some “play” relative to the split key member 31, even when the steel pipe piles 1A, 1B are tilted relative to each other, the sliding movement of the split key member 31 along the longitudinal direction of the key groove will not be
30 interfered.

[0065]

In the foregoing embodiment, the opening portions 22 of the outer joint 20 are provided centrally of the opening unit member 21A. Instead, the opening portions 22, as shown in Fig 14 for instance, can be
35 formed across and between two adjacent unit members 21. Further alternatively as shown in Fig. 15, the opening portions 22 can be formed

with their upper and lower positions being different within the opening unit member 21A. With such arrangement of offsetting the forming positons of the opening portions 22 to the left/right side, it becomes possible to restrict reduction in the rigidness of the opening unit member
5 21A, as compared with a case of forming these opening portions 22 side by side vertically.

[0066]

In the foregoing embodiment, the splitting face of the unit member 21 constituting the outer joint 20 is formed flat. Instead, as
10 shown in Fig. 16 or 17, mutually opposing faces of adjacent unit members 21 may be provided with mutually engaging portions. In addition to the engagement between the engaging projecting portion 24 and the engaging sunk portion 14, mutual engagement between the unit members 21 adjacent each other will prevent detachment of the unit
15 members 21 to the outside.

[0067]

In the foregoing embodiment, the outer joint 20 is formed of the unit members 21 provided as eight equal parts. Instead, the outer joint 20 can be formed directly of a cylindrical body formed of cast steel as
20 shown in Fig. 18. In this case, as shown in Fig. 19, the inner joint 10 may omit the engaging sunk portion 14. However, during an operation of connecting the steel pipe pile 1A and the steel pipe pile 1B to each other, there will be needed a mechanism and a work for retaining the outer joint 20 relative to the circumference of the inner joints 10 until the
25 split key members 31 are inserted into the key groove.

[0068]

As a solution to the above problem, as shown in Fig. 20, an engaging step portion 15 for retaining the outer joint 20 to the circumference of the inner joint 10 may be provided in at least the inner
30 joint 10A of the steel pipe pile 1A.

[0069]

Further, as shown in Fig. 21, the outer circumferential face of the outer joint 20 may not be formed flush with the outer circumferential face of the base portion 11 of the inner joint 10.

[0070]

In the foregoing embodiment, respecting the inner joints 10 and

the outer joint 20, the configurations thereof obtained by working a cylindrical body formed of cast iron into the respective predetermined shape were explained. However, the invention is not limited to such embodiment. For instance, as shown in Fig. 22, the inner joints and the outer joint 20 can be formed of straight steam steel pipes. Incidentally, the tubular body 2 can be formed of a spiral steel pipe.

[0071]

Such straight steam steel pipe is manufactured generally by using a sheet rolling technique comprising forming a flat-plate like steel sheet into a cylindrical shape with using a huge roll or press and welding the bonding portion 3 from the inner and outer faces thereof. The sheet rolling technique is more inexpensive than other techniques such as the ring forging technique used for manufacturing a seamless steel pipe, with much lower costs than the costs required for the latter technique. By forming the inner joints 10 and the outer joint 20 of straight seam steel pipes, the inner joints 10 and the outer joint 20 can be obtained inexpensively.

[0072]

However, the straight seam steel pipe, due to the presence of the bonding portion 3 along its longitudinal direction, suffers non-uniformity in the circumferential direction unlike the seamless steel pipe, thus being unable to obtain uniform rigidity in the circumferential direction, hence being less resistant to inside pressure or torsion.

Further, in the opening unit member 21A and the standard unit member 21B constituting the outer joint 20, the circumferential portion of the opening unit member 21A where the opening portions 22 are formed has lower rigidity due to the smaller amount of material at the opening portions 22 as compared with the portion of the opening unit member 21A where such opening portions 22 are not formed or with the standard unit member 21B.

Therefore, the bonding portion 3 is provided in the standard unit member 21B.

By the arrangement of avoiding overlap between the circumferential portion formed with the opening portion 22 and the bonding portion 3 along the longitudinal direction of the straight seam steel pipe, it is possible to avoid excessive reduction in the rigidity of

one portion in the outer joint 20 as compared with the other portion thereof.

[0073]

Also, preferably, in the outer joint 20, the circumferential portion of the opening unit member 21A where the opening portion 22 is formed and the standard unit member 21B are disposed circumferentially relative to the inner joint 10A and the inner joint 10B, at positions different from the positions where the bonding portions 3 are formed in the inner joint 10A and the inner joint 10B.

By the arrangement of avoiding overlap between the circumferential portion of the outer joint 20 having lower rigidity and the circumferential portions of the inner joint 10A and the inner joint 10B having lower rigidity along the longitudinal direction of the straight seam steel pipe, it is possible to avoid excessive reduction in the rigidity of a certain portion of the joint mechanism as compared with the other portion thereof.

[0074]

Incidentally, preferably, the inner joint 10A and the inner joint 10B are configured to be connected such that the respective bonding portions 3 thereof are not overlapped along the longitudinal direction of the steel pipe piles 1.

[0075]

The joint mechanism according to the present invention may be used not only for the foundation piles for structure installment, but also for steel pipes such as soil retaining steel pipe sheet piles, anti-landslide piles, pier posts, etc.

[0076]

The foregoing embodiments are only specific non-limiting examples of the present invention. The description thereof does not limit the scope of the present invention in any way. The specific arrangements of the respective parts or portions thereof can be modified in any way appropriately as long as the intended advantageous functions/effects of the present invention can be achieved.

[Description of Reference Marks/Numerals]

[0077]

	1:	steel pipe pile (steel pipe)
	2:	tubular body
	10:	inner joint
	11:	base portion
5	12:	inner fitting portion
	13:	outward circumferential groove (engaged portion)
	14:	engaging sunk portion
	20:	outer joint
	21:	unit member
10	21A:	opening unit member
	21B:	standard unit member
	21C:	reference unit member
	21D:	extended unit member
	22:	opening portion
15	23:	inward circumferential groove
	24:	engaging projecting portion
	30:	key member
	31:	split key member
	32:	closing member
20	33:	bolt

CLAIMS

1. A joint mechanism for a steel pipe comprising:
a first inner joint provided at one end of one steel pipe;
5 a second inner joint provided at the other end of the other steel pipe;

an outer joint disposed circumferentially between and across the first inner joint and the second inner joint for connecting a pair of the steel pipes to each other when the first inner joint of one steel pipe is placed adjacent the second inner joint of the other steel pipe;

10 a key member for engaging the first inner joint with the outer joint and also engaging the second inner joint with the outer joint, thereby to prevent relative movement between the pair of steel pipes in a longitudinal direction of these steel pipes;

15 an outward circumferential groove provided respectively in an outer circumference of the first inner joint and an outer circumference of the second inner joint;

an inward circumferential groove provided in an inner circumference of the outer joint in opposition to the outward circumferential grooves provided in the outer circumferences of the first inner joint and the second inner joint respectively; and

20 the outer joint includes an opening portion for inserting the key member from an outer circumference of the outer joint into a key groove constituted of the outward circumferential groove and the inward circumferential groove.

2. The joint mechanism according to claim 1, wherein the key member comprises a plurality of split key members each constituting a portion of a circle, and a closing member having a function of the split key member and a function of closing the opening portion.

3. The joint mechanism according to claim 2, wherein the outer joint comprises a plurality of unit members disposed side by side around the first inner joint and the second inner joint.

35 4. The joint mechanism according to claim 3, wherein the

plurality of unit members include an opening unit member having the opening portion and a standard unit member not having the opening portion.

5 5. The joint mechanism according to claim 3 or 4, wherein:
the plurality of unit members include:

 a reference unit member to be disposed circumferentially across
and between the first inner joint and the second inner joint when the
first inner joint and the second inner joint are placed in contact with
10 each other; and

 an extended unit member to be disposed circumferentially across
and between the first inner joint and the second inner joint when the
first inner joint and the second inner joint are placed apart from each
other.

15 6. The joint mechanism according to claim 5, wherein:

 each of the first inner joint and the second inner joint includes a
base portion and an inner fitting portion extending continuously from
the base portion;

20 an annular engaging sunk portion is provided annularly in an
end face of the base portion facing the inner fitting portion;

 the outward circumferential groove is provided annularly in an
outer circumference of the inner fitting portion;

 at upper and lower end portions of the reference unit member
25 and the extended unit member respectively, there are provided a pair of
engaging projecting portions engageable with the engaging portion when
the reference unit member and the extended unit member are disposed
circumferentially across and around the first inner joint and the second
inner joint;

30 in an inner circumference of the reference unit member and the
extended unit member respectively, a pair of the inward circumferential
grooves are provided in opposition to a pair of the outward
circumferential grooves;

 a distance between the pair of inward circumferential grooves of
35 the reference unit member is set equal to a distance between the pair of
outward circumferential grooves when the first inner joint and the

second inner joint are placed in contact with each other; and

a distance between the pair of inward circumferential grooves of the extended unit member is set equal to a distance between the pair of outward circumferential grooves when the first inner joint and the second inner joint are placed apart from each other.

7. The joint mechanism according to any one of claims 1-6, wherein:

at least the outer joint comprises a straight seam steel pipe; and the bonding portion is disposed at a position not overlapped with the opening portion in the outer joint.

8. The joint mechanism according to any one of claims 1-6, wherein:

at least the outer joint comprises a straight seam steel pipe; and a bonding portion included in the straight seam steel pipe is disposed at a position not overlapped with a position of fixing the closing member in the inner joint.

9. The joint mechanism according to any one of claims 1-6, wherein:

at least the outer joint comprises a straight seam steel pipe; and a bonding portion included in the straight seam steel pipe is disposed at a position not overlapped with a counter bore portion formed in the inner joint or with a counter bore portion formed in the outer joint constituting a rotation preventing key groove.

10. A connection method connecting a pair of steel pipes to each other with using the joint mechanism according to any one of claims 1-9, the method comprising the steps of:

disposing an outer joint circumferentially of a first inner joint provided at one end of one steel pipe;

disposing the first inner joint and a second inner joint provided at the other end of the other steel pipe adjacent each other to insert the second inner joint to an inner face of the outer joint, thereby to dispose the outer joint across and between the first inner joint and the second

inner joint;

inserting a key member for engaging the first inner joint with the outer joint and engaging the second inner joint with the outer joint to prevent relative movement between the pair of steel pipes in the longitudinal direction of these steel pipes through an opening portion provided in the outer joint from an outer circumferential face of the outer joint into a key groove including an outward circumferential groove provided in an outer circumference of the first inner joint and the second inner joint respectively and an inward circumferential groove provided in an inner circumference of the outer joint in opposition to the outward circumferential groove and then sliding the key member inserted into the key groove along a circumferential direction within the key groove, so that the key member is disposed at a predetermined position within the key groove, except for a portion of the key groove corresponding to the opening portion; and

closing the opening portion with using a closing member having a function of the key member and having also a function of closing the opening portion.

11. A connection method connecting a pair of steel pipes to each other with using the joint mechanism according to any one of claims 5-9, the method comprising the steps of:

disposing an outer joint circumferentially of a first inner joint provided at one one end of one steel pipe;

disposing the first inner joint and a second inner joint provided at the other end of the other steel pipe adjacent each other to insert the second inner joint to an inner face of the outer joint, thereby to dispose the outer joint across and between the first inner joint and the second inner joint;

inserting a key member for engaging the first inner joint with the outer joint and engaging the second inner joint with the outer joint to prevent relative movement between the pair of steel pipes in the longitudinal direction of these steel pipes through an opening portion provided in the outer joint from an outer circumferential face of the outer joint into a key groove including an outward circumferential groove provided in an outer circumference of the first inner joint and the second

inner joint respectively and an inward circumferential groove provided in an inner circumference of the outer joint in opposition to the outward circumferential groove and then sliding the key member inserted into the key groove along a circumferential direction within the key groove, so
5 that the key member is disposed at a predetermined position within the key groove, except for a portion of the key groove corresponding to the opening portion; and

closing the opening portion with using a closing member having a function of the key member and having also a function of closing the
10 opening portion;

wherein the step of disposing the outer joint circumferentially includes a step of tilting an axis of the one steel pipe and an axis of the other steel pipe by constituting the outer joint disposed across and between the first inner joint and the second inner joint of a plurality of
15 unit members one or some of which constitute the reference unit members and the other of which constitute the extended unit members.