member-side projections 60. The steel member-side projections 60 fit together with the coupling-side grooves 52 in the spaces between the plural coupling-side projections 50.

[0035] As illustrated in Fig. 11, the outside face 60b on the side of each steel member-side projection 60 that faces away from the vertical joint location 3 configuring the boundary between joined steel sheet piles 2 is a steel member-side inclined face, being inclined with respect to the member-axis-orthogonal direction X, this being the projection direction. Moreover, the inside face 60a on the side of each steel member-side projection 60 closer to the vertical joint location 3 extends along the member-axis-orthogonal direction X. Regarding the steel member-side projections 60, the inside face 60a and the leading end face 60c of each steel member-side projection 60 are substantially orthogonal to each other, such that each steel member-side projection 60 has a profile that is tapered at one face.

[0036] The inside faces 50a on the side of each coupling-side projection 50 closer to the vertical joint location 3 that configures the boundary between joined steel sheet piles 2 is a coupling-side inclined face inclined with respect to the member-axis-orthogonal direction X, this being the projection direction, and opposes the outside face 60b of the corresponding steel member-side projection 60. The outside face 50b on the side of each coupling-side projection 50 on the side facing away from the vertical joint location 3 extends along the member-axis-orthogonal direction X. The outside face 50b and the leading end face 50c of each coupling-side projection 50 are substantially orthogonal to each other, such that each coupling-side projection 50 has a profile that is tapered at one face.

[0037] As illustrated in the modified examples in Fig. 12 and Fig. 13, both member-axial direction Y-side faces 50a, 50b of the coupling-side projections 50, and both member-axial direction Y-side faces 60a, 60b and the steel member-side projections 60 may be inclined, thereby configuring profiles that are tapered on both faces.

[0038] In the coupling-side projections 50 and the steel member-side projections 60 illustrated in the example of Fig. 12, the inside faces 50a and the outside faces 50b of the coupling-side projections 50 are inclined in different directions to each other, and the outside faces 60b and the inside faces 60a of the steel member-side projections 60 are inclined in different directions to each other.

[0039] As illustrated in Fig. 11 and Fig. 12, in the coupling-side projections 50 and the steel member-side projections 60, the leading end face 50c of each coupling-side projections 50 is longer in the member-axial direction Y than the flat plate 51 side of the coupling-side projection 50. Moreover, the leading end face 60c of each steel member-side projection 60 is longer in the member-axial direction Y than the end portion side face 31 side of the steel member-side projection 60. In the examples of Fig. 11 and Fig. 12, the coupling-side

projections 60 apart from each other in the member-axis-orthogonal direction X, the inside faces 50a of the coupling-side projections 50 and the outside faces 60b of the steel member-side projections 60 adopt a coupled state abutting and pressing against each other.

[0048] As illustrated in Fig. 14, predetermined gaps G are formed between the coupling-side projections 50 and the steel member-side projections 60 by spacing the coupling-side projections 50 and the steel member-side projections 60 apart from each other prior to being moved by the shaft members 41. Thus, in a state in which the coupling-side projections 50 are fitted together with the steel member-side grooves 62, and the steel member-side projections 60 are fitted together with the coupling-side grooves 52, at least the inside faces 50a of the coupling-side projections 50 and the outside faces 60b of the steel member-side projections 60 are spaced apart from each other in the member-axial direction Y.

[0049] As illustrated in Fig. 15, the fixing members 4 move the coupling member 5 in the member-axis-orthogonal direction X, and the inside faces 50a of the coupling member 5 are pressed against the opposing inside faces 60a of the steel member-side projections 60 in a state in which a member-axis-orthogonal direction X gap SP is formed between the flat plate 51 of the coupling member 5 and the steel member-side projections 60.

[0050] The fixing members 4 principally employ the shaft members 41 that pass through the coupling member 5 and abut the steel member-side projections 60 or the end portion side faces 31 of the steel sheet piles 2. The shaft members 41 may employ bolts that are passed through the coupling member 5 and screwed into the threaded holes 40, or as other examples, screws, tacks, or the like may be employed such that leading end portions 41a of the bolts or the like abut the steel member-side projections 60 or the like.

[0051] In cases in which the threaded holes 40 are formed opening into the coupling-side grooves 52 of the coupling member 5, the leading end portions 41a of the bolts or the like configuring the shaft members 41 abut the steel member-side projections 60. As another example of the shaft members 41, as illustrated in Fig. 16, in cases in which the threaded holes 40 are formed through the coupling-side projections 50 of the coupling member 5, and the steel member-side projections 60 are provided directly to the end portions 30 of the steel sheet piles 2, the leading end portions 41a of the bolts or the like may abut the end portion side faces 31 of the steel sheet piles 2.

[0052] Moreover, as illustrated in Fig. 17, as another example of the shaft members 41, in cases in which the threaded holes 40 are formed through the coupling-side projections 50 of the coupling member 5, and the plate shaped member 6 integrally formed with the steel member-side projections 60 is attached to the end portions 30 of the steel sheet piles 2, the leading end portions 41a of the bolts or the like may abut the plate shaped member 6.

[0053] As illustrated in Fig. 18, the fixing members 4 may employ shaft members 41 that pass through the end portions 30 of the steel sheet piles 2 and abut the coupling member 5. The shaft members 41 may employ bolts that are passed through the end portions 30 of the steel sheet piles 2 by being screwed into threaded holes 40, or as other examples, screws, tacks, or the like may be employed such that the leading end portions 41a of the bolts or the like abut the coupling member 5.

[0054] As illustrated in Fig. 18, regarding the shaft members 41, in cases in which the steel member-side projections 60 are provided directly to the end portions 30 of the steel sheet piles 2, the threaded holes 40 are formed in the end portions 30 of the steel sheet piles 2 at portions corresponding to the steel member-side grooves 62. The leading end portions 41a of the bolts or the like screwed into the threaded holes 40 abut the coupling-side projections 50 of the coupling member 5.

[0055] As illustrated in Fig. 19, in cases in which the threaded holes 40 are also formed in the plate shaped member 6 attached to the end portions 30 of the steel sheet piles 2, the shaft members 41 may employ bolts or the like that pass through the end portions 30 of the steel sheet piles 2 and through the plate shaped member 6 in order to abut the coupling member 5.

[0056] As illustrated in Fig. 14, immediately after the coupling-side projections 50 and the steel member-side projections 60 have been fitted together, the leading end portions 41a of the bolts or the like configuring the shaft members 41 adopt a state abutting the steel member-side projections 60 or the like. Namely, the bolts or the like configuring the shaft members 41 screwed into the threaded holes 40 in the coupling member 5 are screwed in as illustrated in Fig. 15.

[0057] When this is performed, a reaction force acts on the shaft members 41 as the bolts or the like, of which the leading end portions 41a abut the steel member-side projections 60 or the like, are twisted in, such that as illustrated in Fig. 15 to Fig. 19, the coupling member 5 is moved in the member-axis-orthogonal direction X, toward a direction away from the end portion side faces 31 of the steel sheet piles 2.

[0058] As illustrated in the modified examples of Fig. 20 and Fig. 21, the fixing members 4 may employ a wedge member 42 that moves the coupling member 5 in the member-axis-orthogonal direction X by being interposed between the coupling member 5 and the end portion side face 31 of a steel sheet pile 2. In the present exemplary embodiment, explanation is given regarding an example in which the wedge member 42 is provided on one side in the member-axis-orthogonal direction X; however, the wedge members 42 may be provided on both sides of the coupling member 5 in the member-axis-orthogonal direction X.

[0059] The wedge member 42 is formed in a substantially wedge shape tapered so as to

on a direction away from the vertical joint location 3 function as stoppers that restrict the respective coupling-side projections 50 disposed in the steel member-side grooves 62 between the steel member-side projections 60 from detaching along the direction away from the vertical joint location 3.

[0073] The steel member-side projections 60 disposed on the direction away from the vertical joint location 3 refer to steel member-side projections 60 disposed on the direction away from the vertical joint location 3 as viewed from the respective steel member-side projection 60 pressed by the inside faces 50a of the coupling-side projections 50.

[0074] The stoppers do not only act as stoppers when the inside faces 60a of the steel member-side projections 60 are in contact with the outside faces 50b of the coupling-side projections 50. For example, even when the inside faces 60a of the steel member-side projections 60 are spaced apart from the outside faces 50b of the coupling-side projections 50, a configuration capable of contacting the coupling-side projections 50 to restrict detachment if the coupling-side projections 50 collapse also configures a stopper.

[0075] Operation

In the steel member vertical joint structure 1, forming the gaps G where the coupling-side projections 50 are spaced apart from the steel member-side projections 60 enables the coupling-side projections 50 and the steel member-side projections 60 to be fitted together smoothly. The steel member vertical joint structure 1 thereby achieves a smooth fitting operation of the coupling-side projections 50 and the steel member-side projections 60, thereby facilitating an operation to couple together the plural steel sheet piles 2 in the member-axial direction Y, and enabling the task to be performed speedily.

[0076] In the steel member vertical joint structure 1, when embedding the plural steel sheet piles 2 in the ground 8 as illustrated in Fig. 1, or in a state in which the plural steel sheet piles 2 have been embedded in the ground 8, a bending load acts on the vertical joint location 3 where the plural steel sheet piles 2 are coupled together.

[0077] Moreover, the steel member vertical joint structure 1 is provided in order to secure adequate bending rigidity similar to that of the steel sheet piles 2 themselves at the vertical joint location 3, right from an initial state in which a load is received when the coupling member 5 is slid along so as to fit the coupling-side projections 50 and the steel member-side projections 60 together, as illustrated in Fig. 2.

[0078] As illustrated in Fig. 30, in the steel member vertical joint structure 1 applied with the present disclosure, a compression force P caused by bending load acts in the directions in which the plural steel sheet piles 2 approach each other in the member-axial direction Y. When this occurs, from the state immediately after the coupling-side projections 50 and the

respective leading end faces 50c, 60c.

[0101] As illustrated in Fig. 39, for example, the respective side faces 50a, 50b, 60a, 60b of the coupling-side projections 50 and the steel member-side projections 60 are respectively formed with profiles that are tapered on both faces so as to be inclined with respect to the member-axis-orthogonal direction X. In the coupling-side projections 50 and the steel member-side projections 60, the inside faces 50a and the outside faces 50b of the coupling-side projections 50 are inclined in different directions to each other, and the inside faces 60a and the outside faces 60b of the steel member-side projections 60 are inclined in different directions to each other.

[0102] Explanation has been given regarding a case in which in the coupling-side projections 50 and the steel member-side projections 60, the inside faces 50a of the coupling-side projections 50 and the outside faces 60b of the steel member-side projections 60 are inclined with respect to the member-axis-orthogonal direction X. However, there is no limitation thereto. For example, as illustrated in the modified example of Fig. 40, a profile tapered at one face may be applied, in which the inside faces 50a of the coupling-side projections 50 and the outside faces 60b of the steel member-side projections 60 are inclined with respect to the member-axis-orthogonal direction X.

[0103] As illustrated in Fig. 39 and Fig. 40, the shaft members 41 that are passed through the holes 5a provided in the coupling member 5 and are inserted into holes 60d provided through the steel member-side projections 60 are employed as the fixing members 4. Moreover, as illustrated in the modified example of Fig. 41, the shaft members 41 may be passed through holes 30b provided in the end portions 30 of the steel sheet piles 2, and also inserted into holes 50d provided in the coupling-side projections 50. Here, "inserted into" refers to a non-penetrating, partially inserted state.

[0104] Bolts or the like are employed as the shaft members 41. As illustrated in the modified example of Fig. 40, the shaft members 41 are screwed into the threaded holes 60d provided through the steel member-side projections 60, or as illustrated in Fig. 41, the shaft members 41 are screwed into the holes 50d provided in the coupling-side projections 50. Whether or not to form threads in the holes 5a provided in the coupling member 5, or in the holes 30b provided in the end portions 30 of the steel sheet piles 2, to be penetrated by bolts or the like is optional.

[0105] As illustrated in the modified example of Fig. 42, for example, the bolts or the like configuring the shaft members 41 may be passed through the holes 5a provided in the coupling member 5 and the holes 30b provided in the end portions 30 of the steel sheet piles 2, and be screwed together with nuts 43 or the like. Whether or not to from threads in the holes

[0136] Moreover, at least one of the inside faces 50a of the coupling-side projections 50 and the outside faces 60b of the steel member-side projections 60, or the outside faces 50b of the coupling-side projections 50 and the inside faces 60a of the steel member-side projections 60, run substantially parallel to each other. Accordingly, the contact surface area between the inside faces 50a of the coupling-side projections 50 and the outside faces 60b of the mutually adjacent steel member-side projections 60, or the contact surface area between the outside faces 50b of the coupling-side projections 50 and the mutually adjacent inside faces 60a of the steel member-side projections 60, can be increased. This thereby enables stress to be easily transferred between the coupling-side projections 50 and the steel member-side projections 60, enabling slippage as a result of alternating positive and negative bending loads to be further suppressed.

[0137] The inside faces 50a of the coupling-side projections 50 and the outside faces 60b of the steel member-side projections 60, or the outside faces 50b of the coupling-side projections 50 and the inside faces 60a of the steel member-side projections 60, run substantially parallel to each other. This thereby enables the volume of a space between the coupling-side projections 50 and the steel member-side projections 60 to be reduced. This thereby enables the contact surface area between the coupling-side projections 50 and the steel member-side projections 60 to be increased, facilitating load transmission.

[0138] Note that in the other exemplary embodiments of the steel member vertical joint structure 1 applied with the present disclosure, similarly to in the exemplary embodiment described earlier, the corner portions C of the coupling-side projections 50 and the steel member-side projections 60 may be applied with bevels by hot extrusion as required, as illustrated in Fig. 11 to Fig. 13, for example. Moreover, in the steel member vertical joint structure 1 applied with the present disclosure, hot extrusion can be performed easily at the corner portions C of the coupling-side projections 50 and the steel member-side projections 60, enabling processing of the coupling-side projections 50 and the steel member-side projections 60 to be made easier.

[0139] For example, the other exemplary embodiments of the steel member vertical joint structure 1 applied with the present disclosure may be employed to couple together plural steel members having a particular cross-section profile in the member-axial direction Y, similarly to in the exemplary embodiment described earlier.

[0140] Moreover, the steel sheet piles 2, such as the hat-shaped steel sheet piles 21 illustrated in Fig. 3 to Fig. 5 that have substantially hat-shaped cross-section profiles, have been employed as the steel members. However, there is no limitation thereto. For example, the H-beam steel 24 with a substantially H-shaped cross-section profile illustrated in Fig. 32,