A method of installing a solar panel mounting stand, the method including: forming an installation scheduled surface on which a plurality of piles are scheduled to be installed at a position deeper than an original ground surface, by digging the soil of an installation site of the solar panel mounting stand; installing the plurality of piles at the installation site by supporting the plurality of piles in a state of being relatively aligned, using a pile installation structure, and transporting the plurality of piles to the installation site of the solar panel mounting stand integrally with the pile installation structure, and placing the projecting portions on the installation scheduled surface corresponding to each projecting portion, and refilling the installation site with soil; removing the pile installation structure from the plurality of piles; and assembling a member as a framework of the solar panel mounting stand, using the plurality of piles.
FIG. 1
BACKGROUND

[0001] 1. Technical Field

[0002] The present invention relates to a method of installing a solar panel mounting stand for mounting solar power generation panels (hereinafter, referred to as “solar panels”) to generate electric power by means of sunlight, piles preferably used therefor, and solar panel mounting stands using the piles.

[0003] 2. Background Art

[0004] Recently, for the purpose of preventing a global warming, solar-power plants represented by “mega solar” have been constructed. In such solar-power plants, a large number of solar panel mounting stands are generally installed on the ground (on the soil), and a plurality of solar panels are mounted to each solar panel mounting stand.

[0005] A solar panel mounting stand uses, for example, a concrete foundation as a base. However, to use a concrete foundation as a base, cost and labor required for the installation of solar panel mounting stands are enormous.

[0006] Therefore, conventionally, instead of using a concrete foundation, for example, a technology described in patent document 1 has been known. According to this conventional technology, the lower end of the supporting leg of the solar panel mounting stand is equipped with a projecting portion, a posthole is created in the projecting portion, and a pile is driven into the ground through the posthole, thereby securely fixing the supporting leg into the ground.

PRIOR ART DOCUMENT

[0007] [Patent Document]


[0009] However, the previously mentioned conventional technology has the following problems:

[0010] That is, when installing solar panel mounting stands on the ground, the installation site is not always suitable for the installation of solar panel mounting stands.

[0011] Therefore, driving piles is sometimes difficult, for example, depending on the condition of the installation site. Specifically, when driving piles into the ground mainly composed of sand, the sand is tamped down during the piling process, which makes it difficult to drive piles deeply into the ground. The construction test conducted by the inventors of the present invention has proven that existing piles can be driven into the ground only 50-cm deep at a location having an N value, indicating the hardness of the sand ground of 10 or more. If a pile is not driven into the ground deep enough, when a lifting force is generated due to wind pressure imposed on the solar panels, the pile is easily removed. Furthermore, there is also a well-known pile designed such that the lower end of the pile is formed into a spiral-shaped portion, and the pile is screwed into the ground by using the spiral-shaped portion. However, the cost of this type of pile (hereinafter, referred to as “spiral pile”) is very high. Also, it takes a considerable amount of time and labor to drive spiral piles into the ground on site. Accordingly, material cost and construction cost required for the installation of solar panel mounting stands become very high, resulting in enormous total cost.

[0012] A main objective of the present invention is to provide a method of installing a solar panel mounting stand capable of significantly reducing the cost and labor to install solar panel mounting stands and also provide piles preferably used therefor.

[0013] Generally, it is common knowledge that piles used for civil engineering work are driven into the ground (spiral piles are screwed into the ground). The inventors of the present invention have devised the present invention as the result of an alternative way of thinking about piles beyond what is commonly known. That is, they disregarded the common understanding that “piles are driven into the ground” and conceived an idea of “placing piles” which means that piles are placed in the ground instead of being driven into the ground. However, when piles are used as supporting legs of a solar panel mounting stand, simply placing the piles in the ground will not withstand the lifting force generated by the application of wind pressure.

[0014] On the other hand, most of solar panels mounted to solar panel mounting stands are light enough so that one or more workers can manually lift the panels. Therefore, for example, even when a plurality of solar panels are mounted to one solar panel mounting stand, the load applied on the solar panel mounting stand is not so heavy.

[0015] In light of such circumstances, the inventors of the present invention have realized that a requirement for the solar panel mounting stand is to maintain the condition in which the solar panel mounting stand is securely fixed (immobilized) when a lifting force is generated due to wind pressure imposed on the solar panels, rather than the mechanical strength that supports the weight of the solar panels; and the inventors have focused attention on the piles used as supporting legs and devised the present invention. Hereinafter, preferred embodiments of the present invention will be described.

SUMMARY OF THE INVENTION

[0016] A first aspect of the present invention provides a method of installing a solar panel mounting stand using a pile as a supporting leg, the pile including: a columnar pile body, at least a lower end side thereof being buried in the soil when a solar panel mounting stand equipped with a plurality of supporting legs is installed on the ground; and a non-spiral-shaped projecting portion provided at a lower end of the pile body in a state projected in a radial direction of the pile body—and configured to inhibit a pull-off of the pile body under a load of the soil when the lower end side of the pile body is embedded in the soil.

[0017] the method including:

[0018] a first step of forming an installation scheduled surface on which the plurality of piles are scheduled to be installed at a position deeper than an original ground surface, by digging the soil of an installation site of the solar panel mounting stand;

[0019] a second step of installing the plurality of piles at the installation site by supporting the plurality of piles in a state of being relatively aligned, using a pile installation structure, and while maintaining such a supporting state, transporting the plurality of piles to the installation site of the solar panel mounting stand integrally with the pile installation structure, and placing the projecting portions, which are formed at lower ends of the plurality of piles, on the installation scheduled surface corresponding to each projecting portion, and thereafter refilling the installation site with soil,
a third step of removing the pile installation structure from the plurality of piles; and
a fourth step of assembling a member as a framework of the solar panel mounting stand, using the plurality of piles.
A second aspect of the present invention provides a solar panel mounting stand installation method according to the first aspect, wherein in the second step, the pile installation structure supporting the plurality of piles, is hoisted by a crane and transported to the installation site of the solar panel mounting stand.
A third aspect of the present invention provides a pile used as a supporting leg when a solar panel mounting stand equipped with a plurality of supporting legs is installed, including:
- a columnar pile body; and
- a non-spiral-shaped projecting portion provided at a lower end of the pile body in a state projected in a radial direction of the pile body,
wherein at least a lower end side of the pile body is buried in the soil when the solar panel mounting stand is installed; and
the projecting portion is configured to inhibit a pull-off of the pile body under a load of the soil when the lower end side of the pile body is embedded in the soil.
A fourth aspect of the present invention provides the pile according to the third aspect, wherein the projecting portion is formed into a plate-like shape having a larger external size than an outer diameter of the pile body.
5. The pile according to the third aspect or the fourth aspect, wherein a coupling portion is provided on an upper end of the pile body, for assembling a member as a framework of the upper panel mounting stand.
A sixth aspect of the present invention provides a solar panel mounting stand equipped with a plurality of supporting legs, wherein:
- a pile is used as a supporting leg, said pile comprising:
  - a columnar pile body, at least a lower end portion thereof being buried in the soil; and
  - a non-spiral-shaped projecting portion provided at a lower end of the pile body in a state projected in a radial direction of the pile body, and configured to inhibit a pull-off of the pile body under a load of the soil when the lower end side of the pile body is embedded in the soil.
According to the present invention, it is possible to significantly reduce cost and labor required for the installation of solar panel mounting stands.

**BRIEF DESCRIPTION OF DRAWINGS**

FIG. 1 shows a configuration example of a pile according to an embodiment of the present invention.
FIG. 2 is a cross-sectional view taken along the line A-A of FIG. 1.
FIG. 3 is a cross-sectional view taken along the line B-B of FIG. 1.
FIG. 4 is a front view showing a configuration example of a solar panel mounting stand according to an embodiment of the present invention.
FIG. 5 is a plan view showing a configuration example of a solar panel mounting stand according to an embodiment of the present invention.
FIG. 6 is a side view showing a configuration example of a solar panel mounting stand according to an embodiment of the present invention.
FIG. 7 is an enlarged view of a panel supporting rack (triangular rack).
FIG. 8 is a front view showing a configuration example of the structure for pile installation according to an embodiment of the present invention.
FIG. 9 is a plan view showing a configuration example of the structure for pile installation according to an embodiment of the present invention.
FIG. 10 is a side view showing a configuration example of the structure for pile installation according to an embodiment of the present invention.
FIG. 11 illustrates the configuration of the connecting fitting.
FIG. 12 is an explanatory diagram (part 1) for illustrating the method of installing a solar panel mounting stand according to an embodiment of the present invention.
FIG. 13 is an explanatory diagram (part 2) for illustrating the method of installing a solar panel mounting stand according to an embodiment of the present invention.
FIG. 14 is an explanatory diagram (part 3) for illustrating the method of installing a solar panel mounting stand according to an embodiment of the present invention.
FIG. 15 is an explanatory diagram (part 4) for illustrating the method of installing a solar panel mounting stand according to an embodiment of the present invention.
FIG. 16 is an explanatory diagram (part 5) for illustrating the method of installing a solar panel mounting stand according to an embodiment of the present invention.
FIG. 17 is an explanatory diagram (part 6) for illustrating the method of installing a solar panel mounting stand according to an embodiment of the present invention.
FIG. 18 is an explanatory diagram (part 7) for illustrating the method of installing a solar panel mounting stand according to an embodiment of the present invention.
FIG. 19 is an explanatory diagram (part 8) for illustrating the method of installing a solar panel mounting stand according to an embodiment of the present invention.
FIG. 20 is an explanatory diagram (part 9) for illustrating the method of installing a solar panel mounting stand according to an embodiment of the present invention.
FIG. 21 is an explanatory diagram (part 10) for illustrating the method of installing a solar panel mounting stand according to an embodiment of the present invention.
FIG. 22 is an explanatory diagram (part 11) for illustrating the method of installing a solar panel mounting stand according to an embodiment of the present invention.
FIG. 23 is an explanatory diagram (part 12) for illustrating the method of installing a solar panel mounting stand according to an embodiment of the present invention.
FIG. 24 is a front view showing solar panels mounted to a solar panel mounting stand.
FIG. 25 is a side view showing solar panels mounted to a solar panel mounting stand.
FIGS. 26A, 26B, 26C, AND 26D show specific structural examples where respective members are fastened by bolts and nuts.
FIG. 27 illustrates an adverse condition occurring when piles are driven into the undulating ground.
FIG. 28 illustrates the superior condition in which piles according to this embodiment are installed in the undulating ground.
DETAILED DESCRIPTION OF THE INVENTION

Hereinafter, embodiments of the present invention will be described in detail with reference to the drawings.

1. Configuration of a Pile According to an Embodiment of the Present Invention

FIG. 1 shows a configuration example of a pile according to an embodiment of the present invention. FIG. 2 is a cross-sectional view taken along the line A-A of FIG. 1, and FIG. 3 is a cross-sectional view taken along the line B-B of FIG. 1.

The pile 1, shown in the drawing, roughly comprises a pile body 2, a projecting portion 3, and a coupling portion 4.

The pile body 2 is entirely formed into a column. The cross section of the pile body 2 is circular. The pile body 2 can be formed, for example, by using a straight steel pipe (single pipe, etc.). The length of the pile body 2 is specified, for example, within a range between 2 m and 4 m by taking into account the length that is buried in the ground (in the soil) and the length that protrudes above the ground. The outer diameter of the pile body 2 is specified, for example, within a range of 40 mm or more and 60 mm or less by taking into account the load applied to the pile body 2.

The projecting portion 3 is provided at the lower end of the pile body 2 in the longitudinal direction of the pile body 2. The lower end of the pile body 2 is the end that is disposed downward when the pile 1 is installed in the ground. The projecting portion 3 is provided such that it projects in the radial direction of the pile body 2. The projecting portion 3 has the external size that is larger than the outer diameter of the pile body 2. The projecting portion 3 is formed into a non-spirally shape. In this embodiment, as an example of a non-spirally shape, the projecting portion 3 is formed into a flat plate.

By providing such a plate-like projecting portion 3 at the lower end of the pile body 2, it is indicated that the pile 1 is not intended to be driven or screwed into the ground for the installation. In this respect, this pile is completely different from other known piles. That is, normally, the lower end of the pile is formed into a thin conical shape to facilitate piling into the ground, or a spiral-shaped portion is provided at the tip of the pile to enable the pile to be screwed into the ground; however, in this embodiment, the lower end of the pile body 2 is equipped with a projecting portion 3 shaped such that it hinders the pile from being driven or screwed into the ground. The projecting portion 3 can be formed using a square steel plate, for example. The aforementioned pile body 2 is disposed at the central part of the projecting portion 3 when viewed from the direction of the central axis of the pile 1. The projecting portion 3 is, for example, fixed to the lower end of the pile body 2 by welding or a similar means. Of surfaces 3a and 3b of the projecting portion 3, one surface 3a is disposed upward and the other surface 3b is disposed downward when the pile 1 is installed. At the time of back-filling with soil, described later, one surface (hereinafter, also referred to as the “upper surface”) 3a of the projecting portion 3 is the surface that receives the load (weight pressure) of the soil, and the other surface (hereinafter, also referred to as the “lower surface”) 3b is the surface that comes in contact with (contacts) the ground at the scheduled installation site described later.

The coupling portion 4 is provided at the upper end of the pile body 2 in the longitudinal direction of the pile body 2. The upper end of the pile body 2 is the end that is disposed upward when the pile 1 is installed in the ground. The coupling portion 4 is provided so as to mount a member (described later), which serves as a framework of the solar panel mounting stand, to the pile 1. Similar to the aforementioned projecting portion 3, the coupling portion 4 is provided such that a square steel plate is fixed to the upper end of the pile body 2 by welding or a similar means. The coupling portion 4 is disposed so that it is opposite of the projecting portion 3 with the pile body 2 interposed. Furthermore, at both ends of the pile body 2, the coupling portion 4 and the projecting portion 3 are disposed parallel. Similar to the projecting portion 3, the coupling portion 4 is provided such that it projects in the radial direction of the pile body 2. The projecting portion 3 of the coupling portion 4 has four through-holes 4a. Each through-hole 4a is provided at each corner of the coupling portion 4. The external size of the coupling portion 4 is smaller than the external size of the projecting portion 3. As an example, when the projecting portion 3 and the coupling portion 4 are each made of a flat square plate, the external size of the coupling portion 4 is specified such that the length of one side is, for example, within a range of 150 mm or more and 200 mm or less, and the external size of the projecting portion 3 is specified such that the length of one side is, for example, within a range of 300 mm or more and 600 mm or less. Furthermore, the thickness of the projecting portion 3 and the coupling portion 4 (thickness of the plate) is each specified, for example, within a range of 4 mm or more and 8 mm or less. The surface of the pile 1 is rustproofed by means of molten zine plating, etc.

2. Configuration of a Solar Panel Mounting Stand According to an Embodiment of the Present Invention

FIG. 4 is a front view showing a configuration example of a solar panel mounting stand according to an embodiment of the present invention. FIG. 5 is a plan view, and FIG. 6 is a side view of the same. Moreover, the inverted triangle mark in FIG. 4 and FIG. 6 indicates the assumed surface of the ground on which the solar panel mounting stand 10 is to be installed.

The solar panel mounting stand 10, shown in the drawing, roughly comprises a plurality of supporting legs 11 to serve as members that form the foundation of the mounting rack, and a plurality of panel supporting racks 12, a plurality of beam members 13, a plurality of brace members 14, 15, and 16, and a plurality of panel receiving members 17 to serve as members that form the framework of the mounting rack. Herein, as an example, one solar panel mounting stand 10 is made up of six supporting legs 11, three panel supporting
racks 12, two beam members 13, three brace members 14, 15, and 16, and twelve panel receiving members 17. However, the number of members, dimensions and arrangement thereof can be flexibly changed according to the number and the external size of the solar panels mounted to one solar panel mounting stand 10. The surface of each member is rust-proofed (e.g., molten zinc plating for steel members).

[0080] Supporting legs 11 form the foundation of the solar panel mounting stand 10. The supporting leg 11 is constituted using the aforementioned pile 1. That is, the supporting leg 11 integrates the aforementioned pile body 2, projecting portion 3, and the coupling portion 4. When installing a solar panel mounting stand 10, the lower end of each supporting leg 11 is buried in the ground.

[0081] The panel supporting rack 12 is a triangular rack (triangle rack) that obliquely supports solar panels. The panel supporting rack 12 is mounted onto the aforementioned supporting legs 11. When installing solar panels on the ground using a solar panel mounting stand 10, the solar panels are mounted to the solar panel mounting stand 10 in such a way that they are inclined at a predetermined angle (e.g., about 30 degrees) with regard to the horizontal plane that is perpendicular to the vertical plane (hereinafter, referred to as the “horizontal plane”). Therefore, the panel supporting rack 12 forms a right triangle having the oblique side that corresponds to the solar panel installation angle. The panel supporting rack 12 is made up of three members that form a right triangle. In this embodiment, as a preferred example, as shown in FIG. 7, the three members are made of steel (e.g., channel steel) 12a, 12b, and 12c, and the steel members 12a, 12b, and 12c are fixed to one another by welding or a similar means, thereby forming an integrated panel supporting rack 12.

[0082] Of the three steel members 12a, 12b, and 12c, the steel member 12a forms the base of a right triangle, the steel member 12b forms the vertical side of the right triangle, and the steel member 12c forms the oblique side of the right triangle. The “base” described herein is the horizontally located side when the panel supporting rack 12 is mounted onto the aforementioned supporting legs 11, and the “vertical side” is the vertically (perpendicularly) located side when the panel supporting rack 12 is mounted onto the supporting legs 11. The “oblique side” is the “side opposite to the right angle”, as mathematically defined, which is obliquely located when the panel supporting rack 12 is mounted onto the supporting legs 11. The lower-level end of the steel member 12c protrudes such that it gradually extends downward beyond the end of the steel member 12c. The upper-level end of the steel member 12c protrudes such that it obliquely extends upward beyond the upper end of the steel member 12c.

[0083] One end of the steel member 12a is equipped with a mounting plate 18, and the other end oppositely located is also equipped with another mounting plate 18. Respective mounting plates 18 are used to mount a panel supporting rack 12 onto two supporting legs 11 that are adjacent to each other in the lateral direction of the solar panel mounting stand 10. The two mounting plates 18 are disposed in the longitudinal direction of the steel member 12a at a predetermined distance (the same distance as the clearance between two piles 1 that are adjacent to each other in the lateral direction of the solar panel mounting stand 10). The mounting plate 18 is made of a flat steel plate that is shaped to fit the external size of the aforementioned coupling portion 4. When the mounting plate 18 and the coupling portion 4 are each made of a plate-like member of the same external size, positioning becomes easy when mounting the panel supporting rack 12 onto the piles 1. The mounting plate 18 has four through-holes that have the same positional relationships as the holes in the coupling portion 4. Therefore, when the mounting plate 18 is placed on top of the aforementioned coupling portion 4, the corresponding through-holes are disposed concentrically (ideal state). At one end of the steel member 12a, a mounting plate 18 is fixed to the lower surface of the steel member 12a by welding or a similar means. Also, at the other end of the steel member 12a, another mounting plate 18 is fixed to the lower surface of the steel member 12a and also to the lower end of the steel member 12b by welding or a similar means. Furthermore, the steel member 12b has through-holes (not shown) to mount brace members 14 and 15, and the steel member 12c has through-holes (not shown) to mount brace members 13.

[0084] The beam member 13 is mounted so that it connects together three panel supporting racks 12. The beam member 13 can be formed using a long steel member (e.g., lip groove steel), for example. Both ends of the beam member 13 are disposed such that they protrude outward from respective panel supporting racks 12 (lateral to the solar panel mounting stand 10). Respective beam members 13 are disposed parallel in the longitudinal direction of the solar panel mounting stand 10. One beam member 13 is fixed to the upper-level end of the steel member 12c of the panel supporting rack 12 by using bolts and nuts. The other beam member 13 is fixed to the lower-level end of the steel member 12c by using bolts and nuts.

[0085] Brace members 14 and 15 are designed to mainly inhibit a solar panel mounting stand 10 from rocking in the longitudinal direction of the solar panel mounting stand 10. The brace member 14 is mounted such that it connects together respective steel members 12b of the central panel supporting rack 12 and the one-end side panel supporting rack 12, among three panel supporting racks 12 disposed in the longitudinal direction of the solar panel mounting stand 10. On the contrary, the brace member 15 is mounted such that it connects together respective steel members 12b of the central panel supporting rack 12 and the the-other-end side panel supporting rack 12. Those brace members 14 and 15 are disposed such that they form a mountain shape when the solar panel mounting stand 10 is viewed from the front. That is, the brace member 14 is obliquely disposed from the central panel supporting rack 12 to the one-end side panel supporting rack 12 so that it becomes gradually inclined; and the brace member 15 is obliquely disposed from the central panel supporting rack 12 to the the-other-end side panel supporting rack 12 so that it becomes gradually inclined. The brace members 14 and 15 can be formed using long steel members (e.g., L-shaped steel), for example. One end and the other end of respective brace members 14 and 15 are fixed to the steel members 12b of the corresponding panel supporting racks 12 by using bolts and nuts, for example.

[0086] On the other hand, the brace member 16 is designed to mainly inhibit the solar panel mounting stand 10 from rocking in the lateral direction. The brace member 16 is mounted such that it connects together two supporting legs 11 that support from below the central panel supporting rack 12. Furthermore, the brace member 16 disposed such that it is inclined in the same direction as the steel member 12c of the panel supporting rack 12. Therefore, the brace member 16 is obliquely disposed so that it becomes gradually inclined from the back to the front when the solar panel mounting stand 10 is viewed from the front. The brace member 16 can be formed,
Panel receiving members 17 hold and support solar panels. A solar panel is equipped with a frame member made of aluminum, etc., for example, and the frame member can be mounted to the panel receiving members 17 by using bolts and nuts, for example. The panel receiving member 17 can be formed using a long steel member (e.g., lip groove steel), for example.

A plurality of panel receiving members 17 are mounted in the longitudinal direction of the solar panel mounting stand 10 at appropriate intervals. The panel receiving members 17 are mounted such that they extend across two beam members 13. The panel receiving member 17 is inclined with regard to the horizontal plane. The inclined angle of the panel receiving member 17 is the same as that of the steel member 12 of the panel supporting rack 12. One end of the panel receiving member 17 protrudes obliquely upward beyond the beam member 13 located below on the upper-level side. The other end of the panel receiving member 17 protrudes obliquely downward beyond the beam member 13 located below on the lower-level side. With the configuration in which both ends of the panel receiving member 17 thus protrude, it is possible to mount a larger number of solar panels to one solar panel mounting stand 10. Intervals among panel receiving members 17 that are adjacent to one another in the longitudinal direction of the solar panel mounting stand 10 are determined corresponding to the mounting holes provided in the frame member of the solar panels. Incidentally, solar panels are designed to be disposed (laid) in a reticular pattern using a plurality of panel receiving members 17.

3. Configuration of a Structure for Pile Installation
According to an Embodiment of the Present Invention

FIG. 8 is a front view showing a configuration example of the structure for pile installation according to an embodiment of the present invention, FIG. 9 is a plan view, and FIG. 10 is a side view of the same.

Upon installation of the solar panel mounting stand 10 on the ground, the structure 20, shown in the drawing, is designed to be used to install a plurality of piles 1 that serve as supporting legs 11 of the solar panel mounting stand 10. The structure 20 roughly comprises a plurality of lower-tier transverse beams 21, a plurality of supporting posts 22, a plurality of upper-tier transverse beams 23, and one vertical beam 24. Herein, as an example, one structure 20 comprises three lower-tier transverse beams 21, six supporting posts 22, three upper-tier transverse beams 23, and one vertical beam 24. However, the number, dimensions and arrangement of the members can be changed according to the number and arrangement of the piles 1 to be supported.

The lower-tier transverse beam 21 can be formed by using Z-shaped steel, for example. Plate-like connecting fittings 25 are provided respectively on both ends of the lower-tier transverse beam 21 in the longitudinal direction. When piles 1 are mounted on the structure 20, the connecting fittings 25 are detachably connected to the piles 1. Respective connecting fittings 25 are fixed to the lower surface of the lower-tier transverse beam 21 by welding or a similar means. A part of the connecting fitting 25 protrudes from the lower-tier transverse beam 21, and a notched portion 26, as shown in FIG. 11, is formed on the protruding portion. In FIG. 11, the portion within the broken line represented by number 21 indicates the welded portion that connects the connecting fitting 25 to the lower-tier transverse beam 21. The notched portion 26 allows the connecting fitting 25 to be mounted on and detached from a pile 1. Notched portions 26 of respective connecting fittings 25 are disposed in the same direction (one direction) in the longitudinal direction of the vertical beam 24. One side of the notched portion 26 (open side) is wide open so that it can easily direct the pile 1 to the back side of the notched portion 26.

Furthermore, the connecting fitting 25 has two through-holes 27. Those through-holes 27 are disposed with the notched portion 26 interposed. Each through-hole 27 is intended for mounting a brace 28 on the connecting fitting 25. For a brace 28, a clamp (metal bar member that is bent in a nearly horseshoe shape) can be used, for example. The brace 28 relatively fixes the pile 1 to the connecting fitting 25 by inserting both ends of the brace 28 into the two through-holes 27 while the pile 1 is engaged with the notched portion 26 of the connecting fitting 25.

The supporting post 22 can be formed using H-shaped steel, for example. The supporting post 22 vertically stands on the lower-tier transverse beam 21. The number of supporting posts 22 is the same as the number of piles 1 simultaneously supported by the structure 20. Both ends (upper and lower ends) of the supporting post 22 are fixed to the corresponding lower-tier transverse beam 21 and upper-tier transverse beam 23 by using bolts and nuts, for example.

The upper-tier transverse beam 23 is formed by using H-shaped steel, for example. The upper-tier transverse beam 23 is disposed directly above the lower-tier transverse beam 21 parallel to the lower-tier transverse beam 21. The upper-tier transverse beam 23 has holes into which the coupling portions 4 of respective piles 1 are fitted. Furthermore, as necessary, a reinforcing plate 30 is mounted to each corner portion formed by the upper-tier transverse beam 23 and the supporting post 22.

The vertical beam 24 can be formed by using H-shaped steel, for example. The vertical beam 24 is mounted so as to connect together three upper-tier transverse beams 23. The vertical beam 24 is mounted on respective upper-tier transverse beams 23 using bolts and nuts, for example, while the vertical beam 24 is placed on the upper surfaces of respective upper-tier transverse beams 23. Two metal hangers 29 are provided on the upper surfaces of the vertical beam 24. Those metal hangers 29 are disposed in the longitudinal direction of the vertical beam 24 at appropriate intervals.

Moreover, in FIG. 9, the intersection point indicated by the “X” provided at both ends of the upper-tier transverse beam 23 is the position where the central axis of the pile 1 is located when the pile 1 is mounted on the structure 20.

4. A Method of Installing a Solar Panel Mounting Stand According to an Embodiment of the Present Invention

Next, a method of installing a solar panel mounting stand according to an embodiment of the present invention will be described with reference to FIG. 12 to FIG. 23.

First, upon installing the aforementioned solar panel mounting stand 10 on the ground, the soil (including sand) at the installation site is dug out. In this document, regardless of the size of particles constituting the soil, the term “soil” is
used in a broad sense. When digging in the soil at the installation site of the solar panel mounting stand 10, the entire installation site may be dug out at a uniform depth. However, as the size of the solar panel mounting stand 10 increases, the area of the location at which the soil is dug out also increases accordingly. Therefore, it takes time and labor for the excavating work. For this reason, when digging out the soil at the installation site of the solar panel mounting stand 10, it is preferred that, over the entire installation site, only the soil at the exact locations at which a plurality of (six in this embodiment) piles 1 are scheduled to be installed should be removed.

This construction method is adopted in this embodiment. However, in that case, the side wall of hole H (see FIG. 12) tends to be collapsed during the excavating work depending on the type of the soil at the installation site. Therefore, it is desirable that the soil of the scheduled installation site of the pile 1 be dug out to a desired depth while preventing the hole H from collapsing by using square blocks. The excavation depth may be determined within a range between 1 m to 3 m, for example, although it depends on the weight and size of the solar panel mounting stand 10, weight of the solar panel, length of the pile 1, size of the projecting portion 3, etc.

[0099] By thus digging out the soil, at the installation site of the solar panel mounting stand 10, the planned installation ground surface 19 on which a pile 1 is scheduled to be installed can be formed at a depth greater than the original ground G (ground surface before digging out) as shown in FIG. 12. The planned installation ground surface 19 is exposed at the bottom of the hole H after the soil is dug out. The number of planned installation ground surfaces 19 is equal to the number of piles 1 to be installed and formed at the installation site of the solar panel mounting stand 10. Furthermore, it is desirable that leveling be conducted so that the respective planned installation ground surfaces 19 can be at the same depth, with a common virtual horizontal plane as a reference.

[0100] Next, using the aforementioned structure 20, a plurality of (six in this embodiment) piles 1 are installed so that they are relatively positioned. The condition described herein as “relatively positioned” is the condition in which a plurality of piles 1 are positioned so that they have predetermined positional relationships (defined by design).

[0101] When supporting a plurality of piles 1 by the structure 20, respective piles 1 are mounted on the structure 20 as described below. That is, while the pile body 2 of a pile 1 is engaged with the attached portion 26 of the connecting fitting 25, the coupling portion 4 of the pile 1 is fixed to a predetermined location of the upper-tier transverse beam 23 by using bolts and nuts. Thereafter, the brace 28 is inserted from above into the through-hole 27 of the connecting fitting 25. By doing so, a plurality of piles 1 are integrally supported by the structure 20. The term “integrated” described herein means that “so that the structure 20 and a plurality of piles 1 are immobilized”.

[0102] FIG. 13 is a front view showing the piles 1 mounted to the structure 20, and FIG. 14 is a side view of the same. Furthermore, when mounting piles 1 to the structure 20, whether the plurality of piles 1 are in the prescribed positional relationships is confirmed as needed, and based on the result, fine adjustments of the positions at which piles 1 are mounted may be made.

[0103] Next, as shown in FIG. 15, a wire 40 is attached to two metal hangers 29 of the vertical beam 24, and by hoisting the wire 40 by a crane, a plurality of piles 1 are hoisted integrally with the structure 20 while the aforementioned support condition is maintained. Next, by moving and turning a crane, the hoisted structure 20 and the plurality of piles 1 are transported to the installation site of the solar panel mounting stand 10. At the installation site, as shown in FIG. 12, planned installation ground surfaces 19 formed at the scheduled installation sites of the piles 1 are aligned with the positions of the corresponding piles 1, and the piles 1 are lowered together with the structure 20 by the crane; and then, as shown in FIG. 16, the lower end (the lower surface 30 of the projecting portion 3) of each pile 1 comes in contact with the corresponding planned installation ground surface 19.

[0104] Next, as shown in FIG. 17 and FIG. 18, locations at which respective piles 1 were installed (in hole H in this embodiment) are refilled with the soil. Thus, the projecting portion 3 of the pile 1 is covered with soil and the lower end portion of the pile 1 is buried in the soil. At this time, the refilling soil is compacted as necessary. The soil refilling work should be conducted while the plurality of piles 1 are supported by the structure 20.

[0105] This is because relative positional relationships of the plurality of piles 1 can be maintained even if a small amount of force is imposed on the piles 1 during a refilling process of the soil.

[0106] Thus, a plurality of piles 1 are installed at the installation site of the solar panel mounting stand 10.

[0107] Moreover, the soil that has been dug out to form the planned installation ground surfaces 19 can be used for the refilling use. However, the soil used for refilling does not have to be the same soil that has been dug out.

[0108] Next, the structure 20 is removed from the plurality of piles 1. Specifically, the bolts and nuts that fasten the coupling portions 4 of respective piles 1 to the upper-tier transverse beams 23 are removed. Furthermore, braces 28 are removed from respective connecting fittings 25. Next, the entire structure 20 is horizontally moved to the opposite side of the opening of the notched portion 26 of the connecting fitting 25. Thus, the structure 20 is separated from the respective piles 1. A crane is used to move the structure 20. Thereafter, the structure 20 is hoisted by a crane and transported to a location distant from the installation site of the solar panel mounting stand 10. As a result, at the installation site of the solar panel mounting stand 10, as shown in FIG. 19, a plurality of (six in this embodiment) piles 1 are installed vertically (perpendicularly) upright. At this time, if the lengths of all piles 1 are the same, coupling portions 4 of respective piles 1 are disposed on the same virtual plane. Thus, the installed piles 1 serve as supporting legs 11 of the solar panel mounting stand 10.

[0109] Next, using a plurality of piles 1, members that constitute a framework of the solar panel mounting stand 10 are assembled. Member mounting work is conducted as described below.

[0110] First, as shown in FIG. 20, panel supporting racks 12 are mounted on the piles 1. At this time, one panel supporting rack 12 is mounted on two piles 1 that are adjacent to each other in the lateral direction of the solar panel mounting stand 10. Since two mounting plates 18 (see FIG. 7) are mounted on the lower surface of the steel member 12u of the panel supporting rack 12, the panel supporting rack 12 is placed on two piles 1 so that respective mounting plates 18 are placed on the coupling portions 4 of the respective piles 1. At that time, holes of the coupling portion 4 and those of the mounting plate 18 are aligned, and a bolt is inserted into each aligned hole and fastened by nuts. Thus, one panel supporting rack 12
is fixed to two piles 1. This mounting work is conducted for three panel supporting racks 12.

[0111] Next, as shown in FIG. 21, beam members 13 are installed on the panel supporting racks 12. The beam members 13 are mounted on three panel supporting racks 12 disposed in the longitudinal direction of the solar panel mounting stand 10 using bolts and nuts, for example. Holes used for mounting are provided beforehand in the panel supporting racks 12 and the beam members 13. Each beam member 13 is mounted on the upper side and the lower side of the steel member 12 constituting the oblique side of the panel supporting rack 12.

[0112] Next, as shown in FIG. 22, brace members 14, 15, and 16 are mounted. In this process, two brace members 14 and 15 are obliquely mounted from the panel supporting rack 12, disposed at the center in the longitudinal direction of the solar panel mounting stand 10, toward the panel supporting racks 12 disposed on both sides of the central panel supporting rack 12 so that a mountain shape is formed. Furthermore, the brace member 16 is mounted such that it connects two piles 1 (pile bodies 2) disposed at the center in the longitudinal direction of the solar panel mounting stand 10. The brace member 16 is mounted such that it is inclined in the same direction of the steel member 12 constituting the oblique side of the panel supporting rack 12. Brace members 14, 15, and 16 are mounted using bolts and nuts, for example. Holes used for mounting work are provided beforehand in the panel supporting racks 12 and the piles 1.

[0113] Moreover, brace members 14 and 15 may be mounted at any time after the panel supporting racks 12 have been mounted. Similarly, the brace member 16 may be mounted at any time after piles 1 have been installed.

[0114] Next, as shown in FIG. 23, panel receiving members 17 are mounted on the beam members 13. The panel receiving members 17 are mounted such that they extend across two beam members 13. Furthermore, a plurality of panel receiving members 17 are mounted in the longitudinal direction of the solar panel mounting stand 10 at predetermined intervals. The panel receiving members 17 are mounted using bolts and nuts, for example. Holes used for mounting work are provided beforehand in the beam members 13 and the panel receiving members 17.

[0115] Thus, installation of the solar panel mounting stand 10 is completed. Thereafter, as shown in the front view of FIG. 24 and in the side view of FIG. 25, a plurality of solar panels 31 are mounted on the solar panel mounting stand 10. In FIG. 24, solar panels 31 appear to be transparent so that positional relationships among all the constituent members of the structure 20 and the solar panels 31 are clarified.

[0116] FIG. 26 shows specific structural examples where respective members are fastened by bolts and nuts. In FIG. 26(A) and FIG. 26(B), the panel supporting rack 12 and the beam member 13 are fastened by a bolt 32 and a nut 33, and the beam member 13 and the panel receiving member 17 are fastened by a bolt 34 and a nut 35. And, the frame member 31a of the solar panel is fastened to the panel receiving member 17 by a bolt 36 and a nut 37. Meanwhile, in FIG. 26(C), the panel supporting rack 12 and the brace member 14 (15) are fastened by a bolt 38 and a nut 39; and in FIG. 26(D), the pile 1 that serves as a supporting leg 11 and the brace member 16 are fastened by a bolt 40 and a nut 41. Moreover, the way of fixing members is not limited to the fixing structure of using bolts and nuts, and for example, a fixing structure using fixing brackets not shown, or a fixing means such as welding can be adopted. However, when taking into account the construction cost and material cost, it is preferred that the fixing structure using bolts and nuts be adopted.

5. Effects of the Embodiment of the Present Invention

[0117] In the embodiment of the present invention, a pile 1 equipped with a projecting portion 3 at the lower end of the pile body 2 is adopted and installed in the ground by an original method of "piling" instead of using a commonly-known conventional "piling" method. Furthermore, the use of this type of pile ensures the installation strength of the pile 1 by burying the lower end of the pile 1 including the projecting portion 3 in the ground. This makes troublesome "piling" work unnecessary. Furthermore, at locations where "piling" is difficult, it is possible to install solar panel mounting stands 10 without using expensive spiral piles. As a result, it is possible to significantly reduce cost and labor required for installing solar panel mounting stands. Consequently, it is possible to contribute to prevalence of solar power generation, resulting in further promotion of the use of natural energy.

[0118] Furthermore, using a pile 1 having a projecting portion 3 as a supporting leg 11 of the solar panel mounting stand 10, it is possible to provide a sufficient resisting force against a pressing force caused by the weight of the solar panel mounting stand 10 and the solar panels 31 and an opposite drawing force. Specifically, for the solar panel mounting stand 10, it is important to ensure sufficient installation strength to resist strong wind pressure (lifting force) imposed on solar panels 31 due to a typhoon or the like. In this regard, in the case of piles to be driven into the ground, piling is sometimes difficult depending on the conditions of the ground, and the piles are relatively easy to pull off; thus, it is difficult to ensure sufficient installation strength against wind pressure caused by strong wind. Meanwhile, when a solar panel mounting stand 10 is formed using piles 1 of this embodiment, as described above, it is possible to provide a sufficient resisting force against both the pressing force and the drawing force; consequently, it is possible to ensure superior installation strength specifically against wind pressure caused by strong wind.

[0119] For reference, tensile test was conducted for the piles 1 installed by the method of this embodiment, and better results than expected were obtained.

[0120] In the tensile test, the pile body 2 of the pile 1 was made of a steel pipe with a diameter of 50 mm, and the projecting portion 3 was made of a 500-mm square steel plate. Moreover, the lower end of the pile body 2 was buried in the soil in about 1.8 m depth, and the pile 1 was vertically pulled by applying a 20-kN pulling force. Consequently, the displacement amount (ascending amount) of the pile 1 was only 14 mm. This is the test result obtained from one pile 1. Therefore, as described above, when six piles 1 are used as supporting legs 11 to form a solar panel mounting stand 10, it can withstand at least a 120-kN pulling force in total.

[0121] Furthermore, according to the embodiment of the present invention, even if the solar panel mounting stand installation site is on undulating ground, installation of piles 1 can be conducted without problems. Hereinafter, a detailed description will be given.

[0122] The solar panel mounting stand installation site is not always on level ground. Specifically, a large-scale solar power plant like mega solar requires wide expanse of ground
to lay a large number of solar panels. However, appropriate expanses of level ground are sometimes difficult to find. Furthermore, if undulating ground is to be leveled, a large-scale land grading project is necessary, resulting in enormous cost and labor.

[0123] If piles are installed by “piling” into the undulating ground, there is a concern that the following adverse conditions occur. For example, in the case of driving piles into the ground, as shown in FIG. 27, when a plurality of piles 51 having the same length are driven into the uneven ground so that the upper ends of the piles are aligned in height, it is necessary to drive piles 51 located in the higher-level ground deeper into the ground than the piles 51 located in the lower-level ground. Therefore, when piling depth D1 required for inhibiting the pull-off of piles is ensured at the lower-level ground, it is necessary to drive piles 51 into the higher-level ground at a deeper depth of D1+D2. However, in the ground where piling is difficult, even if piles 51 are successfully driven into the lower-level ground at desired depth D1, it may not be possible to drive piles 51 into the higher-level ground at the desired depth D1+D2. As a result, the height of the upper end of each pile 51 differs by the dimension D2.

[0124] Meanwhile, according to this embodiment, the soil at the installation site is dug out and piles 1 are installed therein, even if the ground is undulating, by changing the excavation (hole) depths D4 and D5 in the higher-level ground and in the lower-level ground as shown in FIG. 28, it is possible to install piles 1 with the upper ends thereof aligned at the same height. Accordingly, it is not necessary to level the ground. Therefore, it is possible to significantly reduce the total cost required for installing solar panel mounting stands, specifically, total cost for installing solar panel mounting stands on the undulating ground or on the inclined ground. Furthermore, as for the undulating ground, it is possible to successfully cope with nearly 1-meter undulation.

[0125] Furthermore, in the embodiment of the present invention, a plurality of piles 1 are supported by a structure 20, and while this condition is maintained, each pile 1 comes in contact with the planned installation ground surface 19 and is securely fixed by the soil used for refilling. Therefore, it is possible to precisely install a plurality of piles 1 at the installation site of the solar panel mounting stand 10. Meanwhile, for example, when driving piles into the ground, respective piles need to be driven into the ground one by one. In this case, it is very difficult to precisely drive piles at desired locations at desired depth. Consequently, deviation tends to occur in the relative positions of the plurality of piles. Therefore, in the process of mounting members constituting a framework of the solar panel mounting stand, on a plurality of piles, positions of the holes provided in the members are greatly misaligned, which could possibly prohibit mounting of the members. Even if all members can be mounted, distortion may occur in the entire solar panel mounting stand.

[0126] Meanwhile, by using the method of installing a solar panel mounting stand according to the embodiment of the present invention, piles 1 are securely fixed by compacting the refilling soil while maintaining the relative positional relationships of the plurality of piles 1 by using the structure 20; therefore, it is possible to precisely install a plurality of piles 1. Consequently, it is possible to mount all members as prescribed without causing the entire mounting rack to distort. Furthermore, since a plurality of piles 1 can be installed simultaneously at the installation site of the solar panel mounting stand 10, construction efficiency significantly increases. As a result, it is possible to simultaneously reduce the installation cost and increase pile installation accuracy.

[0127] Furthermore, in the method of installing a solar panel mounting stand according to the embodiment of the present invention, since the structure 20 that supports a plurality of piles 1 is hoisted by a crane and transported to the installation site of the solar panel mounting stand 10, an unnecessary force is not imposed on the piles 1 during transportation. Therefore, relative positions of the plurality of piles 1 do not change. Furthermore, while piles are hoisted by a crane (piles stay aloft), it is possible to move the positions of entire piles in the horizontal direction without applying a large force while the relative positions of the plurality of piles 1 are maintained. Therefore, it is possible to easily position the projecting portions 3 of respective piles 1 on the corresponding planned installation ground surfaces 19.

6. Modified Example, Etc.

[0128] Moreover, the technical scope of the present invention is not limited to the aforementioned embodiment, and includes variety of modifications and alterations within a scope capable of deriving specific effects obtained by constituting features of the invention and a combination of them.

[0129] For example, in the above embodiment, a cross-sectional shape of the pile body 2 is circular; however, the present invention is not limited thereto, and the cross-sectional shape of the pile body 2 may be a prismatic column such as a quadrangular prism.

[0130] Furthermore, the planar shape of the projecting portion 3 is not limited to a square or other quadrangles, and can be of any shape as long as it receives the load of the refilling soil on the surface thereof; for example, it can be a polygon, circle, oval, flower-petal shape, or cross-like figure. Furthermore, in addition to providing the projecting portion 3 at the lower end of the pile body 2, two or three projecting portions may be disposed at the lower end portion of the pile body 2, which is eventually buried in the soil, at certain intervals in the longitudinal direction of the pile body 2.

[0131] Furthermore, it is preferred that the projecting portion 3 be formed into a flat plate-like shape so as to be a simple structure and efficiently receive the load of the soil; however, the shape is not limited to the flat plate-like shape. For example, although not shown, a part of or the entire outer circumference edge of the projecting portion 3 may be bent upward. Furthermore, when the projecting portion 3 is formed into a plate-like shape, instead of disposing the projecting portion 3 at a right angle with regard to the central axis of the pile body 2, the projecting portion 3 may be disposed slightly inclined (preferably, an inclined angle of more than 0 degrees, and equivalent to or less than 30 degrees). However, since piles according to the present invention are not driven or screwed into the ground, spiral-shaped piles are excluded.

[0132] Furthermore, members of the framework mounted onto the supporting legs 11 (piles 1) of the solar panel mounting stand 10 are not limited to the aforementioned members, and they may be any member to which solar panels can be mounted. Furthermore, in this case, the shape of the coupling portion 4 provided at the upper end of the pile body 2 can be changed according to the member mounted thereon; and it is also possible to mount framework members on the pile body 2 using separate mounting fittings or the like without providing a coupling portion 4. Therefore, the coupling portion 4 may be provided as needed.
However, by adopting a configuration in which a coupling portion 4 is integrally provided at the upper end of the pile body 2, and a triangle panel supporting rack 12 is placed on top of the coupling portion 4 and fixed, it is easy to obliquely mount panel receiving members 17, and the mechanical strength (rigidity, etc.) of the entire mounting rack can be increased. Therefore, it is possible to reduce construction cost and material cost as much as possible, resulting in reduction of the total cost required for installing the solar panel mounting stand 10.

Furthermore, because panel receiving members 17 are made of lip groove steel, by changing the dimensions (mainly length) of the actually-used lip groove steel, hole positions, the number of members, etc., it is possible to mount different manufacturers' solar panels or change the number of solar panels made by the same manufacturer.

Furthermore, constituent material of the solar panel mounting stand is not limited to steel, but it can be any material as long as it satisfies the mechanical strength, durability, anti-weathering property, etc., required for the solar panel mounting stand; for example, other metal (including alloy) such as stainless-steel, aluminum, etc., and plastic such as reinforced plastic can be used.

A pile of the present invention is preferable for use as a supporting leg of the solar panel mounting stand; however, the pile can be widely applied to other use as well. For example, the pile according to the present invention can be used when an advertising display or a sign is installed on the ground. A preferred embodiment of the present invention in that case will be additionally described.

A pile includes a columnar pile body, at least the lower end portion of which is buried in the soil, and a non-spiral-shaped projecting portion provided at the lower end of the pile body so that it projects in the radial direction of the pile body, wherein when the lower end portion of the pile body is buried in the soil, the projecting portion inhibits pull-off of the pile body under load of the soil.

1. A method of installing a solar panel mounting stand using a pile as a supporting leg, the pile comprising: a columnar pile body, at least a lower end side thereof being buried in the soil when a solar panel mounting stand equipped with a plurality of supporting legs is installed on the ground; and a non-spiral-shaped projecting portion provided at a lower end of the pile body in a state projected in a radial direction of the pile body

and configured to inhibit a pull-off of the pile body under a load of the soil when the lower end side of the pile body is embedded in the soil;

the method comprising:

a first step of forming an installation scheduled surface on which the plurality of piles are scheduled to be installed at a position deeper than an original ground surface, by digging the soil of an installation site of the solar panel mounting stand;

a second step of installing the plurality of piles at the installation site by supporting the plurality of piles in a state of being relatively aligned, using a pile installation structure, and while maintaining such a supporting state, transporting the plurality of piles to the installation site of the solar panel mounting stand integrally with the pile installation structure, and placing the projecting portions, which are formed at lower ends of the plurality of piles, on the installation scheduled surface corresponding to each projecting portion, and thereafter refilling the installation site with soil;

a third step of removing the pile installation structure from the plurality of piles; and

a fourth step of assembling a member as a framework of the solar panel mounting stand, using the plurality of piles.

2. A solar panel mounting stand installation method according to claim 1, wherein in the second step, the pile installation structure supporting the plurality of piles is hoisted by a crane and transported to the installation site of the solar panel mounting stand.

3. A pile used as a supporting leg when a solar panel mounting stand equipped with a plurality of supporting legs is installed, comprising:

a columnar pile body; and

a non-spiral-shaped projecting portion provided at a lower end of the pile body in a state projected in a radial direction of the pile body;

wherein at least a lower end side of the pile body is buried in the soil when the solar panel mounting stand is installed; and

the projecting portion is configured to inhibit a pull-off of the pile body under a load of the soil when the lower end side of the pile body is embedded in the soil.

4. The pile according to claim 3, wherein the projecting portion is formed into a plate-like shape having a larger external size than an outer diameter of the pile body.

5. The pile according to claim 3, wherein a coupling portion is provided on an upper end of the pile body, for assembling a member as a framework of the solar panel mounting stand.

6. A solar panel mounting stand equipped with a plurality of supporting legs, wherein a pile is used as a supporting leg, said pile comprising: a columnar pile body, at least a lower end portion thereof being buried in the soil; and

a non-spiral-shaped projecting portion provided at a lower end of the pile body in a state projected in a radial direction of the pile body, and configured to inhibit a pull-off of the pile body under a load of the soil when the lower end side of the pile body is embedded in the soil.

7. The pile according to claim 4, wherein a coupling portion is provided on an upper end of the pile body, for assembling a member as a framework of the solar panel mounting stand.

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