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Foundation comprising a fixture for locating wind turbine equipment on the foundation

Fundament mit Vorrichtung zur Platzierung von Windturbinenausrüstung auf dem Fundament

Fondation comprenant un dispositif pour le positionnement d’équipement d’éolienne

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WO-A1-2006/056196

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Description

[0001] The invention relates generally to wind turbine equipment and more specifically to a fixture and method for locating wind turbine equipment on a foundation for a wind turbine tower, prior to the tower installation.

[0002] Early construction of wind power plants first produced a foundation, then the tower of the wind power plant was erected and subsequently a machine house was outfitted at the tip of the tower and the rotor was affixed with the rotor blades. After this, the electric power modules such as a transformer, switch cabinets, converters, a medium voltage system, a low voltage system, etc., were installed, often in a separate housing in proximity to the wind turbine tower.

[0003] Various conventional techniques for constructing wind turbines are described, for example, in WO 2006/056196 and US 2004/0131467.

[0004] Subsequently, wind plant equipment and methods were developed to construct a foundation and then place the essential power modules, such as transformer; switch cabinets; converters, medium voltage systems, and low voltage distribution on the wind turbine tower foundation, in various arrangements. Under these methods, the wind turbine tower (tower) was erected on the foundation over the electric equipment to provide protection from the elements and make use of otherwise vacant enclosed space within the tower. The electrical equipment may be prefabricated and consolidated in structures and modules, designed for mounting to the tower foundation. However, the locations for these structures and modules needs to be manually measured out and identified, such as by spray painting the foundation, prior to the positioning and mounting of the electrical equipment and subsequent erection of the tower. In the event of faulty location and mounting of these components, it was sometimes necessary to relocate in order to avoid interference with the tower base.

[0005] Accordingly, there is a need to provide a fixture and method for rapidly and accurately locating structures and equipment on the tower foundation prior to the installation of the tower.

[0006] Various aspects and embodiments of the present invention are defined by the appended claims.

[0007] Various features, aspects, and advantages of the present invention will become better understood when the following detailed description is read with reference to the accompanying drawings in which like characters represent like parts throughout the drawings, wherein:

FIG. 1 illustrates a preassembled structure with electric components and an individual electric component mounted to the foundation of a wind turbine tower;

FIG. 2 illustrates one embodiment of an inventive fixture for locating a structure housing wind turbine equipment on the foundation of a wind turbine tower;

FIG. 3A illustrates an isometric view of one embodiment of a fixture adapted for locating wind turbine equipment on a foundation for the wind turbine tower;

FIG. 3B illustrates a top view of one embodiment for a fixture adapted for locating wind turbine equipment on a foundation for the wind turbine tower;

FIG. 3C illustrates a side view for one embodiment of a fixture adapted for locating wind turbine equipment on a foundation for the wind turbine tower;

FIG. 3D illustrates a bottom view for one embodiment of a fixture adapted for locating wind turbine equipment on a foundation for the wind turbine tower;

FIG. 4A illustrates a top view of an empty prearranged foundation (without concrete fill) with a steel reinforcement within an anchor cage;

FIG. 4B illustrates another embodiment of an inventive fixture 100 for locating the placement of stub up tubes or conduits; and

FIG. 5 illustrates a flowchart of an embodiment of a method for locating wind turbine equipment on a foundation for a wind turbine tower prior to erecting the wind turbine tower.

[0008] The following embodiments of the present invention have many advantages, including quickly and accurately identifying the location for structures and wind turbine equipment that must be mounted on the wind turbine tower foundation within the envelope of the tower.

[0009] Many wind turbine towers include cylindrical tower sections that are attached axially together using connections such as bolted joint flanges at their ends. The base tower section may include bottom flanges that establish a tower footprint, of generally cylindrical shape, on the foundation. Alternatively, the bottom end of the base tower section may be bolted radially to a vertical element of inverted T-shaped connection members, or other such element.

[0010] However, prior to erection of the tower, structures and wind turbine equipment must be mounted on the foundation of the tower and internal to the base section of the tower. The mounted structures and wind turbine equipment must also be placed so as to avoid any inner elements for the base section of the tower. These inner elements of the tower may include the inverted T-shaped connection members supporting the base. The inner elements may also include any inward protrusions from the base section of the tower that may interfere with the placement of wind turbine equipment of the foundation of the tower.

[0011] Various embodiments of the present invention
provide the capability to accurately and quickly locate the placement of such structures and wind turbine equipment at predetermined locations within the envelope of the tower. Various embodiments of the present invention eliminate the need for use of detailed drawings in order to establish reference distances and physical relationships for locating the base of the wind turbine equipment. Further, various embodiments of the present invention provide a simple procedure capable of being quickly learned by many different construction crews at disparate locations throughout the world who are responsible for constructing the wind turbines.

Various embodiments of the present invention incorporate a fixture mounted to an accurately known position (guidepoint) on the foundation and extending to a precise location for the placement of the structure or wind turbine component. The guidepoint may include anchor bolts for the tower, where the anchor bolts extend from the anchor cage in the tower foundation.

In alternative tower arrangements, when the lowest part of the tower structure is embedded in the foundation, a horizontal flange may be provided, at the top of such an embedded part and above the upper surface of the foundation. The horizontal flange may be used for mating horizontal flange with a corresponding lower horizontal flange from the upper section of the tower. The bolt holes on the top horizontal flange of the embedded tower part, within the foundation, may serve as guidepoints for the inventive fixture. It should be recognized that other guidepoints may also be established for mounting of the inventive fixture.

One embodiment of the inventive fixture may include a mounting section, a locating section and an orienting section. The fixture mounting section may include a plate adapted to sit flat relative to the foundation when mounted for locating components. The plate may include holes adapted to receive the guidepoints, such as anchor bolts of the tower foundation. The holes in the plate may alternatively aligned be with the bolt holes on the top flange of the embedded tower part, within the foundation. In this case, the mounting section may be bolted to the upper horizontal flange for the embedded tower part.

The locating section may be fixed to the mounting section and extend in a generally inward direction to establish a locating point for a corner or other fixed position on the component to be mounted on the foundation of the tower and within the envelope of the tower.

At the end of the mounting section, an orienting section may be attached. The orienting section may include an element shaped to assist in positioning a structure or wind turbine equipment on the foundation. Such an element may include a right angle normal to the axial direction of the tower. The right angle may define a corner position for the structure or the wind turbine equipment component. However, the orienting section may be sized and shaped to accommodate the positioning of different structures and wind turbine equipment, of varying size, shape and configuration.

The elements being positioned by the fixture may include the corners for an enclosed structure within the tower. The structure may be used to house wind turbine equipment or mount a platform or frame to carry wind turbine equipment. Such a structure may also be preassembled with wind turbine equipment allowing for quick installation of the preassembled components. However, the elements being positioned need not be preassembled on the structure. The elements being positioned may also include individual wind turbine equipment components. Whether preassembled on a structure or mounted individually, such components may be electric components. The wind turbine equipment may be mounted on the structure, platform or frame, or be individually mounted to the foundation. The electric components may include, but not be limited to, transformers; switch cabinets; converters, medium voltage systems, low voltage distribution systems, etc.

FIG. 2 illustrates one embodiment of a fixture for locating a structure housing wind turbine equipment on the foundation of a wind turbine tower. Anchor bolts 70 in the footprint of the anchor cage 60 for the tower provide guidepoints 72 for the mounting of the fixture 10. The anchor bolts 70 projecting upward from the anchor cage 60 are precisely located around the footprint for electric connection. Therefore, the stub up tubes need to be precisely located relative to the equipment they will feed on the structure or tower floor.

The fixture may further include a reversible symmetry, such that the the fixture may be flipped 180 degrees and translated to mount at other predesignated guidepoints on the tower footprint to locate at least one additional corner of the structure or the wind turbine equipment.

FIG. 2 illustrates one embodiment of a fixture for locating a structure housing wind turbine equipment on the foundation of a wind turbine tower. Anchor bolts 70 in the footprint of the anchor cage 60 for the tower provide guidepoints 72 for the mounting of the fixture 10. The anchor bolts 70 projecting upward from the anchor cage 60 are precisely located around the footprint for tower shell. The anchor cage holes 65 are indexed with the anchor bolts 70 in the footprint of the anchor cage 60 for the tower structure. Anchor bolts 70 projecting upward from the anchor cage 60 are accurately located around the footprint for electric connection. Therefore, the stub up tubes need to be precisely located relative to the equipment they will feed on the structure or tower floor.
be indexed to a first predetermined location by designating the specific holes with reference to the centerline 90 to which the fixture is to be mounted. The length and shape of the fixture 10 with respect to the guidepoints determine the placement of the footings 80 for the structure 85 on the foundation 75 for the tower. Fixture 10 is illustrated indexed to the left side of the centerline 90. Further, the fixture 10 may be reversed by flipping over and translating to an indexed position on the right side of centerline 90 as shown for reversed fixture 55. Reversed fixture 55 may locate a second footing 80 for the structure 85. By precisely locating two footings for the structure, the structure may be properly and precisely positioned within the envelope of the tower, thereby avoiding interferences and the potential need for repositioning. While it is not shown, if individual wind turbine equipment components were to be mounted on the tower foundation, one or more of these components may be located by using one or more appropriately configured fixtures.

The locating section 25 extends from and may be attached to the mounting section 15 by welds or other means known in the art. The locating section 25 includes a guide arm 30 of appropriate length and orientation with respect to the mounting section 15 to place the end of the guide arm 30 opposite the mounting section 15 in proximity to the location for the structure or wind turbine equipment to be mounted to the foundation. The guide arm 30 may also include, at the end opposite the mounting section 15, an orienting section 35, adapted to fix the position of a corner of the structure or wind turbine equipment component being located on the foundation. In the embodiment shown, the orienting section 35 may be fixed to the guide arm by welding or other appropriate method known in the art. The orienting section 35 may include a plate 37 forming a 90-degree angle 45, with vertex 38. The plate 37 may define the position for the corner of the structure or wind turbine equipment component mounted on the foundation. Further the top surface and the bottom surface of the guide arm 30 may be marked "LEFT" 45 and "RIGHT" 50 to facilitate orientation. In this case, "LEFT" 45 and "RIGHT" 50 identify which surface should be facing an individual mounting the fixture on the left side and the right side, respectively, of the centerline for the door of the structure.

A method, which is not claimed, is also provided for locating wind turbine equipment on a foundation for a wind turbine tower prior to erecting the wind turbine tower. The method may include providing a guidepoint on a footprint on the foundation of the wind turbine tower. The method provides for mounting a fixture to a first predetermined location on the foundation. The vertex 38 for the 90-degree angle is usually arranged in a parallel configuration with the axis of the tower. In other embodiments the orienting section may be formed in other shapes or sizes to define the position for other objects being located on the foundation. The top surface and the bottom surface of the guide arm 30 may be marked "LEFT" 45 and "RIGHT" 50 to facilitate orientation. In this case, "LEFT" 45 and "RIGHT" 50 identify which surface should be facing an individual mounting the fixture on the left side and the right side, respectively, of the centerline for the door of the structure.
such as the centerline for the door of a structure being positioned. The method further includes marking a locator spot for the wind turbine equipment or structure according to the orienting section of the fixture.

[0027] The step of providing the guidepoint may further include providing anchor bolts for the foundation of the tower or providing botholes on a top flange of an embedded tower part, within the foundation, to act as the guidepoints.

[0028] The step of marking locating spots for a plurality of components on the foundation may also include marking spots for a plurality of different components according to a plurality of associated fixtures, which may be of different size and orientation and be mounted at different guidepoint locations according to the required positioning for the components. The step of marking may also include marking the locating spot for a structure. These structures may include enclosed spaces such as a machinery or equipment room, or frames for components. The marking step may also include marking the spot for an electric component of the wind turbine equipment. The electric equipment may include, but not be limited to, transformers; switch cabinets; converters, medium voltage systems, low voltage distribution systems, etc. The electric component may also include a stub up tube for electric wiring for electric components within the tower. The method may include marking the locating spot for a stub tube for electric cabling for wind turbine equipment.

[0029] Further, the method for locating wind turbine equipment may also include the step of flipping the fixture 180 degrees and translating the fixture to a second pre-designated guidepoint. The second pre-designated point may also be indexed to the designated position for the centerline of the door for the structure being positioned. For example, the procedure may index the mounting section of the fixture to a first pre-designated point (e.g., 9th hole 96 and 10th hole 97 on the anchor cage to the left of the centerline in FIG. 2). The method may further include mounting the fixture to the second pre-designated guidepoint (e.g. 9th hole 98 and 10th hole 99 on the anchor cage to the right FIG. 2) of the centerline. The method may also include marking the locating spot according to the orienting section of the fixture.

[0030] FIG. 5 illustrates a flowchart of a method for locating wind turbine equipment on a foundation for a wind turbine tower prior to erecting the wind turbine tower. Step 200 includes providing a guidepoint on a footprint for locating the wind turbine tower. Step 210 includes mounting a fixture to a first pre-designated guidepoint. Step 220 includes marking a locator spot for the wind turbine equipment according to an orienting section of the fixture.

Claims

1. A wind turbine tower foundation (75) comprising: anchor cage bolts (70) provided in an anchor cage (60) for the wind turbine tower, and a fixture (10) adapted for locating wind turbine equipment (85) on the foundation within an inner envelope of the tower prior to erecting the tower, the fixture comprising:

   a mounting section (15), the mounting section being a mounting element (15), the mounting element being adapted to mate with guidepoints (72) at pre-designated locations on the foundation, wherein the mounting element is attached to the foundation by a plurality of said anchor cage bolts which are received in a plurality of mounting holes (20) of the mounting element, said plurality of mounting holes being positioned normal to a face of the mounting element, wherein said guidepoints comprise said plurality of anchor cage bolts; and a locating section (25), extending inward from the mounting element, adapted to locate wind turbine equipment on the foundation for the wind turbine tower and within the inner envelope of the wind turbine tower, wherein the locating section is mounted to the mounting element and comprises a guide arm (30) extending inward from the mounting element to the intended position of the wind turbine equipment.

2. The wind turbine tower foundation according to Claim 1, wherein the guidepoints (72) on the foundation comprise: embedded guidepoints within the foundation (75).

3. The wind turbine tower foundation according to Claim 2, wherein the locating section (25) fixes the location for a corner of a structure (85).

4. The wind turbine tower foundation according to any preceding Claim, wherein the locating section (25) fixes the location for a wind turbine equipment component.

5. The wind turbine tower foundation according to any preceding Claim, wherein the locating section fixes the location for a wind turbine equipment electric component.

6. The wind turbine tower foundation according to Claim 5, wherein the wind turbine electric component is a stub up tube for electric wiring.

7. The wind turbine tower foundation according to any preceding Claim, wherein the locating section (25) comprises:

   an orienting section (35) at the inner end of the guide arm (30) adapted to orient at least one of the structure (85) and the wind turbine equipment.
8. The wind turbine tower foundation according to any preceding Claim, further comprising:

a reversible symmetry such that the fixture may be flipped 180 degrees and translated to mount at predesignated locations to locate an additional position of the at least one of the structure (85) and the wind turbine equipment.

9. The wind turbine tower foundation according to any preceding Claim, wherein the fixture is indexed to mount at predesignated locations on the guidepoints (72).

Patentansprüche

1. Windkraftanlagen-Turmfundament (75), umfassend:

Ankerkorrbolzen (70), bereitgestellt in einem Ankerkorb (60) für den Windkraftanlagenturm, und eine Fixierung (10), die zum Lokalisieren einer Windkraftanlagenausrüstung (85) auf dem Fundament, innerhalb einer inneren Umhüllung des Turms vor Errichten des Turms, ausgebildet ist, wobei die Fixierung umfasst:

einen Montageabschnitt (15), wobei der Montageabschnitt ein Montageelement (15) ist, wobei das Montageelement ausgebildet ist, sich mit Führungspunkten (72) an vorbestimmten Stellen auf dem Fundament zusammenzufügen, wobei das Montageelement durch mehrere der Ankerkorrbolzen, welche in mehreren Montagelöchern (20) des Montageelements aufgenommen sind, am Fundament befestigt ist, wobei die mehreren Montagelöcher normal zu einer Vorderseite des Montageelements positioniert sind, wobei die Führungspunkte die mehreren Ankerkorrbolzen umfassen; und einen Lokalisierungsabschnitt (25), welcher sich vom Montageelement aus nach innen erstreckt, der ausgebildet ist, eine Windkraftanlagenausrüstung auf dem Fundament für den Windkraftanlagenturm und innerhalb der inneren Umhüllung des Windkraftanlagenturms zu lokalisieren, wobei der Lokalisierungsabschnitt am Montageelement montiert ist und einen Führungssarm (30) umfasst, welcher sich vom Montageelement aus nach innen, zur angedachten Position der Windkraftanlagenausrüstung erstreckt.

2. Windkraftanlagen-Turmfundament nach Anspruch 1, wobei die Führungspunkte (72) auf dem Fundament umfassen: im Fundament (75) eingebettete Füh-

rungspunkte.


5. Windkraftanlagenfundament nach einem der vorangehenden Ansprüche, wobei der Lokalisierungsabschnitt die Stelle für eine elektrische Windkraftanlagenausrüstungskomponente fixiert.

6. Windkraftanlagenfundament nach Anspruch 5, wobei die elektrische Windkraftanlagenkomponente eine Aufwärtsstichleitungsrohre für elektrische Verkabelung ist.

7. Windkraftanlagenfundament nach einem der vorangehenden Ansprüche, wobei der Lokalisierungsabschnitt (25) umfasst:

einen Ausrichtungsabschnitt (35) am Innenende des Führungssarms (30), der ausgebildet ist, zumindest eine von der Struktur (85) und der Windkraftanlagenausrüstung auszurichten.

8. Windkraftanlagenfundament nach einem der vorangehenden Ansprüche des Weiteren umfassend:

eine umkehrbare Symmetrie, sodass die Fixierung um 180 Grad gedreht und verschoben werden kann, um an vorbestimmten Stellen montiert zu werden, um eine zusätzliche Position der zumindest einen von der Struktur (85) und der Windkraftanlagenausrüstung zu lokalisieren.

9. Windkraftanlagenfundament nach einem der vorangehenden Ansprüche, wobei die Fixierung indiziert ist, um an vorbestimmten Stellen an den Führungspunkten (72) montiert zu werden.

Revendications

1. Fondation de tour d'éolienne (75) comprenant : des boulons de cage d’ancrage (70) disposées dans une cage d’ancrage (60) pour la tour de l’éolienne et un dispositif de fixation (10) adapté pour localiser l’équipement d’éolienne (85) sur la fondation dans une enveloppe interne de la tour avant de dresser celle-ci, le dispositif de fixation comprenant :

une section de montage (15), la section de mon-
tage étant un élément de montage (15), l’élément de montage étant adapté pour se jumeler à des points de guidage (72) dans des emplacements pré-désignés de la fondation, dans lequel l’élément de montage est fixé à la fondation par une pluralité de dits boulons de cage d’ancrage qui sont reçus dans une pluralité de trous de montage (20) de l’élément de montage, ladite pluralité de trous de montage étant positionnés normalement à une face de l’élément de montage, dans laquelle lesdits points de guidage comprennent ladite pluralité de boulons de la cage d’ancrage ; et 

une section de localisation (25) s’étendant vers l’intérieur de l’élément de montage et qui est adaptée pour localiser l’équipement de l’éolienne sur la fondation pour la tour de l’éolienne et dans l’enveloppe interne de la tour de l’éolienne, dans laquelle la section de localisation est montée sur l’élément de montage et comprend un bras de guidage (30) s’étendant vers l’intérieur de l’élément de montage dans la position prévue de l’équipement de l’éolienne.

2. Fondation de tour d’éolienne selon la revendication 1, dans laquelle les points de guidage (72) sur la fondation comprennent des points de guidage noyés dans la fondation (75).

3. Fondation de tour d’éolienne selon la revendication 2, dans laquelle la section de localisation (25) fixe l’emplacement pour un coin d’une structure (85).


5. Fondation de tour d’éolienne selon l’une quelconque des revendications précédentes, dans laquelle la section de localisation fixe l’emplacement pour un composant électrique de l’équipement de l’éolienne.

6. Fondation de tour d’éolienne selon la revendication 5, dans laquelle le composant électrique de l’éolienne est un tube passe-câbles pour un câblage électrique.

7. Fondation de tour d’éolienne selon l’une quelconque des revendications précédentes, dans laquelle la section de localisation (25) comprend :

une section d’orientation (35) à l’extrémité interne du bras de guidage (30) adaptée pour orienter au moins l’un(e) de la structure (85) et de l’équipement de l’éolienne.

8. Fondation de tour d’éolienne selon l’une quelconque des revendications précédentes, comprenant en outre :

une symétrie réversible telle que le dispositif de fixation puisse être basculé de 180 degrés et transférer lors du montage à des emplacements pré-désignés pour localiser une position supplémentaire de l’un(e) de la structure (85) et de l’équipement de l’éolienne.

9. Fondation de tour d’éolienne selon l’une quelconque des revendications précédentes, dans laquelle le dispositif de fixation est indexé pour être monté à des emplacements pré-désignés aux points de guidage (72).
200 Providing a guidepoint on a footprint on the foundation of the wind turbine.

210 Mounting a fixture to a first predesignated guide point

220 Marking a locator spot for the wind turbine equipment according to an orienting section of the fixture

Fig. 5
REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description