

LIFTING APPLIANCE AND LIFTING METHOD FOR THREE-DIMENSIONAL PREFABRICATED MEMBER

5 Field of the Invention

The present invention relates to a lifting appliance and a lifting method, and particularly, to a lifting appliance and a lifting method suitable for various three-dimensional prefabricated members, with which lifting requirements of three-dimensional prefabricated members with different sizes can be satisfied.

Background of the Invention

Currently, a lifting appliance is generally not used on a construction site for lifting three-dimensional components, or alternatively, a relatively simple lifting appliance is used to be directly connected, through hanging ropes thereon, to suspension points on a three-dimensional prefabricated member. The existing lifting appliance is largely limited, only suitable for lifting some three-dimensional prefabricated members of relatively regular sizes, but incapable of lifting overweight prefabricated members, thus failing to satisfy lifting requirements of complex and diverse components. Moreover, lifting will be unstable in case of a hollow prefabricated member or a structurally complex prefabricated member subject to serious deviation in a center of gravity, where a center of gravity largely deviates from a lifting point. In this case, the hanging ropes on a commonly-used lifting appliance are under inhomogeneous forces, such that the hanging ropes are partly tightened and partly in a loose state free from any forces. As a result, thicker hanging ropes and suspension points of stronger lifting capacity are required. The above situations lead to security risks.

30 Summary of the Invention

The technical problem to be solved by the present invention is to provide a lifting appliance suitable for lifting diversified three-dimensional prefabricated members, which can satisfy lifting requirements of three-dimensional prefabricated members

with different sizes. Upper hanging eyes in an upper part of the lifting appliance are connected to a lifting apparatus by means of first hanging ropes, and lower hanging eyes in a lower part of the lifting appliance can be located at different positions in such a manner as to enable all suspension points on three-dimensional prefabricated members with different sizes to be vertically connected to the lower hanging eyes of the lifting appliance, and to enable centers of gravity of the prefabricated members to be vertically aligned with a lifting point and a center of gravity of the lifting appliance. Thus, the three-dimensional prefabricated members can be lifted smoothly, and the hanging ropes can be guaranteed to work safely under balanced forces.

In order to solve the above technical problem, the present invention provides a lifting appliance for three-dimensional prefabricated member, comprising a hanger. An upper part of the hanger is provided with at least three upper hanging eyes, which are connected to a lifting point of a lifting apparatus arranged thereabove via first hanging ropes to keep a center of gravity of the hanger to be vertically aligned with the lifting point. A lower part of the hanger is provided with a plurality of lower hanging eyes, which is vertically connected to suspension points of the three-dimensional prefabricated member to be lifted via second hanging ropes. Positions of the lower hanging eyes connected to the second hanging ropes are variable, so that through variation of the positions of the lower hanging eyes connected to the suspension points of different three-dimensional prefabricated members to be lifted, centers of gravity of the three-dimensional prefabricated members to be lifted are located directly below the center of gravity of the hanger and the lifting point of the lifting apparatus along a vertical direction.

In the lifting appliance for three-dimensional prefabricated member, the lower part of the hanger is provided with a plurality of optional lower hanging eyes that is numbered and arranged around the center of gravity of the hanger, and at least three of the optional lower hanging eyes are selected, in accordance with structural characteristics of the three-dimensional prefabricated member to be lifted, as the lower hanging eyes to be connected to the second hanging ropes, so as to enable the center of gravity of the three-dimensional prefabricated member to be lifted directly below the center of gravity of the hanger and the lifting point of the lifting apparatus along the vertical direction, with the suspension points of the three-dimensional

prefabricated member to be lifted being vertically aligned with the lower hanging eyes.

5 In the lifting appliance for three-dimensional prefabricated member, the lower hanging eyes are movable left and right or back and forth along longitudinal and lateral guideways disposed on the hanger, and are locked when being moved until the center of gravity of the three-dimensional prefabricated member to be lifted is located directly below the center of gravity of the hanger and the vertical direction of the lifting point of the lifting apparatus along the vertical direction.

10 In the lifting appliance for three-dimensional prefabricated member, the longitudinal and lateral guideways of the hanger are provided with position coordinates.

15 In the lifting appliance for three-dimensional prefabricated member, the hanger has a regular geometric shape, the center of gravity of the hanger being located at a geometric center of the hanger.

20 In the lifting appliance for three-dimensional prefabricated member, the hanger is formed as a rectangular frame by welding I-beams, the upper hanging eyes of the hanger being provided in an upper portion of the rectangular frame and the lower hanging eyes being provided in a lower portion of the rectangular frame.

25 In the lifting appliance for three-dimensional prefabricated member, brackets are provided below the hanger to facilitate placement of the hanger on ground.

30 The present invention further discloses a method for lifting a three-dimensional prefabricated member with the above-mentioned lifting appliance, specifically comprising the following steps: i) determining positions of the suspension points of the three-dimensional prefabricated member to be lifted and pre-embedding hooks at the positions in a prefabricating factory, wherein at least three suspension points are selected to keep the three-dimensional prefabricated member stable when being lifted; and ii) determining, according to the positions of selected suspension points of the three-dimensional prefabricated member to be lifted, positions of corresponding lower hanging eyes of the hanger, the lower hanging eyes being vertically connected to the

suspension points of the three-dimensional prefabricated member to be lifted by means of the second hanging ropes, and moving the lower hanging eyes in such a manner as to enable the center of gravity of the three-dimensional prefabricated member to be lifted to be vertically aligned with the center of gravity of the hanger and the lifting point of the lifting apparatus, thus to stably lift the three-dimensional prefabricated member to be lifted.

The present invention further discloses a method for lifting a three-dimensional prefabricated member with the lifting appliance, comprising the following steps: i) determining positions of the suspension points of the three-dimensional prefabricated member to be lifted and pre-embedding hooks at the positions in a prefabricating factory; vertically aligning the center of gravity of the three-dimensional prefabricated member to be lifted with the center of gravity of the hanger and the lifting point of the lifting apparatus; and determining the lower hanging eyes according to the suspension points of the three-dimensional prefabricated member to be lifted, so as to vertically aligning the suspension points with the lower hanging eyes of the hanger or with points on the guideways, with numbers of the lower hanging eyes or position coordinates of the points on the guideways being recorded; and ii) vertically connecting the suspension points of the three-dimensional prefabricated member to be lifted to correspondingly numbered lower hanging eyes through the second hanging ropes, or moving the lower hanging eyes to the position coordinates of the points on the guideways as determined in step i), to stably lifting the three-dimensional prefabricated member to be lifted.

Compared with the prior arts, when the lifting appliance of the present invention is used to lift the three-dimensional prefabricated member, the center of gravity of the hanger, the lifting point, and the center of gravity of the three-dimensional prefabricated member can be located in a same vertical line, thereby ensuring stability of a lifting procedure. The lifting appliance is vertically connected to the three-dimensional prefabricated member to be lifted through the hanging ropes, which enables more balanced forces. The positions of the lower hanging eyes can be changed to satisfy lifting requirements of three-dimensional prefabricated members with different sizes, without having to replace the lifting appliance. This remarkably improves work efficiency and facilitates safer and more efficient operations.

Brief Description of the Drawings

Fig. 1 is a three-dimensional lifting diagram of a lifting appliance for three-dimensional prefabricated member according to the present invention; and

Fig. 2 is a bottom view of the lifting appliance for three-dimensional prefabricated member according to the present invention.

Detailed Description of the Embodiments

The present invention will be described in further detail with reference to the accompanying drawings and the embodiments, in which the objectives, technical solutions, and advantages of the present invention will become more apparent. It is to be understood that the specific embodiments described herein are merely to illustrate the present invention but are not intended to limit the present invention.

As shown in Fig. 1, a lifting appliance for three-dimensional prefabricated member according to the present invention includes a hanger 101, an upper part of which is provided with at least three upper hanging eyes 102. The number of the upper hanging eyes 102 can be flexibly determined according to the geometric shape and the loading condition of the hanger 101, which has preferably a regular geometric shape with its center of gravity 104 at its geometric center. The hanger 101 of the present embodiment is configured to have a rectangular shape. The hanger 101 may be formed by I-beams or the like through welding, and the upper part of the hanger 101 is welded with four upper hanging eyes 102, which are connected to a lifting point 301 of a lifting apparatus through first hanging ropes 201. When the hanger 101 is lifted, the lifting point 301 is vertically aligned with the center of gravity 104 of the hanger 101.

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As shown in Fig. 2, a plurality of lower hanging eyes 103 numbered 1 to 62 is provided at a lower part of the hanger 101, with the center of gravity 104 as a center. The lower hanging eyes 103 are numbered to facilitate rapid and accurate positioning of specific lower hanging eyes 103 to be connected by construction workers on site

during lifting operations.

As shown in Fig. 1, the lower hanging eyes 103 are connected to suspension points 402 on a three-dimensional prefabricated member 401 to be lifted by means of second hanging ropes 202 or hand chain hoists. The suspension points 402 on the three-dimensional prefabricated member 401 are determined in advance at the factory through calculation. Hooks can be pre-embedded at the suspension points 402, so as to be conveniently connected to the hanging ropes. The suspension points 402 can be located in such a manner as to enable vertical alignment of the center of gravity of the three-dimensional prefabricated member 401, the center of gravity 104 of the hanger 101, and the lifting point 301 of the lifting apparatus. According to the structural characteristics of the three-dimensional prefabricated member 401, points vertically projected on the three-dimensional prefabricated member 401 by at least three suitable lower hanging eyes 103 of the hanger 101 are selected as the suspension points 402 of the three-dimensional prefabricated member 401. Serial numbers of corresponding lower hanging eyes 103 are recorded then. When the three-dimensional prefabricated member 401 is required to be lifted, one end of each second hanging rope 202 is connected to the suspension point 402 of the three-dimensional prefabricated member 401 to be lifted, and the other end of each second hanging rope 202 is connected to a correspondingly numbered lower hanging eye 103 of the hanger 101, such that the three-dimensional prefabricated member 401 can be lifted. At such a moment, the lifting point 301 of the lifting apparatus, the center of gravity 104 of the hanger, and the center of gravity of the three-dimensional prefabricated member 401 are located on a same straight vertical line. In addition, the hanger 101 is vertically connected to the three-dimensional prefabricated member 401 through the second hanging ropes 202, and the first hanging ropes 201 and the second hanging ropes 202 are under more balanced forces, such that lifting can be stable.

If the hanger 101 is desired to lift various three-dimensional prefabricated members of complex shapes or sizes, lower hanging eyes 103 equidistantly arranged in an array may be provided at the lower part thereof with its center of gravity 104 as a center.

The lower hanging eyes 103 in the above embodiment may also be configured to

be slidable along longitudinal and lateral guideways (not shown) provided on the hanger 101 in the right-left and front-rear directions. Since positions of the lower hanging eyes can be flexibly changed, lifting requirements of three-dimensional prefabricated members 401 of different sizes can be satisfied without a large number of lower hanging eyes provided at the lower part of the hanger 101. Such being the case, a larger range will be selectable for the suspension points 402 when they are arranged on the three-dimensional prefabricated member 401 at the factory, and it is only necessary to ensure that the suspension points 402 are located within a slide range of the lower hanging eyes 103 when being vertically aligned therewith. During lifting operations, the second hanging ropes 202 vertically connects the suspension points 402 of the three-dimensional prefabricated member 401 to be lifted and the lower hanging eyes 103 of the hanger 101. The lower hanging eyes 103 can be adjusted in positions thereof so as to be locked by means of locking devices when the center of gravity of the three-dimensional prefabricated member to be lifted is located directly below the center of gravity 104 of the hanger 101 and the lifting point 301 of the lifting apparatus. The lifting apparatus can then be used to lift the three-dimensional prefabricated member 401 smoothly. In order to facilitate field operation, position coordinates such as scales can be provided on the guideways of the hanger 101. The position coordinates on the guideways for the lower hanging eyes 103 vertically aligned with the suspension points 402 are recorded when the suspension points 402 on the three-dimensional prefabricated member 401 are being arranged at the factory. When the lower hanging eyes 103 are directly moved to corresponding positions on the guideways during on-site lifting operations, it can be ensured that the second hanging ropes 202 are vertically connected to the suspension points 402 of the three-dimensional prefabricated member 401 and the lower hanging eyes 103 of the hanger 101, with the center of gravity of the three-dimensional prefabricated member 401, the center of gravity of the hanger 104, and the lifting point 301 of the lifting device being vertically aligned. It is unnecessary to repeatedly move the lower hanging eyes 103 to achieve the above-mentioned result, thereby improving lifting efficiency.

Brackets 105 can be provided below the hanger 101, for example, being welded to the lower part of the hanger 101, to facilitate placement of the hanger 101 on ground.

The present invention further discloses a method for lifting diversified three-dimensional prefabricated members with the above lifting appliance. As shown in Fig. 1, when the lower hanging eyes 103 are fixedly arranged at the lower part of the hanger 101, it is necessary to determine positions of the suspension points 402 on the three-dimensional prefabricated member 401 to be lifted. The center of gravity of the three-dimensional prefabricated member 401 is vertically aligned with the center of gravity 104 of the hanger 101 and the lifting point 301, and the lower hanging eyes 103 are vertically projected on the three-dimensional prefabricated member 401. At least three suitable projection points are selected as the suspension points 402 of the three-dimensional prefabricated member 401 according to structural characteristics of the three-dimensional prefabricated member 401, and the positions of the lower hanging eyes 103 corresponding to the suspension points 402 in terms of projection are recorded. Preferably, the lower hanging eyes 103 of the hanger 101 can be numbered to uniquely determine the positions thereof, so that on-site operators can quickly and accurately connect the three-dimensional prefabricated member to the lower hanging eyes 103 on the hanger 101 by means of the hanging ropes. During the lifting operations, the second hanging ropes 202 each is connected, through one end thereof, to a hanging point 402 on the three-dimensional prefabricated member 401, and through the other end thereof, to a correspondingly numbered lower hanging eye 103 on the hanger 101. When the lifting apparatus lifts the three-dimensional prefabricated member 401 by means of the hanger 101, the lifting point 301 of the lifting apparatus, the center of gravity 104 of the hanger 101, and the center of gravity of the three-dimensional prefabricated member 401 to be lifted can be vertically aligned, and the second hanging ropes 202 can vertically connect the three-dimensional prefabricated member 401 and the lower hanging eyes 103 of the hanger 101.

When the lower part of the hanger 101 is provided with the guideways, on which the locking devices are arranged for fixing the lower hanging eyes, and the lower hanging eyes can slide left and right or back and forth along the longitudinal and lateral guideways, only a small amount of lower hanging eyes 103 can be provided to satisfy the lifting requirements of three-dimensional prefabricated member 401 of different sizes. Thus, the suspension points 402 can be more flexibly arranged on the

three-dimensional prefabricated member 401, so long as it can be ensured that the sizes of the suspension points 402 are within a variable range of the lower hanging eyes 103 of the hanger 101. When the second hanging ropes 202 are vertically connected to the suspension points 402 for lifting the three-dimensional prefabricated member 401, since the positions of the lower hanging eyes 103 can be continuously changed, it is always possible to find suitable positions such that the center of gravity of the three-dimensional prefabricated member 401 is vertically aligned with the lifting point 301 of the lifting apparatus and the center of gravity 104 of the hanger. At such a moment, the lower hanging eyes 103 are securely locked by the locking devices, and thus can no longer move along the guideways on the hanger 101. The lifting apparatus can then be started to smoothly lift the three-dimensional prefabricated member 401.

When the lifting appliance and the method as aforementioned are used to lift the three-dimensional prefabricated member, the lifting point of the lifting apparatus, the center of gravity of the hanger, and the center of gravity of the three-dimensional prefabricated member to be lifted can be located in a same vertical line. The second hanging ropes are vertically connected to the hanger and the three-dimensional prefabricated member to be lifted, which enables more balanced forces. Where an overweight three-dimensional prefabricated member is to be lifted, it is merely necessary to increase the number of the suspension points, without use of thicker hanging ropes. Through variation in the positions of the lower hanging eyes, different prefabricated members can be lifted without having to replace the lifting appliance, thereby remarkably improving work efficiency.

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The foregoing is merely preferred embodiments of the present invention, but is not intended to be limitation of the present invention. It will be apparent to those skilled in the art that various changes and modifications can be made to the present invention. Any modifications, equivalent substitutions, improvements, and the like within the spirit and principles of the present invention are intended to be included within the scope of the present invention.

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CLAIMS

1. A lifting appliance for three-dimensional prefabricated member, comprising a hanger (101), an upper part of the hanger (101) being provided with at least three
5 upper hanging eyes (102), which are connected to a lifting point (301) of a lifting apparatus arranged thereabove via first hanging ropes (201) to keep a center of gravity (104) of the hanger (101) to be vertically aligned with the lifting point (301), and a lower part of the hanger (101) being provided with a plurality of lower hanging eyes (103), which is vertically connected to suspension points (402) of the three-
10 dimensional prefabricated member (401) to be lifted via second hanging ropes (202),
wherein positions of the lower hanging eyes (103) connected to the second hanging ropes (202) are variable, so that through variation of the positions of the lower hanging eyes (103) connected to the suspension points (402) of different three-dimensional prefabricated members (401) to be lifted, centers of gravity of the three-
15 dimensional prefabricated members (401) to be lifted are located directly below the center of gravity (104) of the hanger (101) and the lifting point (301) of the lifting apparatus along a vertical direction.

2. The lifting appliance for three-dimensional prefabricated member according to
20 claim 1, wherein the lower part of the hanger (101) is provided with a plurality of optional lower hanging eyes that is numbered and arranged around the center of gravity (104) of the hanger, and at least three of the optional lower hanging eyes are selected, in accordance with structural characteristics of the three-dimensional prefabricated member (401) to be lifted, as the lower hanging eyes (103) to be
25 connected to the second hanging ropes (202), so as to enable the center of gravity of the three-dimensional prefabricated member (401) to be lifted directly below the center of gravity (104) of the hanger (101) and the lifting point (301) of the lifting apparatus along the vertical direction, with the suspension points (402) of the three-dimensional prefabricated member (401) to be lifted being vertically aligned with the
30 lower hanging eyes (103).

3. The lifting appliance for three-dimensional prefabricated member according to claim 1, wherein the lower hanging eyes (103) are movable left and right or back and forth along longitudinal and lateral guideways disposed on the hanger (101), and are

locked when being moved until the center of gravity of the three-dimensional prefabricated member (401) to be lifted is located directly below the center of gravity (104) of the hanger (101) and the vertical direction of the lifting point (301) of the lifting apparatus along the vertical direction.

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4. The lifting appliance for three-dimensional prefabricated member according to claim 3, wherein the longitudinal and lateral guideways of the hanger (101) are provided with position coordinates.

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5. The lifting appliance for three-dimensional prefabricated member according to any one of claims 1 to 4, wherein the hanger (101) has a regular geometric shape, the center of gravity (104) of the hanger (101) being located at a geometric center of the hanger (101).

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6. The lifting appliance for three-dimensional prefabricated member according to claim 5, wherein the hanger (101) is formed as a rectangular frame by welding I-beams, the upper hanging eyes (102) of the hanger (101) being provided in an upper portion of the rectangular frame and the lower hanging eyes (103) being provided in a lower portion of the rectangular frame.

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7. The lifting appliance for three-dimensional prefabricated member according to any one of claims 1 to 4, wherein brackets (105) are provided below the hanger (101) to facilitate placement of the hanger (101) on ground.

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8. A method for lifting a three-dimensional prefabricated member with the lifting appliance according to claim 1 or 3, comprising:

step i): determining positions of the suspension points (402) of the three-dimensional prefabricated member (401) to be lifted and pre-embedding hooks at the positions in a prefabricating factory, wherein at least three suspension points (402) are selected to keep the three-dimensional prefabricated member stable when being lifted; and

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step ii): determining, according to the positions of selected suspension points (402) of the three-dimensional prefabricated member (401) to be lifted, positions of corresponding lower hanging eyes (103) of the hanger (101), the lower hanging eyes

(103) being vertically connected to the suspension points (402) of the three-dimensional prefabricated member (401) to be lifted by means of the second hanging ropes (202), and moving the lower hanging eyes (103) in such a manner as to enable the center of gravity of the three-dimensional prefabricated member (401) to be lifted
5 to be vertically aligned with the center of gravity (104) of the hanger and the lifting point (301) of the lifting apparatus, thus to stably lift the three-dimensional prefabricated member (401) to be lifted.

9. A method for lifting a three-dimensional prefabricated member with the lifting
10 appliance according to claim 2 or 4, comprising:

step i): determining positions of the suspension points (402) of the three-dimensional prefabricated member (401) to be lifted and pre-embedding hooks at the positions in a prefabricating factory; vertically aligning the center of gravity of the three-dimensional prefabricated member (401) to be lifted with the center of gravity
15 (104) of the hanger (101) and the lifting point (301) of the lifting apparatus; and determining the lower hanging eyes (103) according to the suspension points (402) of the three-dimensional prefabricated member (401) to be lifted, so as to vertically aligning the suspension points (402) with the lower hanging eyes (103) of the hanger (101) or with points on the guideways, with numbers of the lower hanging eyes (103)
20 or position coordinates of the points on the guideways being recorded; and

step ii): vertically connecting the suspension points (402) of the three-dimensional prefabricated member (401) to be lifted to correspondingly numbered lower hanging eyes (103) through the second hanging ropes (202), or moving the lower hanging eyes (103) to the position coordinates of the points on the guideways as
25 determined in step i), to stably lifting the three-dimensional prefabricated member (401) to be lifted.