MOLD APPARATUS FOR MODULAR INTEGRATED BUILDING UNIT

Field of the Invention

The present invention relates to a mold apparatus for a building structure, and in particular, to a mold apparatus for manufacturing a prefabricated building unit of a modular integrated building.

Background of the Invention

The construction of traditional cast-in-situ concrete buildings suffers problems such as long construction period, hardly controlled quality, and great disturbance on surrounding residents. In order to solve these problems, currently the construction of buildings gradually adopts modular integrated buildings. That is, prefabricated building units of reinforcing concrete structure, such as prefabricated kitchens, prefabricated bathrooms, prefabricated bedrooms and so on, have been completed at respective factories in advance, and then assembled together at the construction site. This kind of construction can essentially reduce on-site workload, shorten the construction duration, and cut down labor cost. In addition, the disturbance on surrounding residents can be greatly reduced also.

When such an existing prefabricated building unit is manufactured in factory, a mold core for four wall plates and the ceiling is usually made first, and then reinforcing bars are bounded outside the mold core before outer molds for the four wall plates are established. Subsequently, the four wall plates and the ceiling are formed through pouring concrete between the mold core and the outer molds. After the concrete reaches sufficient strength, the molds are removed. Then, the prefabricated four wall plates and the ceiling are hoisted as a piece on a bottom plate, and connected with the bottom plate through pouring concrete. Finally, the

prefabricated building unit as required is formed.

For this existing mold apparatus for the prefabricated building unit, since the contact surfaces between the inner/outer molds and the building unit are relatively large, the binding force generated between the molds and the building unit is also relatively large. In this case, removing the molds from the prefabricated building unit is extremely troublesome, so that hoisting the prefabricated building unit is often difficult. This is a challenge in the production of the prefabricated building unit. At the same time, the material amount and weight of the mold apparatus are very large, so that the production cost of the mold apparatus is high. Moreover, in the traditional mold apparatus for the prefabricated building unit, mold plates are welded to a supporting system, so that these mold plates cannot be reused, thus failing to save cost. Further, for various prefabricated building units having different lengths or widths, mold apparatus of different sizes have to be provided, which further increases the mold cost.

Summary of the Invention

In order to overcome the deficiencies existing in the prior arts, the present invention is directed to provide a mold apparatus for a modular integrated building unit, which requires less amount of material, has a low cost, and is convenient in mold removal.

The present invention adopts a technical solution as follows. A mold apparatus for a modular integrated building unit is provided, comprising: a base platform having a horizontal table, a fixed formwork fixed to a side of the base platform, a movable formwork, wall plate inner molds, wall plate outer mold, a top plate base mold, and a top plate supporting frame for supporting a prefabricated top plate. The wall plate outer molds are detachably mounted on the fixed formwork and/or the movable

formwork and/or the base platform, and the top plate supporting frame is detachably mounted on the base platform.

Preferably, the mold apparatus for the modular integrated building unit further comprises a working platform fixed on a top of the fixed formwork and that of the movable formwork, and a staircase leading to the working platform and fixed at an outside of the fixed formwork. A height from the horizontal table of the base platform to the working platform is slightly greater than a height of a prefabricated building unit, and a guard rail is arranged at an outside of the working platform.

The base platform is rectangular in a horizontal direction, and has a width greater than or equal to that of the prefabricated building unit and a length greater than that of the prefabricated building unit. The base platform includes a base frame formed by welding longitudinal and transverse steel profiles together, and a steel plate, which is fixed on a top of the base frame and forms said horizontal table.

A plurality of threaded holes and nuts fixed at bottom of respective threaded holes are provided in advance on the horizontal table of the base platform, for connection with bolts or screws.

The fixed formwork is L-shaped in the horizontal direction, and fixed to one of long sides and one of short sides of the rectangular base platform from outside.

A sliding rail is arranged at an outer side of a long side of the base platform opposite to the fixed formwork, and a pulley is arranged at a bottom of the movable formwork. In addition, the pulley is arranged to slide along the sliding rail, so as to be close to or away from the base platform.

The top plate supporting frame has a structural frame formed by welding a

plurality of uprights with horizontal or diagonal rods connecting the uprights. The structural frame includes a ladder, a supporting frame platform and a supporting frame guard rail that are fixed at a lower portion, a middle portion and an upper portion thereof, respectively.

A top of the top plate supporting frame is fixed with a horizontal supporting arm from outside, to which the top plate base mold is connected from above by leveling screws.

A width of each of the wall plate inner molds and the top plate base mold is in a range of 400-500 mm, and that of each of the wall plate outer molds is in a range of 400-700 mm.

Optionally, the mold apparatus further comprises a detachable pedestrian bridge, which is arranged between the fixed formwork and the movable formwork, and connected to the fixed formwork and the movable formwork by bolts, respectively.

The mold apparatus for the modular integrated building unit according to the present invention is very simple in structure and easy to operate. The operation of the mold apparatus is not difficult for workers, and the error of the product obtained thereby can be easy to control. Moreover, the mold core as used in the traditional manufacturing method is no longer necessary. Normally, a traditional mold apparatus for the building unit has a weight of about 25 tons, while the mold apparatus required by the manufacturing method of the present invention is only about 10 tons, whereby the weight of the mold apparatus can be greatly reduced. In addition, according to the present invention, the molds are detachably connected with corresponding formworks, so that the molds can be removed and replaced flexibly, thus achieving reuse of part of molds to some extent and further reducing the cost. Moreover, one single mold apparatus according to the present invention can be shared for various products

having a size less than or equal to that of the base platform, which is almost impossible for the mold apparatus used in the traditional manufacturing method. Therefore, the production cost of the mold apparatus can be significantly reduced. Further, the wall plates and the top plate of the building unit can be readily assembled on the formwork, and late removal of molds is also very convenient and quick to perform.

Brief Description of the Drawings

Figure 1 schematically shows a planar view of a mold apparatus for a modular integrated building unit according to the present invention;

Figure 2 is a cross-sectional view along line A-A of Figure 1;

Figure 3 is a cross-sectional view along line B-B of Figure 1;

Figure 4 is a cross-sectional view along line C-C of Figure 1;

Figure 5 is cross-sectional view along line D-D of Figure 1;

Figure 6 is a cross-sectional view along line E-E of Figure 1;

Figure 7 schematically shows a planar view of a base platform;

Figure 8 is a vertical cross-sectional view of the base platform;

Figure 9 is a front view of a top plate supporting frame;

Figure 10 is a side view of the top plate supporting frame;

Figure 11 schematically shows the structure of a prefabricated building unit;

Figure 12 schematically shows an exploded view of the prefabricated building unit;

Figure 13 is an enlarge view showing a connection between a prefabricated wall plate and a prefabricated top plate of the prefabricated building unit; and

Figure 14 is an enlarge view showing a connection between adjacent prefabricated wall plates of the prefabricated integrated building unit.

Detailed Description of the Embodiments

In the following, the embodiments of the present invention will be further illustrated with reference to the appending drawings.

The mold apparatus for the modular integrated building unit according to the present invention is intended to manufacture a prefabricated building unit 10 used in a modular integrated building. The prefabricated building unit 10 can have various shapes and models. Figure 11 shows a common rectangular parallelepiped structure, comprising a top plate, a bottom plate, and four wall plates. Among said four wall plates, two of them are arranged along a lengthwise direction of the building unit, while the other two are arranged along a widthwise direction of the building unit, and at least one of the wall plates may also be provided with a door opening or a window opening 107. When the prefabricated building unit 10 is manufactured, the building unit is firstly disintegrated into multiple plates, with respective late-pouring areas and exposed reinforcing bars are provided between adjacent plates for late connection of the plates. As shown in Figure 12, the plates include a top plate 101 and multiple wall

plates 102, and may further include a bottom plate 3. A top plate late-pouring area 104 is formed in advance between the top plate 101 and each wall plate 102. These top plate late-pouring areas 104 are located around the periphery of the top plate 101, and in a same plane as the top plate 101. Four wall plate late-pouring areas 105 are formed in advance between adjacent wall plates 102, and located at both sides of the two wall plates 102 arranged in the widthwise direction, respectively. A bottom plate late-pouring area 106 is formed in advance between the bottom plate 103 and each wall plate 102. These bottom plate late-pouring areas 106 are located around the periphery of the bottom plate 103, and in a same plane as the bottom plate 103. Preferably, each top plate late-pouring area 104 is connected with a corresponding wall plate late-pouring area 105, in order to facilitate pouring concrete in the late-pouring areas. In production, all the plates are prefabricated individually in a manner similar to that for manufacturing floor panel, and then prefabricated plates are connected with each other on the mold apparatus according to the present invention by means of reinforcing bars and cast-in-situ concrete at the late-pouring areas, thus forming the prefabricated building unit 10 finally.

In the following, the mold apparatus of the present invention for manufacturing the above prefabricated building unit of a rectangular parallelepiped structure will be illustrated in detail as an example.

As shown in Figure 1, Figure 2 and Figure 3, the mold apparatus for the modular integrated building unit according to the present invention includes: a base platform 1 having a horizontal table, a fixed formwork 21 fixed to a side of the base platform 1, a movable formwork 22, wall plate inner molds 31 and wall plate outer mold 32 for wall plate late-pouring areas 105, a top plate base mold 4 for the top plate late-pouring areas 104, and a top plate supporting frame 5 for supporting a prefabricated top plate 101. The wall plate outer molds 32 are detachably mounted on the fixed formwork 21 and/or the movable formwork 22 and/or the base platform 1 through bolts, and the top

plate supporting frame 5 is detachably mounted on the base platform 1 through bolts.

As shown in Figures 7 and 8, in this embodiment, the base platform 1 is rectangular in a horizontal direction, and has a width equal to that of the prefabricated building unit and a length greater than that of the prefabricated building unit. The base platform 1 includes a base frame 11 formed by welding longitudinal and transverse steel profiles together, and a horizontal steel plate 12, which is fixed on a top of the base frame 11 and thus forms said horizontal table. A plurality of threaded holes 13 and nuts 14 fixed at the bottom of respective threaded holes are provided in advance on the horizontal table of the base platform 1, for connection with bolts or screws. Of course, according to the size of the prefabricated building unit, these threaded holes 13 and nuts 14 can be respectively arranged at positions where the base platform 1 is connected with the wall plate inner molds 31, the wall plate outer molds 32, the top plate supporting frame 5, the wall plates 102, or the like. In this manner, detachable connection with bolts or screws between the above members and the base platform 1 can be facilitated.

As shown in Figures 1, 2 and 3, the fixed formwork 21 and the movable formwork 22 each have a main body, which is a load-bearing main frame formed by welding vertical, horizontal and oblique steel profiles together. The inner side of the main frame may be further welded with L-shaped profiles and/or channel steels for connecting with the formworks or wall plates 102, while the top thereof may be further fixedly provided with a working platform 23. For safety reasons, a guard rail 25 is arranged at the outside of the working platform 23. In addition, a staircase 24 leading from the ground to the working platform 23 is also fixed at the outside of the fixed formwork 21. The height from the horizontal table of the base platform 1 to the working platform 23 is slightly greater than the height of the prefabricated building unit, so that it is convenient for workers to perform operations on the working platform 23. For example, these operations may be binding reinforcing bars, pouring

concrete, or the like, at the position of the top plate 101 of the building unit.

In this embodiment, as shown in Figure 1, the fixed formwork 21 is L-shaped in the horizontal direction, and fixed to one of long sides and one of short sides of the rectangular base platform 1 from outside through welding or by bolts. As shown in Figure 3, a sliding rail 222 perpendicular to the long side of the base platform 1 is arranged at the outer side of the other long side of the base platform 1 opposite to the fixed formwork 21, and a pulley 221 is arranged at the bottom of the movable formwork 22. The pulley 221 can slide along the sliding rail 222, so as to be close to or away from the base platform 1. When the mold is removed, the movable formwork 22 can be easily slid outward in a horizontal direction, so as to separate from the base platform 1, thus ensuring a space for the mold removal. Of course, according to different shapes, sizes or the like of the prefabricated building unit, the fixed positions of the fixed formwork 21 and the movable formwork 22 can also be changed accordingly.

As shown in Figures 9 and 10, the top plate supporting frame 5 has a structural frame 56 formed by welding a plurality of uprights with horizontal or diagonal rods connecting the uprights. The structural frame 56 includes a supporting frame platform 52 fixed at a middle portion of the structural frame, a ladder 51 leading to the supporting frame platform 52 at a lower portion thereof, and a supporting frame guard rail 53 fixed at an upper portion thereof. With this structure, it is convenient for workers to board the top plate supporting frame 5 for operations. A top surface of the top plate supporting frame 5 is exactly located under a bottom surface of the prefabricated top plate 101 of the building unit, and thus provides support thereto. Dependent on the length and width of the prefabricated building unit, a plurality of top plate supporting frames 5 can be provided on the base platform 1. In addition, the top of the top plate supporting frame 5 is fixedly provided with, at a side thereof close to the top plate late-pouring areas 104, a horizontal supporting arm 54, to which the

top plate base mold 4 is connected from above by leveling screws 55. As shown in Figure 13, in this embodiment, the top plate base mold 4 includes a plastic board 41 having a thickness of 20 mm at a top portion thereof, and wooden blocks 42 each having a size of 100×50 mm and supporting the bottom of the plastic board 41. Each wooden block 42 is connected with the horizontal supporting arm 54 by a leveling screw 55, and the plastic board 41 supports the bottom surface of the top plate late-pouring areas 104. The top plate late-pouring areas 104 each have a width usually in a range of 350 to 450 mm. Correspondingly, the width of the plastic board 41 of the top plate base mold 4 is larger, usually in a range of 400 to 500 mm.

As shown in Figure 4, Figure 5, Figure 6 and Figure 14, the wall plate inner molds 31 and the wall plate outer molds 32 are mounted at the wall plate late-pouring areas 105, respectively. When the wall plate late-pouring areas 105 are located at a side with the fixed formwork 21 or the movable formwork 22 as shown in Figures 4 and 5, the wall plate outer molds 32 can be detachably fixed to the fixed formwork 21 or the movable formwork 22 by bolts in advance, while the wall plate inner molds 31 can be connected with the wall plate outer molds 32 and the fixed formwork 21 or the movable formwork 22 together by bolts 34. Alternatively, when the wall plate late-pouring areas 105 are located at a side without the fixed formwork 21 or the movable formwork 22 as shown in Figure 6, the wall plate outer mold 32 can be fixed, at a middle portion thereof, to the base platform 1 through an adjustable diagonal brace 71 and screws, and fixed, at a bottom portion thereof, to the base platform 1 through screws directly. Similarly, the wall plate inner mold 31 can be connected with a corresponding wall plate outer mold 32 through bolts 34. As shown in Figure 5, for the wall plate late-pouring area 105 located above the door opening 107, the bottom of each of the wall plate inner mold 31 and the wall plate outer mold 32 associated with said wall plate late-pouring area 105 can be supported by an adjustable vertical brace 72, which has a top fixing plate also functioning as a base mold for said wall plate late-pouring area 105.

The width of the wall plate late-pouring areas 105 is usually in a range of 350-450 mm. Correspondingly, the width of the wall plate inner molds 31 is in a range of 400-500 mm, and that of the wall plate outer molds 32 is in a range of 400-700 mm. The wall plate outer molds 32 to be fixed on the formworks should have a larger width in view of spaces that are required by arrangement of bolts, while the wall plate outer molds 32 located at other positions can have a smaller width.

In addition, in order to facilitate the operations performed by workers at the top of the prefabricated building unit, the mold apparatus of the present invention may also include a detachable pedestrian bridge 6 that is arranged between the fixed formwork 21 and the movable formwork 22, as shown in Figure 1. The detachable pedestrian bridge 6 can be connected to the top portions of the fixed formwork 21 and the movable formwork 22 by bolts, respectively.

In the following, a method of using the mold apparatus of the present invention for manufacturing the prefabricated building unit of a rectangular parallelepiped structure will be described as an example. The method of manufacturing the prefabricated building unit includes the following steps.

In Step 1, individual plates of the building unit are prefabricated separately. The plates include the top plate 101, the four wall plates 102, and the bottom plate 103 as shown in Figure 12. Each plate is provided with exposed reinforcing bars at a junction with a corresponding late-pouring area.

In Step 2, wall plate outer molds 32 associated with the wall plate late-pouring areas 105 are fixed on the fixed formwork 21 and/or the movable formwork 22.

In Step 3, a prefabricated wall plate 102 to be arranged in the lengthwise

direction and a prefabricated wall plate 102 to be arranged in the widthwise direction are mounted on the base platform 1, at respective positions where the base platform 1 is connected with the formwork 21. Said two wall plates 102 are connected with and thus fixed to the formwork 21 by members, such as bolts 33 or the like.

In Step 4, the top plate supporting frame 5 is mounted on the base platform 1 at an appropriate position with bolts or screws.

In Step 5, another wall plate 102 to be arranged in the lengthwise direction and another wall plate 102 to be arranged in the widthwise direction are mounted on the base platform 1, respectively. Said two wall plates 102 can be temporarily fixed to the base platform 1 with diagonal braces 71, connecting angles or the like.

In Step 6, the movable formwork 22 is pushed along the sliding rail 222 to be close to another long side of the base platform 1 and connected thereto.

In Step 7, reinforcing bars are bounded in the wall plate late-pouring areas 105 between adjacent wall plates 102, and wall plate inner molds 31 and remaining wall plate outer molds 32 other than that outer mold 32 used in Step 2 are mounted in said wall plate late-pouring areas 105.

In Step 8, the top plate base mold 4 associated with the top plate late-pouring areas 104 is mounted around a top of the top plate supporting frame 5 and then set as being horizontal.

In Step 9, a prefabricated top plate 101 is installed on the top plate supporting frame 5, and reinforcing bars are bounded at the top plate late-pouring areas 104. In addition, several profiles 55 can be further arranged between the fixed formwork 21 and the movable formwork 22, as shown in Figure 3, in order to assist in fixing the

prefabricated top plate 101.

In Step 10, concrete is poured in the wall plate late-pouring areas 105 and the top plate late-pouring areas 104.

In Step 11, after the concrete poured in Step 10 reaches sufficient strength, the wall plate outer molds 32, the wall plate inner molds 31 and the top plate base mold 4 are removed, and the connecting members for connecting the wall plates 102 with the base platform 1, the fixed formwork 21 and the movable formwork 22 are all dismantled also. Then, the whole piece formed by the top plate 101 and four wall plates 102 is hoisted to be disposed on a prefabricated bottom plate 103, and reinforcing bars are bounded in the bottom plate late-pouring areas 106 and then concrete is poured therein. The production of the prefabricated building unit is completed after the concrete reaches sufficient strength.

It can be seen that it is very simple and easy to perform operations when the mold apparatus of the present invention is used to manufacture the prefabricated building unit. The mold apparatus is simple in structure, the operation thereof is not difficult for workers, and the error of the product obtained thereby is easy to control. Since the molds are used in the late-pouring areas only, not so many molds will be required, and the mold core as used in the traditional manufacturing method is no longer necessary, whereby the weight of the mold apparatus can be greatly reduced. Further, according to the characteristics of the mold apparatus of the present invention, one single mold apparatus can be shared for various building units having a size less than or equal to that of the base platform, whereby the production cost of the mold apparatus can be advantageously reduced also. Moreover, the formworks and the molds are all detachable, so that the molds can be removed and replaced flexibly, thus achieving reuse of part of molds to some extent and further reducing the cost. Furthermore, the wall plates and the top plate can be readily assembled on the

formwork, and late removal of molds is also convenient to perform.

The foregoing are only preferred embodiments of the present invention, and are not intended to limit the present invention. Any modification, equivalent replacement or improvement made within the spirit and principle of the present invention should be included in the protection scope of the present invention.

CLAIMS

1. A mold apparatus for a modular integrated building unit, comprising: a base platform (1) having a horizontal table, a fixed formwork (21) fixed to a side of the base platform (1), a movable formwork (22), wall plate inner molds (31), wall plate outer mold (32), a top plate base mold (4), and a top plate supporting frame (5) for supporting a prefabricated top plate,

wherein the wall plate outer molds (32) are detachably mounted on the fixed formwork (21) and/or the movable formwork (22) and/or the base platform (1), and the top plate supporting frame (5) is detachably mounted on the base platform (1);

the base platform (1) is rectangular in a horizontal direction, and has a width greater than or equal to that of the prefabricated building unit and a length greater than that of the prefabricated building unit; and

the fixed formwork (21) is L-shaped in the horizontal direction, and fixed to one of long sides and one of short sides of the rectangular base platform (1) from outside.

2. The mold apparatus for the modular integrated building unit according to claim 1, characterized in that the mold apparatus further comprises a working platform (23) fixed on a top of the fixed formwork (21) and that of the movable formwork (22), and a staircase (24) leading to the working platform (23) and fixed at an outside of the fixed formwork (21); and

a height from the horizontal table of the base platform (1) to the working platform (23) is slightly greater than a height of a prefabricated building unit, and a guard rail (25) is arranged at an outside of the working platform (23).

3. The mold apparatus for the modular integrated building unit according to claim 2, characterized in that ~~the base platform (1) is rectangular in a horizontal direction, and has a width greater than or equal to that of the prefabricated building unit and a length greater than that of the prefabricated building unit; and~~

the base platform (1) includes a base frame (11) formed by welding longitudinal and transverse steel profiles together, and a steel plate (12), which is fixed on a top of the base frame (11) and forms said horizontal table.

4. The mold apparatus for the modular integrated building unit according to claim 3, characterized in that a plurality of threaded holes and nuts fixed at bottom of respective threaded holes are provided in advance on the horizontal table of the base platform (1), for connection with bolts or screws.

~~5. The mold apparatus for the modular integrated building unit according to claim 3 or 4, characterized in that the fixed formwork (21) is L-shaped in the horizontal direction, and fixed to one of long sides and one of short sides of the rectangular base platform (1) from outside.~~

5~~6~~. The mold apparatus for the modular integrated building unit according to claim 1~~5~~, characterized in that a sliding rail (222) is arranged at an outer side of a long side of the base platform (1) opposite to the fixed formwork (21), and a pulley (221) is arranged at a bottom of the movable formwork (22); and

the pulley (221) is arranged to slide along the sliding rail (222), so as to be close to or away from the base platform (1).

6~~7~~. The mold apparatus for the modular integrated building unit according to any one of claims 1 to 4, characterized in that the top plate supporting frame (5) has a structural frame formed by welding a plurality of uprights with horizontal or diagonal rods connecting the uprights,

wherein the structural frame includes a ladder (51), a supporting frame platform (52) and a supporting frame guard rail (53) that are fixed at a lower portion, a middle portion and an upper portion thereof, respectively.

7~~8~~. The mold apparatus for the modular integrated building unit according to any one of claims 1 to 4, characterized in that a top of the top plate supporting frame (5) is fixed with a horizontal supporting arm (54) from outside, to which the top plate base mold (4) is connected from above by leveling screws (55).

8~~9~~. The mold apparatus for the modular integrated building unit according to any one of claims 1 to 4, characterized in that a width of each of the wall plate inner molds (31) and the top plate base mold (4) is in a range of 400-500 mm, and that of each of the wall plate outer molds (32) is in a range of 400-700 mm.

9~~10~~. The mold apparatus for the modular integrated building unit according to any one of claims 1 to 4, characterized in that the mold apparatus further comprises a detachable pedestrian bridge (6), which is arranged between the fixed formwork (21) and the movable formwork (22), and connected to the fixed formwork (21) and the movable formwork (22) by bolts, respectively.