

METHOD FOR MANUFACTURING MODULAR INTEGRATED BUILDING UNIT

5 **Field of the Invention**

The present invention relates to a method for manufacturing a building structure, and in particular, to a method for manufacturing a prefabricated building unit of a rapidly-detachable and reconstructable modular integrated building.

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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.

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20 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

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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.

5 In this existing manufacturing method 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
10 difficult. This is a challenge in the production of the prefabricated building unit. At the same time, the quantity and weight of the molds are very large, so that the production cost of the molds is high.

Summary of the Invention

15 In order to overcome the deficiencies existing in the prior arts, the present invention is directed to provide a method for manufacturing a rapidly-detachable and reconstructable modular integrated building unit, which requires not many of molds, and is convenient in mold removal.

20 The present invention adopts a technical solution as follows. A method for manufacturing a modular integrated building unit, comprising: Step A, prefabricating individual plates, including a top plate and multiple wall plates, of the building unit separately, wherein late-pouring areas are formed in advance between the top plate
25 and each of the wall plates and between adjacent wall plates, respectively, and exposed reinforcing bars are provided in the late-pouring areas of the top plate and the wall plates, and in a bottom of each wall plate; Step B, mounting prefabricated wall plates on a base platform, and fixing them to a formwork that is fixed to the base platform from outside; Step C, mounting a top plate supporting frame on the base

platform; Step D, binding reinforcing bars in the late-pouring areas between adjacent wall plates; Step E, mounting wall plate inner and outer molds in the late-pouring areas between adjacent wall plates; Step F, mounting a base mold in the late-pouring areas between the top plate and the wall plates; Step G, disposing the prefabricated top plate on the top plate supporting frame, and binding reinforcing bars in the late-pouring areas between the top plate and the wall plates; Step H, pouring concrete in the late-pouring areas between adjacent wall plates and in the late-pouring areas between the top plate and the wall plates; Step I, removing the wall plate inner and outer molds and the base mold after the concrete poured in Step H reaches sufficient strength; and Step J, integrating the wall plates and a bottom plate of the building unit together.

In Step A, the plates further include a prefabricated bottom plate, wherein late-pouring areas are formed between the bottom plate and the wall plates for late connection, and reinforcing bars are provided in the late-pouring areas of the bottom plate.

In Step J, a whole piece formed by the top plate and the wall plates is hoisted to be disposed on the prefabricated bottom plate, and concrete is poured after reinforcing bars are bounded in the late-pouring areas between the prefabricated bottom plate and the wall plates.

Alternatively, in Step J a whole piece formed by the top plate and the wall plates is hoisted to be disposed on a bottom plate mold, and after the exposed reinforcing bars at the bottom of the wall plates are bounded with bottom plate reinforcing bars, concrete is poured on the bottom plate mold, so as to form a bottom plate of the building unit that is connected with all wall plates.

In Step B, the formwork is fixed to two adjacent sides of the base platform from

outside, with two of the wall plates being fixed on the formwork firstly; and in Step C the other two of the wall plates are fixed on the formwork.

5 In Step B, wall plate outer molds are fixed on the formwork before fixing the wall plates, the wall plate outer molds being located in the late-pouring areas between adjacent wall plates.

In Step F, the base mold is arranged outside of a top of the top plate supporting frame.

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Preferably, each of the late-pouring areas has a width in a range of 300 to 500 mm.

15 Preferably, in Step A a ledge extending in a direction toward the top plate is provided on a top of each wall plate when the wall plate is prefabricated.

According to the method for manufacturing the modular integrated building unit of the present invention, molds are only required for the late-pouring areas, so that the mold core used in the traditional manufacturing method is no longer necessary. In this manner, the weight of the molds can be greatly reduced. Normally, a set of traditional molds for the building unit has a weight of about 25 tons, while the set of molds required by the manufacturing method of the present invention is only about 10 tons. In addition, a set of molds can be shared for various products having a size less than or equal to the base platform, which is almost impossible for the molds used in the traditional manufacturing method. Therefore, the production cost of the molds can be significantly reduced. Moreover, the plates, such as the top plate, the wall plates or the like, of the building unit are all made separately by means of planar molds in a manner similar to that for manufacturing floor panels, so that the product quality can be easily controlled, the production error can be reduced, and the quality of the overall

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building unit can be improved. Further, the wall plates and the top plate can be readily assembled on the formwork, and late removal of molds is also very convenient and quick to perform.

5 **Brief Description of the Drawings**

Figure 1 schematically shows the structure of a modular integrated building unit;

Figure 2 schematically shows, in Step 1 of a method for manufacturing a
10 rapidly-detachable and reconstructable modular integrated building unit according to the present invention, an exploded view of individual plates of the modular integrated building unit;

Figure 3 schematically shows Step 2 of the method for manufacturing the
15 rapidly-detachable and reconstructable modular integrated building unit according to the present invention;

Figure 4 schematically shows Step 3 of the method for manufacturing the
20 rapidly-detachable and reconstructable modular integrated building unit according to the present invention;

Figure 5 schematically shows Step 4 of the method for manufacturing the
rapidly-detachable and reconstructable modular integrated building unit according to the present invention;

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Figure 6 schematically shows Step 5 of the method for manufacturing the rapidly-detachable and reconstructable modular integrated building unit according to the present invention;

Figure 7 schematically shows Step 6 of the method for manufacturing the rapidly-detachable and reconstructable modular integrated building unit according to the present invention;

5 Figure 8 schematically shows Step 7 of the method for manufacturing the rapidly-detachable and reconstructable modular integrated building unit according to the present invention;

10 Figure 9 schematically shows Step 8 of the method for manufacturing the rapidly-detachable and reconstructable modular integrated building unit according to the present invention;

15 Figure 10 schematically shows Step 9 of the method for manufacturing the rapidly-detachable and reconstructable modular integrated building unit according to the present invention;

20 Figure 11 schematically shows Step 10 of the method for manufacturing the rapidly-detachable and reconstructable modular integrated building unit according to the present invention;

Figure 12 schematically shows Step 11 of the method for manufacturing the rapidly-detachable and reconstructable modular integrated building unit according to the present invention; and

25 Figure 13 schematically shows Step 12 of the method for manufacturing the rapidly-detachable and reconstructable modular integrated building unit according to the present invention.

Detailed Description of the Embodiments

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

5 The prefabricated modular integrated building unit made by a method for manufacturing the rapidly-detachable and reconstructable modular integrated building unit according to the present invention can have various shapes and models. Figure 1 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
10 arranged along a lengthwise direction of the building unit, while the other two are arranged along a widthwise direction of the building unit, and one of the wall plates may also be provided with a door opening or a window opening. In the following the manufacturing method of the present invention will be illustrated with the prefabricated building unit of such a rectangular parallelepiped structure as an
15 example.

In one embodiment of the manufacturing method according to the present invention, the building unit is disintegrated into multiple plates as shown in Figure 2. Between adjacent plates there are provided with respective late-pouring areas and
20 exposed reinforcing bars for subsequent connection of the plates. In production, all the plates are prefabricated individually, and then these prefabricated plates are connected with each other on a mold by means of reinforcing bars and cast-in-situ concrete at the late-pouring areas, thus forming the building unit finally. The plates include a top plate 1 and four wall plates 2, and may further include a bottom plate 3.
25 In this embodiment, as shown in Figure 2, a top plate late-pouring area 11 is formed in advance between the top plate 1 and each wall plate 2. These top plate late-pouring areas 11 are located around the periphery of the top plate 1, and in a same plane as the top plate 1. Four wall plate late-pouring areas 21 are formed in advance between two adjacent wall plates 2, and located at both sides of the two wall plates 2 arranged in

the widthwise direction, respectively. A bottom plate late-pouring area 31 is formed in advance between the bottom plate 3 and each wall plate 2. These bottom plate late-pouring areas 31 are located around the periphery of the bottom plate 3, and in a same plane as the bottom plate 3. Accordingly, the length and width of each of the top plate 1 and the bottom plate 3 are smaller than the length and width of the building unit, respectively, and the length of each of the two wall plates 2 arranged in the widthwise direction is also smaller than the width of the building unit. The top plate 1, each wall plate 2 and the bottom plate 3 are all provided with exposed reinforcing bars 8 in corresponding late-pouring areas and at the bottom of each wall plate, for subsequent connection of the plates. The width of the top plate late-pouring area 11, the wall plate late-pouring area 21 and the bottom plate late-pouring area 31 is in a range of 300 to 500 mm, and 400 mm in this embodiment.

According to the above-mentioned principle of disintegrating a building unit, the method for manufacturing the rapidly-detachable and reconstructable modular integrated building unit according to the present invention may include the following steps.

In Step 1, individual plates of the building unit are prefabricated separately. The plates include the top plate 1, the four wall plates 2, and the bottom plate 3 as shown in Figure 2. Each plate is provided with exposed reinforcing bars 8 at a position where the plate is connected with a corresponding late-pouring area.

In Step 2, as shown in Figure 3, a formwork 5 is fixed to a long side and an adjacent short side of a rectangular base platform 4 from outside, and wall plate outer molds 61 associated with the wall plate late-pouring areas 21 are fixed on the formwork 5.

In Step 3, as shown in Figure 4, a prefabricated wall plate 2 to be arranged in the

lengthwise direction and a prefabricated wall plate 2 to be arranged in the widthwise direction are mounted on the base platform 4, at respective positions where the base platform 4 is connected with the formwork 5. The two wall plates 2 are fixed to the formwork 5 by components, such as bolts or the like.

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In Step 4, as shown in Figure 5, a top plate supporting frame 71 is mounted on the base platform 4 at an appropriate position thereof.

10 In Step 5, as shown in Figure 6, another wall plate 2 to be arranged in the lengthwise direction and another wall plate 2 to be arranged in the widthwise direction are mounted on the base platform 4, respectively. The two wall plates 2 can be temporarily fixed to the base platform 4 with a diagonal brace 72, a connecting angle or the like.

15 In Step 6, as shown in Figure 7, another formwork 5 is fixed at the other long side of the base platform 4 from outside.

In Step 7, as shown in Figure 8, reinforcing bars are bounded in the wall plate late-pouring areas 21 between adjacent wall plates 2, and wall plate inner molds 62 and remaining wall plate outer molds 61 other than that outer mold 61 used in Step 2 are all mounted in these late-pouring areas 21.

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In Step 8, as shown in Figure 9, a base mold 63 associated with the top plate late-pouring areas 11 is mounted and leveled with the top plate. The base mold 63 can be installed around a top of the top plate supporting frame 71. The base mold 63 can be supported with a plastic board having a thickness of 20 mm at a top portion thereof and with a wooden block having a size of 100×50 mm at a bottom portion thereof.

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In Step 9, as shown in Figure 10, a prefabricated top plate 1 is placed on the top

plate supporting frame 71, and reinforcing bars are bounded at the top plate late-pouring areas 11.

In Step 10, as shown in Figure 11, concrete is poured in the top plate late-pouring areas 11 and the wall plate late-pouring areas 21.

In Step 11, as shown in Figure 12, after the concrete poured in Step 10 reaches sufficient strength, the wall plate outer molds 61, the wall plate inner molds 62 and the base mold 63 are all removed, and the connecting members for connecting the wall plates 2 with the bottom platform 4 and the formwork 5 are dismantled. Then, the whole piece formed by the top plate 1 and four wall plates 2 is hoisted to be disposed on a prefabricated bottom plate 3, and reinforcing bars are bounded in the bottom plate late-pouring areas 31 formed between the periphery of the bottom plate 3 and the wall plates 2.

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In Step 12, concrete is poured in the bottom plate late-pouring areas 31, and the production of the prefabricated building unit is completed after the concrete reaches sufficient strength.

The foregoing merely discloses one embodiment of the manufacturing method of the present invention. In Step 1, it is also possible that no prefabricated bottom plate 3 is provided. In this case, in Step 11 above, the whole piece formed by the top plate 1 and four wall plates 2 is hoisted to be disposed on a bottom plate mold. After the exposed reinforcing bars 8 at the bottom of the wall plates 2 are bounded with bottom plate reinforcing bars, concrete is poured on the bottom plate mold, so as to form a cast-in-situ bottom plate 3 of the building unit that is connected with all the wall plates 2.

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In addition, it should be noted here that the above manufacturing method only

indicates the steps included in this embodiment, but does not limit the sequence of these steps. Some of the above steps can be adjusted appropriately in sequence according to actual conditions, such as labor, materials or the like, at the construction site. Alternatively, some steps can be performed concurrently.

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The base platform 4 as described in the above steps is formed by fixing a steel plate on a top of a frame formed by fixedly connecting longitudinal and transverse steel profiles. The length and width of the base platform 4 are respectively greater than or equal to the length and width of the building unit, and the differences in the
10 lengths and widths may be used for arrangement of components such as formwork, diagonal braces, or the like. A set of molds can be shared for various building units whose lengths and widths are less than or equal to the base platform 4. In order to facilitate the production of the building unit, threaded holes and nuts can be provided in advance at appropriate positions of the base platform 4, in order to mount the top
15 plate supporting frame 71, the diagonal braces 72, or the like. Moreover, connecting elements can also be provided in advance around the base platform 4 for connection with the formwork 5 or the like.

Preferably, a working platform 51 may be arranged on the top of the formwork 5,
20 and a staircase 52 leading to the working platform 51 may be arranged on the outside of the formwork 5. The height of the working platform 51 may be slightly higher than that of the wall plates 2 when the wall plates 2 are mounted on the base platform 4. In this manner, it is convenient for workers to go to the top plate of the building unit to perform operations, such as binding reinforcing bars, pouring concrete, or the like.

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Preferably, as shown in Figure 2, when the wall plates 2 are prefabricated in Step 1, a ledge 22 extending in a direction toward the top plate 1 may be also provided on the top of each wall plate 2. The ledge 22 is beneficial for mounting the base mold associated with the top plate late-pouring areas 11, and also for preventing leakage

when concrete is poured in the top plate late-pouring areas 11.

The foregoing are only preferred embodiments of the present invention, and are not intended to limit the present invention. Any modification, equivalent replacement
5 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 method for manufacturing a modular integrated building unit, comprising:

Step A, prefabricating individual plates, including a top plate and multiple wall
5 plates, of the building unit separately, wherein late-pouring areas are formed in
advance between the top plate and each of the wall plates and between adjacent wall
plates, respectively, and exposed reinforcing bars are provided in the late-pouring
areas of the top plate and the wall plates, and in a bottom of each wall plate;

Step B, mounting prefabricated wall plates on a base platform, and fixing them to
10 a formwork that is fixed to the base platform from outside;

Step C, mounting a top plate supporting frame on the base platform;

Step D, binding reinforcing bars in the late-pouring areas between adjacent wall
plates;

Step E, mounting wall plate inner and outer molds in the late-pouring areas
15 between adjacent wall plates;

Step F, mounting a base mold in the late-pouring areas between the top plate and
the wall plates;

Step G, disposing the prefabricated top plate on the top plate supporting frame,
and binding reinforcing bars in the late-pouring areas between the top plate and the
20 wall plates;

Step H, pouring concrete in the late-pouring areas between adjacent wall plates
and in the late-pouring areas between the top plate and the wall plates;

Step I, removing the wall plate inner and outer molds and the base mold after the
concrete poured in Step H reaches sufficient strength; and

25 Step J, integrating the wall plates and a bottom plate of the building unit together.

2. The method for manufacturing the modular integrated building unit according
to claim 1, characterized in that the bottom plate is a prefabricated bottom plate,
wherein late-pouring areas are formed between the bottom plate and the wall plates

for late connection, and reinforcing bars are provided in the late-pouring areas of the bottom plate.

3. The method for manufacturing the modular integrated building unit according to claim 2, characterized in that in Step J a whole piece formed by the top plate and the wall plates is hoisted to be disposed on the prefabricated bottom plate, and concrete is poured after reinforcing bars are bounded in the late-pouring areas between the prefabricated bottom plate and the wall plates.

4. The method for manufacturing the modular integrated building unit according to claim 1, characterized in that in Step J a whole piece formed by the top plate and the wall plates is hoisted to be disposed on a bottom plate mold, and after the exposed reinforcing bars at the bottom of the wall plates are bounded with bottom plate reinforcing bars, concrete is poured on the bottom plate mold, so as to form the bottom plate of the building unit that is connected with all wall plates.

5. The method for manufacturing the modular integrated building unit according to any one of claims 1 to 4, characterized in that in Step B the formwork is fixed to two adjacent sides of the base platform from outside, with two of the wall plates being fixed on the base platform and secured to the formwork firstly; and in Step C the other two of the wall plates are fixed on the base platform.

6. The method for manufacturing the modular integrated building unit according to claim 5, characterized in that in Step B wall plate outer molds are fixed on the formwork before fixing the wall plates, the wall plate outer molds being located in the late-pouring areas between adjacent wall plates.

7. The method for manufacturing the modular integrated building unit according to any one of claims 1 to 4, characterized in that in Step F the base mold is arranged

outside of a top of the top plate supporting frame.

8. The method for manufacturing the modular integrated building unit according to any one of claims 1 to 4, characterized in that each of the late-pouring areas has a
5 width in a range of 300 to 500 mm.

9. The method for manufacturing the modular integrated building unit according to any one of claims 1 to 4, characterized in that in Step A a ledge extending in a direction toward the top plate is provided on a top of each wall plate when the wall
10 plate is prefabricated.