

DOUBLE-SKIN EXTERIOR WALL STRUCTURE FOR MODULAR INTEGRATED BUILDING AND CONSTRUCTION METHOD THEREOF

5 Field of the Invention

The present invention relates to a building structure and construction method thereof, and in particular, to an exterior wall structure for prefabricated building unit in modular integrated building and construction method thereof.

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Background of the Invention

In the prior arts, a modular integrated building is formed by combining a plurality of prefabricated building units, each having a semi-prefabricated wall body.

15 At the construction site, steel bars need to be fixed and wall body formworks need to be installed outside the semi-prefabricated wall body, and then concrete is poured in situ to form a cast-in-situ outer layer of the wall body. However, for a wall body of an exterior wall in a modular integrated building, the semi-prefabricated wall body of the prefabricated building unit should be provided with preformed through-holes, so that

20 the form panels of the exterior wall can be fixed to the prefabricated building unit with through-wall bolts, because there is no support at the bottom of the form panels of the exterior wall. It is also necessary to remove the through-wall bolts and fill the through-holes on the wall body after the cast-in-situ outer layer of the wall body is formed. Therefore, the construction processes of exterior wall are cumbersome, labor

25 and time-consuming, and require the use of a large amount of formworks. Meanwhile, the quality of the surface of exterior wall is difficult to improve and keep consistent, and the integrated decoration for the interior surface of the wall body in the prefabricated building unit cannot be achieved.

Summary of the Invention

The technical problem to be solved by the present invention is to provide a double-skin exterior wall structure for modular integrated building and construction method thereof, whereby it is no longer necessary to install formworks and through-wall bolts for the exterior wall.

The present invention adopts technical solutions as follows. A double-skin exterior wall structure for modular integrated building is provided, comprising a prefabricated interior wall body. The structure further comprises a prefabricated exterior wall body fixed outside of the prefabricated interior wall body, and a cast-in-situ reinforced concrete layer between the prefabricated interior wall body and the prefabricated exterior wall body.

A plurality of protruding columns is fixedly arranged on an outer side surface of the prefabricated interior wall body, with a first connector embedded in each of the columns. A plurality of recesses is provided on an outer side surface of the prefabricated exterior wall body in positions corresponding to the respective columns, with a second connector provided at each of the recesses. The first connector and the second connector are connected to each other, thereby connecting the prefabricated interior wall body and the prefabricated exterior wall body together.

The first connector is formed as a nut while the second connector is formed as a bolt, and through holes are provided in respective positions of a column and a corresponding recess for the bolt to pass through.

Each first connector is welded to two L-shaped reinforcing bars, which are embedded in the prefabricated interior wall body.

Vertical interior-wall protruding strips and vertical interior-wall grooves are alternately provided on the outer side surface of the prefabricated interior wall body, whereby the outer side surface of a horizontal section of the prefabricated interior wall body has an alternating concave and convex shape; and vertical exterior-wall protruding strips and vertical exterior-wall grooves are alternately provided on an inner side surface of the prefabricated exterior wall body, whereby the inner side surface of a horizontal section of the prefabricated exterior wall body also has an alternating concave and convex shape.

10 The positions of vertical interior-wall protruding strips correspond to those of vertical exterior-wall protruding strips, respectively, wherein the columns are provided on the vertical interior-wall protruding strips to abut against the respective ones of the vertical exterior-wall protruding strips.

15 The recesses are filled and leveled with cement mortar.

The construction method of the double-skin exterior wall structure for modular integrated building in the present invention includes steps of:

(a) providing a prefabricated interior wall body and a prefabricated exterior wall body, wherein a plurality of columns protruding outward is arranged on an outer side surface of the prefabricated interior wall body, with a first connector is embedded in each of the columns, and a plurality of recesses is provided on an outer side surface of the prefabricated exterior wall body;

(b) erecting the prefabricated interior wall body;

25 (c) hoisting the prefabricated exterior wall body to a position outside the prefabricated interior wall body in step (b), and connecting the first connectors with the second connectors at the respective recesses, so that the prefabricated interior wall body and the prefabricated exterior wall body are connected as a whole;

(d) hoisting the whole combination of the prefabricated interior wall body and

the prefabricated exterior wall body to an installation position and fixing there;

(e) placing steel reinforcing bars in appropriate positions of the cast-in-situ reinforced concrete layer between the prefabricated interior wall body and the prefabricated exterior wall body; and

- 5 (f) pouring concrete between the prefabricated interior wall body and the prefabricated exterior wall body.

In step (a), the first connector is formed as a nut while the second connector is formed as a bolt, and through holes are provided in respective positions of a column
10 and a corresponding recess for the bolt to pass through.

In step (a), each first connector is welded to two L-shaped reinforcing bars, which are embedded in the prefabricated interior wall body.

- 15 In step (c), the recesses are filled and leveled with cement mortar after the prefabricated interior wall body and the prefabricated exterior wall body are connected as a whole.

Compared with the prior arts, the prefabricated interior wall body and the
20 prefabricated exterior wall body are provided for the double-skin exterior wall structure for modular integrated building in the present invention. First and second connectors that do not need to be removed afterwards are adopted to connect the prefabricated interior wall body and the prefabricated exterior wall body as a whole, which is then hoisted to the construction site for fixing with steel reinforcing bars and
25 concrete pouring. Therefore, there is no need to preform through-holes on the wall bodies of the prefabricated building unit, or install formworks and through-wall bolts for the exterior wall during on-site construction, which significantly reduces the construction processes of the exterior wall and avoids the use of hanging cages at the construction site. At the same time, there would be no through holes on the interior

wall of the prefabricated building unit, thereby avoiding the repairing of the preformed through-holes on the wall bodies afterwards. Accordingly, the interior decoration and on-site construction and production cycle will not be affected, and the integrated decoration of the interior wall surface for modular integrated building can be achieved. In addition, the use of steel plates and cranes can be reduced, which can shorten the on-site construction and production cycle and improve the quality of the exterior wall surface.

Brief Description of the Drawings

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Fig. 1 schematically shows step (a) of the construction method according to the present invention.

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Fig. 2 schematically shows step (b) of the construction method according to the present invention.

Fig. 3 is a perspective view of step (c) of the construction method according to the present invention.

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Fig. 4 is a sectional view of step (c) of the construction method according to the present invention.

Fig. 5 schematically shows step (d) of the construction method according to the present invention.

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Fig. 6 is a perspective view of step (e) of the construction method according to the present invention.

Fig. 7 is a sectional view of step (e) of the construction method according to the

present invention.

Fig. 8 is a horizontal sectional view through the columns and the recesses in Fig. 4.

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Fig. 9 is a vertical sectional view of a double-skin exterior wall structure for modular integrated building according to the present invention.

Fig. 10 is a horizontal sectional view of a double-skin exterior wall structure for modular integrated building according to the present invention.

Detailed Description of the Embodiments

The present invention will be described in further detail with reference to the embodiments as shown in the accompanying drawings.

A double-skin exterior wall structure for modular integrated building according to the present invention is arranged at the exterior wall of the modular integrated building. As shown in Figs. 6 and 10, the double-skin exterior wall structure comprises a prefabricated interior wall body 1 on the inner side, a prefabricated exterior wall body 2 on the outer side, and a cast-in-situ reinforced concrete layer 3 arranged therebetween.

As shown in Fig. 2, the prefabricated interior wall body 1, prefabricated at a factory, can be one of the walls of a prefabricated building unit 10 arranged near the outdoor side of the modular integrated building, and is prefabricated with the prefabricated building unit 10 into one piece. A plurality of protruding columns 11 is prefabricated integrally with the outer side surface of the prefabricated interior wall body 1, with a first connector 4 embedded in each of the protruding columns 11. In

this embodiment, each protruding column 11 is formed as a square concrete block of 75×75×70 mm, and protrudes from the prefabricated interior wall body 1 at a distance of 70mm. The protruding columns 11 are arranged in multiple rows and columns at a certain distance, and the front end faces of the protruding columns 11 are on a same vertical plane.

The prefabricated exterior wall body 2 is also prefabricated at a factory. As shown in Fig. 3, a plurality of recesses 21 are provided on the outer side surface of the prefabricated exterior wall body 2, corresponding to the protruding columns 11 on the prefabricated interior wall body 1 in position, with a second connector 5 provided at each of the recesses 21. In this embodiment, each recess 21 is formed as a square recess of 85×85 mm, with a depth of 42 mm.

As shown in Figs. 8 and 9, the first connector 4 is a nut, and the second connector 5 is a bolt in this embodiment. Accordingly, a first hole 14 and a second hole 24 opposite to each other are provided respectively on a protruding column 11 and a respective recess 21, for the bolts to pass through. By connecting the first and second connectors 4 and 5 with each other, the prefabricated interior wall body 1 and the prefabricated exterior wall body 2 can be securely connected together. Moreover, the layer formed between the prefabricated interior wall body 1 and the prefabricated exterior wall body 2 can be used for installing steel bars and pouring concrete in situ at the construction site, so as to form the cast-in-situ reinforced concrete layer 3. As shown in Fig. 9, a washer 51 also is further provided at the bottom of the recess 21, so that the bolt is connected with the nut embedded in the protruding column 11 after passing through the washer 51, the second through-hole 24 and the first through-hole 14. Of course, the first connector 4 and the second connector 5 can also adopt other connecting members, such as common snap-fitting members.

The protruding columns 11 are provided to fixedly arrange the first connectors 4,

and to separate the opposing surfaces of the prefabricated interior wall body 1 and the prefabricated exterior wall body 2 from a certain distance to form the interlayer. The recesses 21 are provided to accommodate and install the second connectors 5. After connecting the first connectors 4 and the second connectors 5, the recesses 21 can be filled and leveled with cement mortar. Thus there is no need to install the formwork for the exterior wall at the construction site, as the prefabricated exterior wall body 2 can additionally function as the formwork for the exterior wall. There is also no need to provide through-holes that pass through the whole wall body, or install through-wall bolts on the prefabricated interior wall body 1. Accordingly, the integrated decoration of the inner surface of the prefabricated interior wall body 1 can be achieved at respective factories.

To ensure the first connectors 4 can be fixedly arranged in the respective protruding columns 11, each of the first connectors 4 is welded to the ends of two L-shaped steel bars 6, one of which is positioned above the other, which are embedded in the prefabricated interior wall body 1, as shown in Fig. 9. Hence, when the first connectors 4 and the second connectors 5 are connected to each other, the first connectors 4 will not be pulled out of the respective protruding columns 11.

In order to enhance the bonding between the prefabricated wall bodies and the cast-in-situ wall body, and further to facilitate the arrangement of steel bars, the opposing surfaces of the prefabricated interior wall body 1 and the prefabricated exterior wall body 2 are each configured to have an alternating concave and convex shape. As shown in Fig. 1, vertical interior-wall protruding strips 12 and vertical interior-wall grooves 13 are alternately provided on the outer side surface of the prefabricated interior wall body 1, whereby the outer side surface of a horizontal section of the prefabricated interior wall body 1 has an alternating concave and convex shape. Similarly, vertical exterior-wall protruding strips 22 and vertical exterior-wall grooves 23 are alternately provided on an inner side surface of the

prefabricated exterior wall body 2, whereby the inner side surface of a horizontal section of the prefabricated exterior wall body 2 has an alternating concave and convex shape. Moreover, the positions of vertical interior-wall protruding strips 12 correspond to those of vertical exterior-wall protruding strips 22, respectively, and the positions of vertical interior-wall grooves 13 correspond to those of vertical exterior-wall grooves 23, respectively, wherein the protruding columns 11 are provided on the vertical interior-wall protruding strips 12 to abut against the respective ones of the vertical exterior-wall protruding strips 22, as shown in Figs. 8 and 10.

The construction method of the double-skin exterior wall structure for modular integrated building in the present invention includes the following steps.

(a) As shown in Fig. 1, a prefabricated interior wall body 1 and a prefabricated exterior wall body 2 are provided, wherein a plurality of protruding columns 11 protruding outward is integrally prefabricated on an outer side surface of the prefabricated interior wall body 1. A nut is embedded in each of the protruding columns 11 in advance, and welded to the ends of two L-shaped steel bars 6, which are embedded in the prefabricated interior wall body 1 in advance. A plurality of recesses 21 corresponding to the respective protruding columns 11 in position is provided on an outer side surface of the prefabricated exterior wall body 2.

(b) As shown in Fig. 2, the prefabricated interior wall body 1 is erected with diagonal bracings.

(c) As shown in Figs. 3 and 4, the prefabricated exterior wall body 2 is hoisted to a position outside the erected prefabricated interior wall body 1. The prefabricated exterior wall body 2 is adjusted to an erect gesture so that the positions of the protruding columns 11 correspond to those of the recesses 21, respectively. Bolts are used at the recesses 21 for connection with the respective nuts in the protruding

columns 11, so that the prefabricated interior wall body 1 and the prefabricated exterior wall body 2 are connected as a whole. The recesses 21 are filled and leveled with cement mortar. The top of the prefabricated interior wall body 1 is fixedly connected with that of the prefabricated exterior wall body 2 with an L-shaped temporary fixing part 8.

(d) As shown in Fig. 5, the whole combination of the prefabricated interior wall body 1 and the prefabricated exterior wall body 2 is hoisted to an installation position at the construction site, and fixed with diagonal bracings after being adjusted to an erect gesture.

(e) As shown in Figs. 6 and 7, bent steel bars 7 for the cast-in-situ layer are placed in appropriate positions in the interlayer between the prefabricated interior wall body 1 and the prefabricated exterior wall body 2. The right and left ends of the wall bodies are sealed with mode plates.

(f) Concrete is poured in the interlayer between the prefabricated interior wall body 1 and the prefabricated exterior wall body 2, thereby forming an exterior wall structure as shown in Figs. 9 and 10.

The foregoing description is merely illustrative of preferred embodiments of the present invention, and is not intended to limit 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 protection of the present invention.

CLAIMS

1. A double-skin exterior wall structure for modular integrated building, comprising a prefabricated interior wall body (1), characterized in that

5 the double-skin exterior wall structure further comprises a prefabricated exterior wall body (2) fixed outside of the prefabricated interior wall body (1), and a cast-in-situ reinforced concrete layer (3) between the prefabricated interior wall body (1) and the prefabricated exterior wall body (2);

a plurality of protruding columns (11) protruding outward is fixedly arranged on
10 an outer side surface of the prefabricated interior wall body (1), with a first connector (4) embedded in each of the protruding columns (11);

a plurality of recesses (21) is provided on an outer side surface of the prefabricated exterior wall body (2) in positions corresponding to the respective protruding columns (11), with a second connector (5) provided at each of the recesses
15 (21); and

the first connector (4) and the second connector (5) are connected to each other, thereby connecting the prefabricated interior wall body (1) and the prefabricated exterior wall body (2) together.

20 2. The double-skin exterior wall structure for modular integrated building according to claim 1, characterized in that the first connector (4) is formed as a nut while the second connector (5) is formed as a bolt, and through holes are provided in respective positions of a protruding column (11) and a corresponding recess (21) for the bolt to pass through.

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3. The double-skin exterior wall structure for modular integrated building according to claim 2, characterized in that each first connector (4) is welded to two L-shaped steel bars (6), which are embedded in the prefabricated interior wall body (1).

4. The double-skin exterior wall structure for modular integrated building according to claim 1, 2 or 3, characterized in that vertical interior-wall convex strips (12) and vertical interior-wall grooves (13) are alternately provided on the outer side surface of the prefabricated interior wall body (1), whereby the outer side surface of a horizontal section of the prefabricated interior wall body (1) has an alternating concave and convex shape; and

vertical exterior-wall protruding strips (22) and vertical exterior-wall grooves (23) are alternately provided on an inner side surface of the prefabricated exterior wall body (2), whereby the inner side surface of a horizontal section of the prefabricated exterior wall body (2) has an alternating concave and convex shape.

5. The double-skin exterior wall structure for modular integrated building according to claim 4, characterized in that the positions of the vertical interior-wall protruding strips (12) correspond to those of the vertical exterior-wall protruding strips (22), respectively, wherein the protruding columns (11) are provided on the vertical interior-wall protruding strips (12) to abut against the respective ones of the vertical exterior-wall protruding strips (22).

6. The double-skin exterior wall structure for modular integrated building according to claim 4, characterized in that the recesses (21) are filled and leveled with cement mortar.

7. A construction method of the double-skin exterior wall structure for modular integrated building according to claim 1, characterized in that the construction method includes steps of:

(a) providing a prefabricated interior wall body (1) and a prefabricated exterior wall body (2), wherein a plurality of protruding columns (11) protruding outward is arranged on an outer side surface of the prefabricated interior wall body (1), with a

first connector (4) is embedded in each of the protruding columns (11), and a plurality of recesses (21) is provided on an outer side surface of the prefabricated exterior wall body (2);

(b) erecting the prefabricated interior wall body (1);

5 (c) hoisting the prefabricated exterior wall body (2) to a position outside the prefabricated interior wall body (1) in step (b), and connecting the first connectors (4) with the second connectors (5) at the respective recesses (21), so that the prefabricated interior wall body (1) and the prefabricated exterior wall body (2) are connected as a whole;

10 (d) hoisting the whole combination of the prefabricated interior wall body (1) and the prefabricated exterior wall body (2) to an installation position and fixing there;

(e) placing steel bars in appropriate positions of the cast-in-situ reinforced concrete layer (3) between the prefabricated interior wall body (1) and the prefabricated exterior wall body (2); and

(f) pouring concrete between the prefabricated interior wall body (1) and the prefabricated exterior wall body (2).

8. The construction method of the double-skin exterior wall structure for modular integrated building according to claim 7, characterized in that in step (a), the first connector (4) is formed as a nut while the second connector (5) is formed as a bolt, and through holes are provided in respective positions of a protruding column (11) and a corresponding recess (21) for the bolt to pass through.

25 9. The construction method of the double-skin exterior wall structure for modular integrated building according to claim 8, characterized in that in step (a), each first connector (4) is welded to two L-shaped reinforcing bars (6), which are embedded in the prefabricated interior wall body (1) in advance.

10. The construction method of the double-skin exterior wall structure for modular integrated building according to any one of claims 7, 8 and 9, characterized in that in step (c), the recesses (21) are filled and leveled with cement mortar, after the prefabricated interior wall body (1) and the prefabricated exterior wall body (2) are
5 connected as a whole.