

(19) World Intellectual Property Organization
International Bureau



(43) International Publication Date
14 May 2009 (14.05.2009)

PCT

(10) International Publication Number
WO 2009/061702 A1

(51) International Patent Classification:
E04B 1/348 (2006.01) *E04B 1/02* (2006.01)

(21) International Application Number:
PCT/US2008/082277

(22) International Filing Date:
3 November 2008 (03.11.2008)

(25) Filing Language: English

(26) Publication Language: English

(30) Priority Data:
60/985,889 6 November 2007 (06.11.2007) US

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(81) Designated States (unless otherwise indicated, for every
kind of national protection available): AE, AG, AL, AM,
AO, AT, AU, AZ, BA, BB, BG, BH, BR, BW, BY, BZ, CA,
CH, CN, CO, CR, CU, CZ, DE, DK, DM, DO, DZ, EC, EE,
EG, ES, FI, GB, GD, GE, GH, GM, GT, HN, HR, HU, ID,
IL, IN, IS, JP, KE, KG, KM, KN, KP, KR, KZ, LA, LC, LK,
LR, LS, LT, LU, LY, MA, MD, ME, MG, MK, MN, MW,
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RO, RS, RU, SC, SD, SE, SG, SK, SL, SM, ST, SV, SY, TJ,
TM, TN, TR, TT, TZ, UA, UG, US, UZ, VC, VN, ZA, ZM,
ZW.

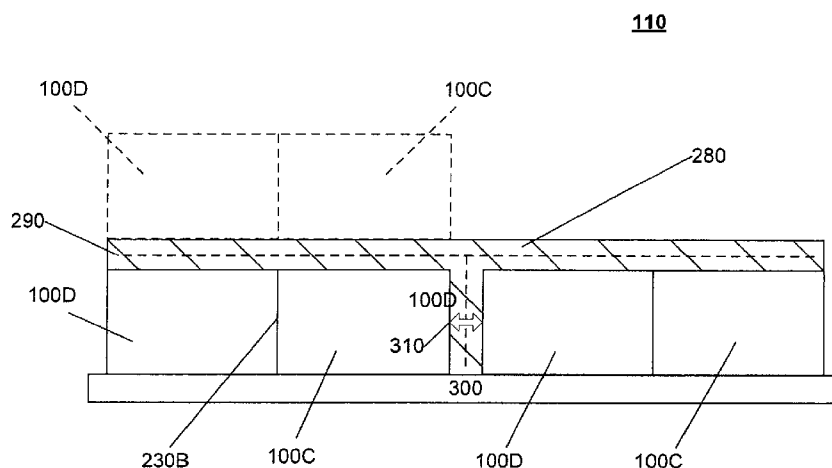
(84) Designated States (unless otherwise indicated, for every
kind of regional protection available): ARIPO (BW, GH,
GM, KE, LS, MW, MZ, NA, SD, SL, SZ, TZ, UG, ZM,
ZW), Eurasian (AM, AZ, BY, KG, KZ, MD, RU, TJ, TM),
European (AT, BE, BG, CH, CY, CZ, DE, DK, EE, ES, FI,
FR, GB, GR, HR, HU, IE, IS, IT, LT, LU, LV, MC, MT, NL,
NO, PL, PT, RO, SE, SI, SK, TR), OAPI (BF, BJ, CF, CG,
CI, CM, GA, GN, GQ, GW, ML, MR, NE, SN, TD, TG).

Published:
— with international search report

[Continued on next page]

(54) Title: MODULAR BUILDING CONSTRUCTION UNIT, SYSTEM, AND METHOD

FIG. 5



(57) Abstract: A modular building construction system includes a) a plurality of modular building construction units of a pre-determined length, width, and height that are substantially the same as standard shipping containers, the modular building construction units configured to be placed upon a foundation at specified separation distances, the modular building construction unit including outer surfaces, some of which act as forms for poured concrete; b) reinforcements configured to be placed between and above the modular building construction units; c) concrete poured over the reinforcements and formed by some of the outer surfaces of the modular building construction unit, whereby the concrete and reinforcements create a monolithic concrete-reinforced supporting structure for the modular building construction system; and d) one or more additional floors including a, b, and c whereby the concrete-reinforced supporting structure for the last completed floor forms the foundation for a, b, and c.

WO 2009/061702 A1



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- *before the expiration of the time limit for amending the claims and to be republished in the event of receipt of amendments*

MODULAR BUILDING CONSTRUCTION UNIT, SYSTEM, AND METHOD

FIELD OF THE INVENTION

[01] The field of the invention relates to modular buildings and construction methods.

BACKGROUND OF THE INVENTION

[02] Modular buildings and construction methods in the past have been used mainly to construct single family housing. Two separate, pre-manufactured modules or halves (pre-manufactured at a manufacturing facility off site) are attached together to form one, single-family house structure. These housing modules typically have a wood-framed structure, and occasionally have a steel-framed structure. The normal method(s) for attaching the two, separate pre-manufactured modules or halves together is by nailing, bolting, and/or welding the frames the modules/halves together at the destination housing/job site.

[03] The modules are normally multiples of the architectural plans in size. For example, each module may comprise one-half of the overall width of the completed structure. The modules are typically designed for room-sized efficiencies, with the room walls normally forming the sides of each module.

[04] Although creating a house out of two pre-manufactured modules, which are pre-manufactured off-site, reduces the cost and time of constructing a home, this type of construction creates some problems. One of the main problems with this type of modular construction is the shipping difficulties caused by the oversized modules. To create a sufficiently sized home out of two modules/halves requires

the modules to be long and significantly wide. The width must be significant because the width of the module defines wall-to-wall room width. The oversized nature of the modules, especially the oversized width of the modules, makes shipping of the modules from the off-site manufacturing factories to the destination housing/job site problematic. Special road permits, special transportation vehicles/trailers, and numerous transportation vehicles are required for shipping the modules from the off-site manufacturing factories to the destination housing/job site.

[05] The oversized nature of the modules also makes shipping by sea/land (and, thus, manufacturing overseas/abroad) not economical. Another problem with these modules, when used to construct multi-family buildings, is that the resulting building must be limited in height (e.g., typically no more than four or five stories in seismic regions such as California). Because of the shipping difficulties with this type of modular construction, the manufacturing factories must be located close to the destination job sites. Having to distribute multiple manufacturing facilities across a state/country versus having a single manufacturing facility in a central location reduces economies of scale and leads to other efficiencies. Also, because a possible housing site must be located close to a manufacturing facility, remote areas in a state/country, where a demand for cheaper housing may be the greatest, cannot take advantage of this type of modular construction.

SUMMARY OF THE INVENTION

[06] To overcome the above problems and others, an aspect of the invention involves a modular building construction unit, a modular building construction

system, and a modular building construction method that allows for the quick, easy, and inexpensive construction of almost unlimited building heights, allows economical shipping of modules anywhere in the world, utilizes concrete (a construction material common throughout the world), and utilizes poured-in-place reinforced concrete construction (a common building construction process throughout the world).

[07] Using concrete in the modular construction, compared to modular construction in the past, provides better fire and acoustic qualities in the building and makes the building more durable. The modular unit, system, and construction method includes using standard shipping-container-sized, pre-fabricated modules (e.g., room modules or corridor/hallway modules) as concrete supporting panels (e.g., forms or boxing) to allow the modular building system structure to be made of poured-in-place, reinforced concrete.

[08] The standard shipping-container-sized, pre-fabricated modules are standard in size and exactly or substantially the same outer dimensions as 20 foot, 30 foot, and 40 foot standard shipping containers. Thus, the height and width of all modules would be the same (e.g., 9 foot, 6 inches in height by 8 foot in width). However, similar to standard shipping containers, the modules would come in a variety of lengths (e.g., a 20 foot length module, a 30 foot length module, or a 40 foot length module). The modules are pre-manufactured at a central manufacturing facility (or facilities).

[09] The modules are manufactured so that less fit-out components and installation are required on the destined job/housing site, reducing construction cost. For example, a room module includes pre-installed walls (painted,

wallpapered), floors (with flooring), ceilings (with lights/fixtures), bathrooms, sinks, toilets, and showers, and is pre-wired/pre-plumbed. A corridor/hallway module includes pre-installed walls (painted, wallpapered), floors (with flooring), and ceilings (with lights/fixtures). The modules include hollow wall sections, ceiling sections, and/or floor sections to provide for services (e.g., electrical wiring and plumbing).

[10] Completing out as much as possible in the modules during manufacturing of the module reduces job site labor time/cost, accelerates site construction considerably, and eliminates the middleman margins in supplying all the fit-out components. The standard shipping container size of the modules allows the modules to be quickly, easily, and inexpensively shipped all over the world to destination housing/job sites.

[11] At the housing/job site, a foundation is constructed, and the modules are arranged on the foundation using a crane. The modules are spaced a pre-determined separation distance from each other, the separation distance varying with the pre-determined height of the modular building system (e.g., 5 floors, 10 floors, 30 floors). For example, a ten-story modular building system may require a separation distance of X , a twenty-story modular building system may require a separation distance of $2X$, and a thirty-story modular building system may require a separation distance of $3X$. The configuration in which the modules are arranged will determine the concrete forming structure for the concrete pouring process.

[12] The external walls/rooftop of the modules form the concrete supporting panels of the concrete forming structure. Reinforcements such as steel reinforcement rods are provided where needed (e.g., vertically oriented between

modules and horizontally oriented above the top of modules) for providing the necessary reinforcement for the poured-in-place, reinforced concrete process. Additional forms (e.g., small metal plates attached to the modular units) are provided where needed to hold poured concrete in place at end/exterior walls and between two adjoining modules that are part of the same room. Concrete is then poured into the forming structure created by the modules. Concrete is poured over the modules/forms, between the modules/forms, and around the reinforcement rods. The dried, formed concrete creates a monolithic T or H shaped concrete-reinforced support structure.

[13] It should be noted that in the present invention, it is this concrete-reinforced support structure created by the modules/forms that provides the structure support for the modular building system. The next floor (and subsequent higher floors) are created in a like manner to that described above, except the modules/forms are arranged on top of the new concrete-reinforced floors (instead of the bottom foundation) on top of the lower modules.

[14] Unlike modular construction in the past, the modules in the present invention do not provide the structural support for the modular building system. The modular construction method of the present invention eliminates most connection details of connecting modules, as was required in the past with prior modular construction, creates the walls of the concrete-reinforced support structure (including the shear walls), creates the floors of the concrete-reinforced support structure, and provides the structure to support the gravity loads of upper floors of the modular building system.

[15] Another aspect of the invention involves a modular building construction system including a) a plurality of modular building construction units of a pre-determined length, width, and height that are substantially the same as standard shipping containers, the modular building construction units configured to be placed upon a foundation at specified separation distances, the modular building construction unit including outer surfaces, some of which act as forms for poured concrete; b) reinforcements configured to be placed between and above the modular building construction units; c) concrete poured over the reinforcements and formed by some of the outer surfaces of the modular building construction unit, whereby the concrete and reinforcements create a monolithic concrete-reinforced supporting structure for the modular building construction system; and d) one or more additional floors including a, b, and c whereby the concrete-reinforced supporting structure for the last completed floor forms the foundation for a, b, and c.

[16] Another aspect of the invention involves a modular building construction unit of a modular building construction system. The modular building construction unit includes a length, a width, and a height that is substantially the same as the length, the width, and the height of a standard shipping container; and one or more external surfaces configured to serve as a form for poured-in-place concrete for creating a concrete-reinforced structure between and above adjacent modular building construction units.

[17] A still further aspect of the invention involves a modular building construction method for constructing a modular building construction system. The method includes a) constructing a foundation; b) arranging modular building construction units on the building foundation at predetermined separation distances dependent

on a total height of the modular building construction system; c) providing reinforcements in areas between and above modular building construction units; d) using one or more external surfaces of modular building construction units as concrete forms and pouring concrete in areas between and above modular building construction units, around reinforcements to form a monolithic concrete-reinforced structure; e) repeating steps a-d for each additional floor whereby the concrete-reinforced structure for the last completed floor is the constructed foundation in step a.

BRIEF DESCRIPTION OF THE DRAWINGS

[18] The accompanying drawings, which are incorporated in and form a part of this specification, illustrate embodiments of the invention and together with the description, serve to explain the principles of this invention.

[19] FIG. 1 is a perspective view of an embodiment of a modular building construction unit;

[20] FIG. 2 is a perspective view of another embodiment of modular building construction unit and shows shipping container connectors used for lifting and moving the modular building construction unit;

[21] FIG. 3 is a top view of an embodiment of a modular building construction system;

[22] FIG. 4 is a cross-sectional view of an embodiment of the modular building construction unit of FIG. 1;

[23] FIG. 5 is a front elevational view of the modular building construction system of FIG. 3; and

[24] FIG. 6 is a flowchart of an embodiment of a modular building construction method.

DETAILED DESCRIPTION OF A PREFERRED EMBODIMENT

[25] With reference to FIGS. 1-6, embodiments of a modular building construction unit 100, a modular building construction system 110, and a modular building construction method 115 will be described. The modular building construction unit (“module”) 100, the modular building construction system 110 (“system”), and the modular building construction method 115 (“method”) allow for the quick, easy, and inexpensive construction of almost unlimited building heights, allow economical shipping of modules anywhere in the world, utilize concrete (a construction material common throughout the world), and utilize poured-in-place reinforced concrete construction (a common building construction process throughout the world).

[26] As illustrated in FIG. 1, the pre-fabricated module 100 has a substantially rectangular block-shaped configuration. The module 100 comes in pre-determined sizes, including a pre-determined length, width, and height. In one embodiment, the pre-determined size is substantially the same size(s) as standard shipping containers. In one embodiment, the height and the width of all modules are the same as the height and width of standard shipping containers, namely, 9 foot, 6 inches in height by 8 foot in width. However, the modules 100 come in different lengths (e.g., a 20 foot length module, 30 foot length module, and a 40 foot length

module). The module 100 includes a top 120, a bottom 130, a left end 140, a right end 150, a front side 160, and a rear side 170.

[27] In one embodiment, the top 120, the bottom 130, the left end 140, the right end 150, the front side 160, and the rear side 170 are made of steel decking and connected to a module frame 180 made of 4 inch tubular steel. The module 100 includes an inside surface 190 and an external surface 200.

[28] FIG. 2 is a perspective view of another embodiment of a modular building construction unit 100. The modular building construction unit 100 of FIG. 2 is similar to the modular building construction unit 100 of FIG. 1, except the modular building construction unit 100 of FIG. 2 includes shipping container connectors 210 and 220. The shipping container connectors 210 and 220 are used by cranes and other lifting equipment at shipping centers. In one embodiment, the shipping container connectors 210 and 220 are mounted on the external surface 200 and coupled to or integrated into the steel module frame 180. The cranes and/or other lifting equipment use the shipping container connectors 210 and 220 at shipping centers to grab a hold of, handle, and move/stack the module 100, similar to that done with standard shipping containers. The inside 190 of the module 100 varies in construction depending on the pre-determined use of the module.

[29] FIG. 3 is a top view of an embodiment of the modular building construction system 110. In the embodiment shown, two basic types of modules 100 are used in the modular building construction system 110. The two basic types of modules include room modules 100A-100D and a corridor/hallway module 100E. However, in alternative embodiments, additional/other types of modules are provided. The modules 100 are manufactured at a central manufacturing facility (or facilities). The

modules 100 are manufactured so that little to no fit-out components and installation are required on the destined job/housing site, reducing overall construction cost.

[30] For example, in an exemplary embodiment, a room module includes one or more of pre-installed finished walls (painted, wallpapered), floors (with flooring), finished ceilings (with lights/fixtures), bathrooms, sinks, toilets, and showers, and is pre-wired/pre-plumbed. In another exemplary embodiment, a corridor/hallway module includes pre-installed finished walls (painted, wallpapered), floors (with flooring), and ceilings (with lights/fixtures). Completing out as much as possible in the modules during manufacturing of the module reduces job site labor time/cost, accelerating site construction considerably, and eliminates the middleman margins in supplying all the fit-out components.

[31] The modules 100A-100D include false wall sections 230A and 230B. In one embodiment, some modules 100 include one or more removable ends 140 and 150 and/or sides 160 and 170 (FIG. 1). For example, where two modules 100A and 100B are placed side by side, opposing sides of the adjoining modules 100A and 100B are removable at the false wall sections 230A and 230B for connecting the two halves/modules 100A and 100B together to form a single room (16 ft. in width).

[32] FIG. 4 is a cross-sectional view of modular building construction unit 100. The module 100 of FIG. 4 illustrates hollow ceiling sections 240, hollow floor sections 250, and hollow wall sections 260. In general, the hollow ceiling sections 240, hollow floor sections 250, and hollow wall sections 260 allow for the provision of services such as electrical wiring and plumbing. In one embodiment, the floor is

strong enough to support an 8 foot span across tube steel runners 270 (14g or 16g) at a 3 ½ inch depth to sit above the concrete floor.

[33] FIG. 5 is a front elevational view of the modular building construction system 110, and shows how concrete 280 is poured/applied using the modules 100 as forms for creating the reinforcing structure of the building. In the system 110, the modules 100C, 100D are used as concrete supporting panels (e.g., forms or boxing) to allow the reinforcing structure to be made of concrete 280, which can be poured-in-place and reinforced. In one embodiment, the reinforcements 290 are metal rods such as rebar.

[34] At the housing/job site, a foundation 300 is constructed. The modules 100A and 100B are arranged on the foundation 300 using a crane (not shown). The modules 100A and 100B are spaced a pre-determined separation distance 310 from each other. The separation distance 310 varies with the pre-determined height of the modular building system 110. In the present example, the system 110 is two stories. However, it is contemplated that other building systems can be of substantially any height (e.g., 5 floors, 10 floors, 30 floors), so long as the separation distance 310 is appropriate. For example, a ten-story modular building system may require a separation distance 310 of X, a twenty-story modular building system may require a separation distance 310 of 2X, and a thirty-story modular building system may require a separation distance 310 of 3X.

[35] The configuration in which the modules 100A and 100B are arranged will determine the concrete forming structure for the concrete pouring process. The external walls/rooftop of the modules 100A and 100B form the concrete supporting panels of the concrete forming structure. The reinforcement 290, such as steel

reinforcement rods, are provided where needed (e.g., vertically oriented between modules 100A and 100B and horizontally oriented above the top of modules 100A and 100B and beneath module 100C). The reinforcement 290 provides the necessary reinforcement for the poured-in-place, reinforced concrete process. Additional forms (e.g., small metal plates attached to the modular units) are provided where needed to hold poured concrete in place at end/exterior walls and between two adjoining modules that are part of the same room.

[36] During construction, the concrete 280 is poured into the forming structure created by the modules 100A and 100B. Concrete is poured over the modules 100A and 100B, between the modules 100A and 100B, and around the reinforcement 290. The dried, formed concrete forms a monolithic T or H shaped concrete-reinforced support structure.

[37] It should be noted that in the present invention, it is this concrete-reinforced support structure created by the modules 100A and 100B that provides the structure support for the modular building system 110. The next floor (and subsequent higher floors) are created in a like manner to that described above, except the modules/forms are arranged on top of the new concrete-reinforced floors (instead of the bottom foundation) on top of the lower modules. In the present example, the module 100C is placed on the concrete-reinforced support structure above the module 100A. However, the present invention contemplates other arrangements for the second and/or subsequent floors. For example, the module 100C can be placed over the module 100B. The module 100C can also be placed above the modules 100A and 100B substantially centered between the two. Furthermore, an additional module can be placed next to the module 100C and

above the module 100B to form a traditional four-walled base for a larger building that can be constructed by adding additional floors on top of each preceding floor.

[38] FIG. 6 is a flowchart of one embodiment of a modular building construction method. The method 115 begins at step 600 where a foundation is constructed, typically out of concrete. At step 602, the modules are arranged on the foundation at pre-determined separation distances, depending on the eventual height of the finished structure. The separation between the modules creates a forming structure and at step 604, reinforcement in the form of rebar, for example, is provided or placed in the forming structure between and on top of the modules.

[39] At step 606, concrete is poured into the forming structure between the modules, on top of the modules, and around the reinforcement. Once the poured concrete dries, it creates a monolithic support structure. At step 608, if there are no additional floors, the method 115 is complete. Otherwise, the monolithic support structure is used at step 610 as a foundation for the next level. Thereafter, the method 115 repeats at step 602, wherein an additional floor is created on top of the preceding floor. The process continues until eventually there are no additional floors to add at step 608.

[40] Unlike modular construction in the past, the modules in the present invention do not provide the structural support for the modular building system. The modular construction method of the present invention eliminates most connection details of connecting modules, as was required in the past with prior modular construction, creates the walls of the concrete-reinforced support structure (including the shear walls), creates the floors of the concrete-reinforced support structure, and provides the structure to support the gravity loads of upper floors of the modular building

system. The concrete walls, floors, and ceilings of the system 110 provide better fire and acoustic qualities in the building and make the building more durable.

[41] The above description of the disclosed embodiments is provided to enable any person skilled in the art to make or use the invention. Various modifications to these embodiments will be readily apparent to those skilled in the art, and the generic principles described herein can be applied to other embodiments without departing from the spirit or scope of the invention. Thus, it is to be understood that the description and drawings presented herein represent a presently preferred embodiment of the invention and are therefore representative of the subject matter which is broadly contemplated by the present invention. It is further understood that the scope of the present invention fully encompasses other embodiments that may become obvious to those skilled in the art.

CLAIMS

1. A modular building construction system comprising:
 - a) a plurality of modular building construction units of a pre-determined length, width, and height that are substantially the same as standard shipping containers, the modular building construction units configured to be placed upon a foundation at specified separation distances, the modular building construction unit including outer surfaces, some of which act as forms for poured concrete;
 - b) reinforcements configured to be placed between and above the modular building construction units;
 - c) concrete poured over the reinforcements and formed by some of the outer surfaces of the modular building construction unit, whereby the concrete and reinforcements create a monolithic concrete-reinforced supporting structure for the modular building construction system; and
 - d) one or more additional floors including a, b, and c whereby the concrete-reinforced supporting structure for the last completed floor forms the foundation for a, b, and c.
2. The modular building construction system of claim 1, wherein the modules are substantially 9 ft., 6 in. in height and 8 ft. in width.
3. The modular building construction system of claim 1, wherein the modules are at least one of 20 ft. length, 30 ft. in length, and 40 ft. in length.
4. The modular building construction system of claim 1, wherein the modules include pre-fabricated room modules.
5. The modular building construction system of claim 1, wherein the modules include pre-fabricated corridor modules.

6. The modular building construction system of claim 1, wherein the modules are spaced separation distances from each other that are dependent on a total height of the modular building construction system.
7. The modular building construction system of claim 1, wherein the concrete and reinforcements form at least one of monolithic T-shaped concrete-reinforced structures and monolithic H-shaped concrete-reinforced structures.
8. The modular building construction system of claim 1, wherein the modules include one or more hollow sections to run pre-installed plumbing and wiring.
9. A modular building construction unit of a modular building construction system, comprising:
 - a length, a width, and a height that is substantially the same as the length, the width, and the height of a standard shipping container; and
 - one or more external surfaces configured to serve as a form for poured-in-place concrete for creating a concrete-reinforced structure between and above adjacent modular building construction units.
10. The modular building construction unit of claim 9, wherein the modular building construction unit is substantially 9 ft., 6 in. in height and 8 ft. in width.
11. The modular building construction unit of claim 10, wherein the modular building construction unit is at least one of 20 ft. length, 30 ft. in length, and 40 ft. in length.
12. The modular building construction unit of claim 9, wherein the modular building construction unit is a pre-fabricated room module.
13. The modular building construction unit of claim 9, wherein the modular building construction unit is a pre-fabricated corridor modules.

14. The modular building construction unit of claim 9, wherein the modular building construction unit includes one or more hollow sections to run pre-installed plumbing and wiring.

15. The modular building construction unit of claim 9, wherein the modular building construction unit includes a frame and one or more external connectors coupled to the frame, the one or more external connectors configured to be used by lifting equipment to lift and move the modular building construction unit.

16. A modular building construction method for constructing a modular building construction system, comprising:

- a) constructing a foundation;
- b) arranging modular building construction units on the building foundation at predetermined separation distances dependent on a total height of the modular building construction system;
- c) providing reinforcements in areas between and above modular building construction units;
- d) using one or more external surfaces of modular building construction units as concrete forms and pouring concrete in areas between and above modular building construction units, around reinforcements to form a monolithic concrete-reinforced structure;
- e) repeating steps a-d for each additional floor whereby the concrete-reinforced structure for the last completed floor is the constructed foundation in step a.

17. The method of claim 16, wherein the modular building construction units are substantially 9 ft., 6 in. in height and 8 ft. in width.

18. The method of claim 16, wherein the modular building construction units are at least one of 20 ft. length, 30 ft. in length, and 40 ft. in length.
19. The method of claim 16, wherein the modular building construction units include pre-fabricated room modular building construction units.
20. The method of claim 16, wherein the modular building construction units include pre-fabricated corridor modular building construction units.
21. The method of claim 16, wherein the concrete and reinforcements form at least one of monolithic T-shaped concrete-reinforced structures and monolithic H-shaped concrete-reinforced structures.
22. The method of claim 16, wherein the modular building construction units include one or more hollow sections to run pre-installed plumbing and wiring.

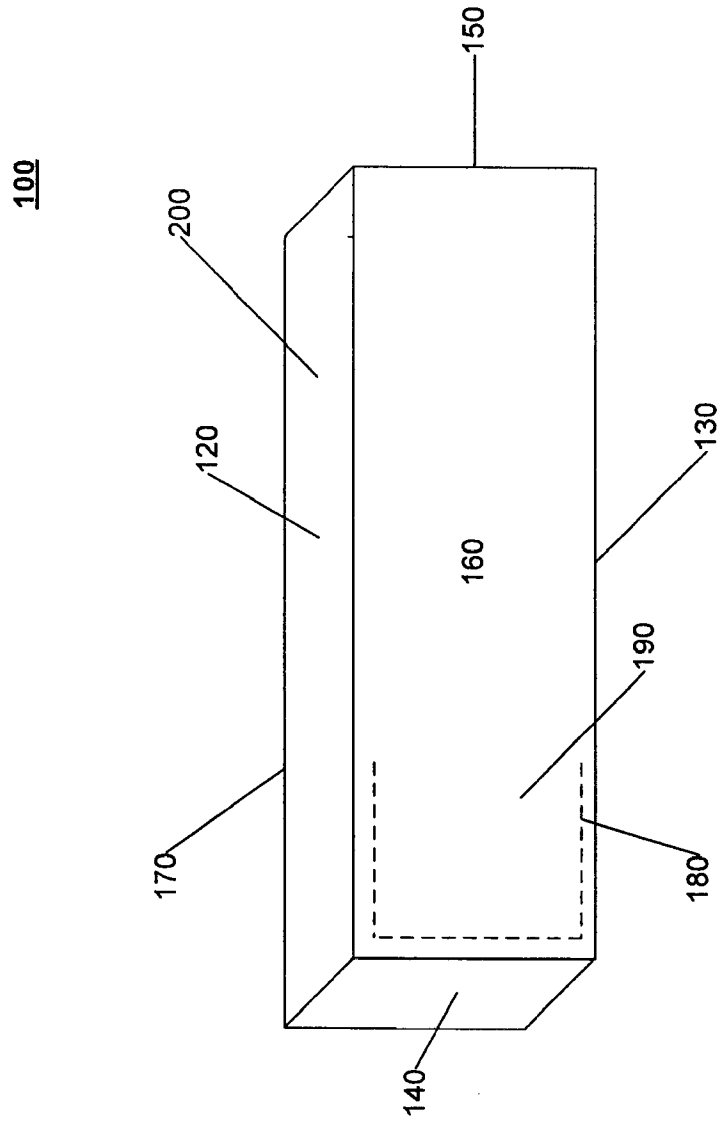


FIG. 1

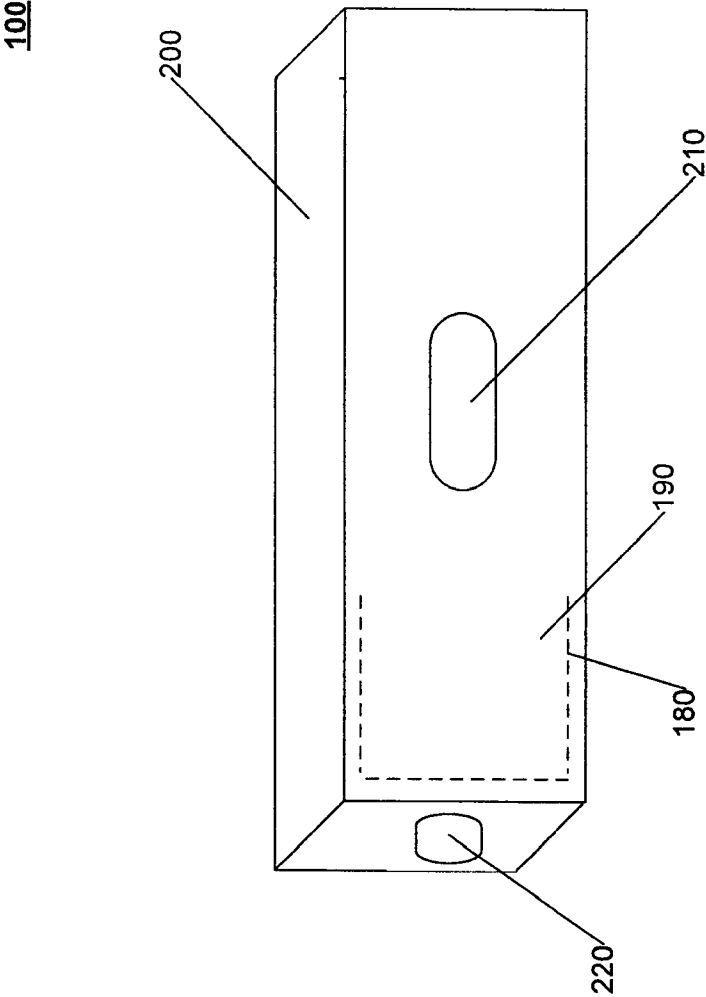


FIG. 2

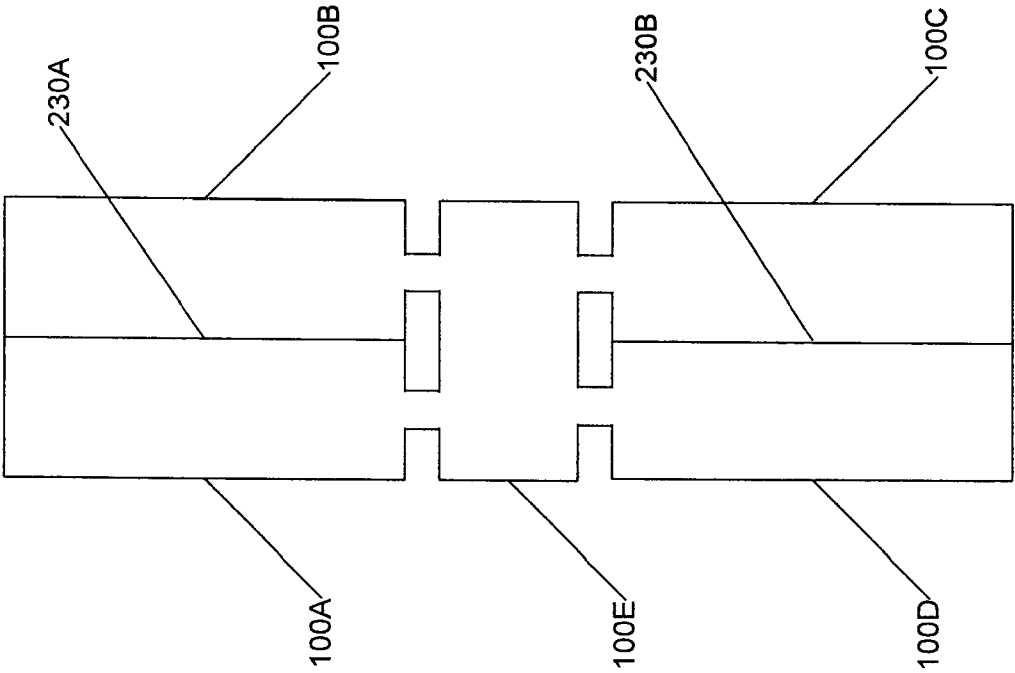


FIG. 3

110

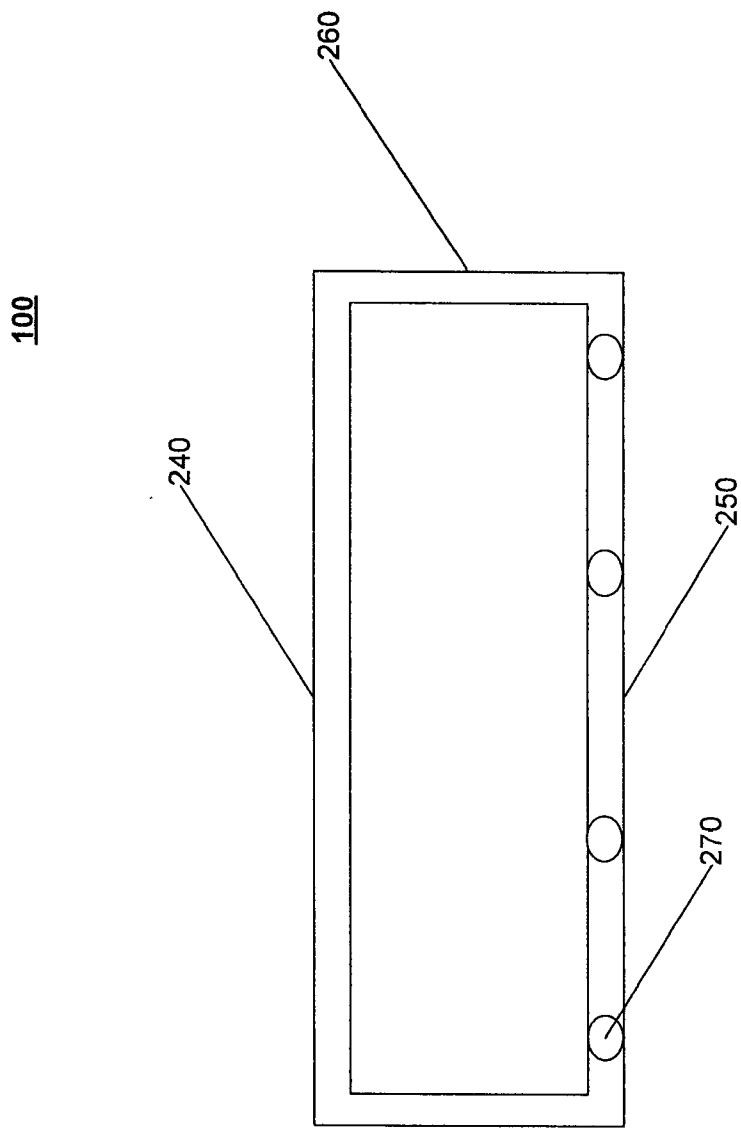


FIG. 4

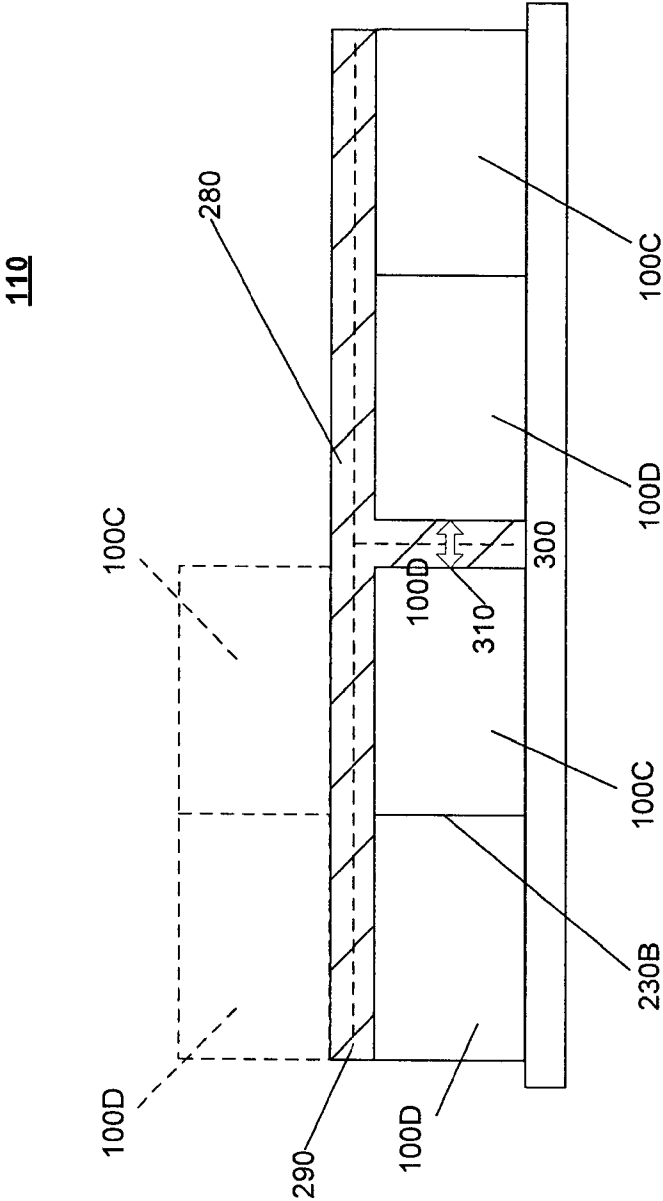


FIG. 5

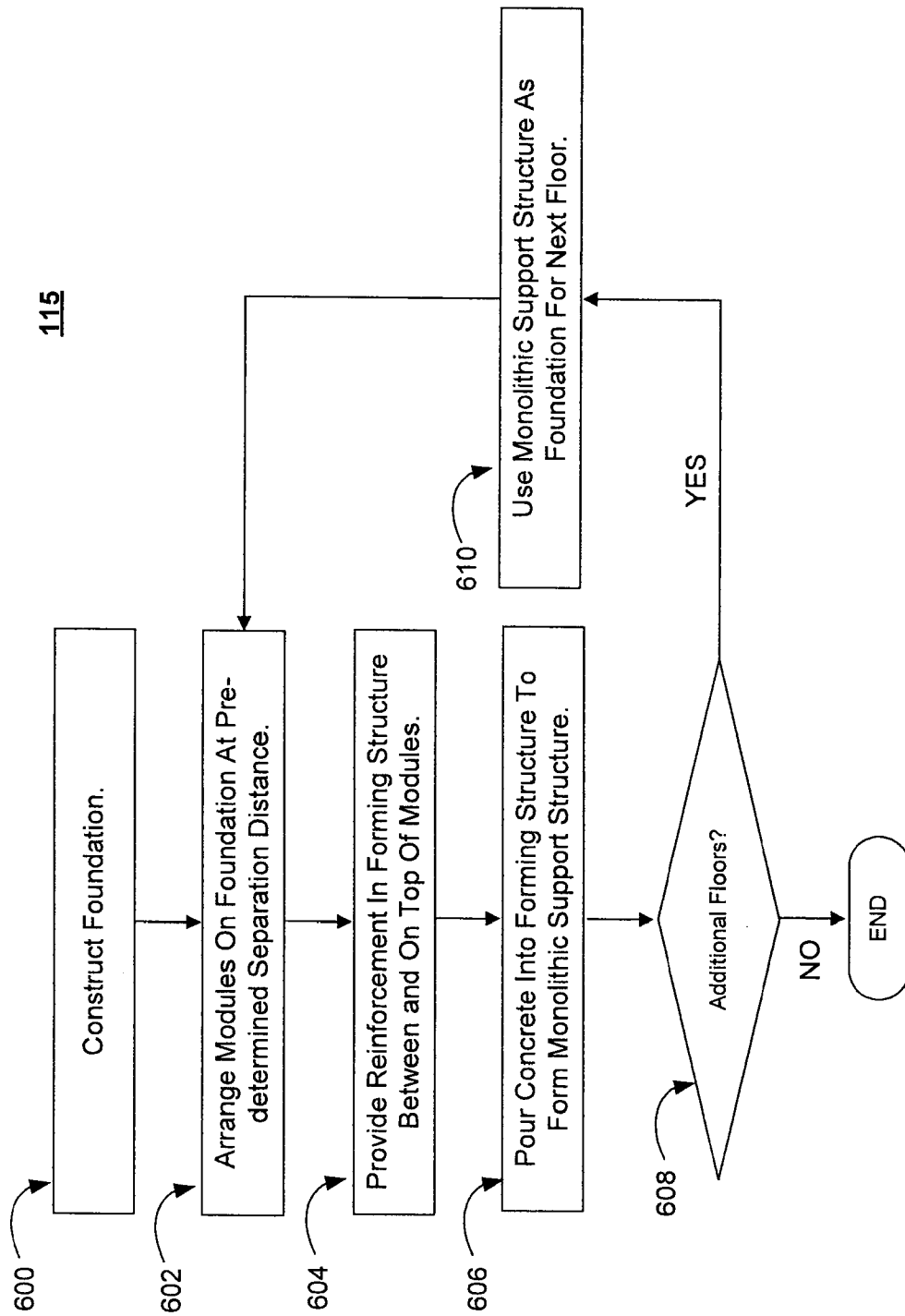


FIG. 6

INTERNATIONAL SEARCH REPORT

International application No.
PCT/US2008/082277**A. CLASSIFICATION OF SUBJECT MATTER*****E04B 1/348(2006.01)i, E04B 1/02(2006.01)i***

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 8: E04B 1/348

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

KR,JP IPC as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

eKIPASS(KIPO internal) "modular", "unit", "building"

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 09032325 A (KUKDONG CORP.) 04 February 1997 see the all Claims and the Fig 1	1-22
A	JP 2004084310 A (JUNGSU CORP.) 18 March 2004 see the Claim 1	1-22
A	KR 1020010089315 A (STOODLEY, WILLIAM, RICHARD, CHARLES) 29 September 2001 see the Fig 2, Claim 1	1-22
A	KR 1020030008723 A (MOON, SUKJOO) 29 January 2003 see the whole document.	1-22

☐ Further documents are listed in the continuation of Box C.☒ See patent family annex.

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Date of the actual completion of the international search

13 APRIL 2009 (13.04.2009)

Date of mailing of the international search report

14 APRIL 2009 (14.04.2009)

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

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