

# A METHOD FOR CONSTRUCTING A MODULAR WALL USING MODULAR WALL PANELS

## BACKGROUND OF THE INVENTION

### 1. Field of the Invention

- 5 This present invention relates to a construction method of modular wall, and in particular, to method of constructing modular wall using a structural wall connection system (MSC) having beams and columns structure or framework.

### 2. Description of the Prior Art

10 There are available methods for forming structural walls from modular wall panels, for instance, two or more primary modular wall panels are aligned to form a first structural wall and the primary modular wall panels are then fastened to each other. Another secondary modular wall panels are then aligned opposite to the first structural wall and coupled to the primary modular wall panels to form a secondary structural wall. It is laborious and inefficient in forming structural wall to use such a method.

15 PCT/SG2010/000336 discloses a modular wall fastener for fastening adjacent first and second modular wall panels together to form at least part of a wall, each of the first and second modular wall panels including an outer face portion and a first and a second side portion, the fastener comprising a rod-like body having: a pin portion insertable into and through respective aligned apertures of the second side portion of the first modular wall panel and the first side  
20 portion of the second modular wall panel; a main portion connected to the pin portion; a clip portion connected to the main portion and configured to fasten the second and first side portions of the first and second modular wall panels together to align the respective outer face portions to form the at least part of the wall. PCT/SG2010/000336 also relates to a method of constructing a modular wall using a plurality of brackets, the modular wall being constructed  
25 from a first, second and third modular wall panels, each modular wall panels including an outer face portion and a first and a second side portion, the method comprising: attaching an engagement device to respective apertures of the first, the second and the third modular wall panels; mounting a first one of the plurality of brackets by slotting the respective engagement devices of the first modular wall panel into the first slot means of the first one of the plurality  
30 of brackets; mounting a second one of the plurality of brackets by slotting the respective engagement devices of the second modular wall panel into the first slot means of the second one of the plurality of brackets; the first and second modular wall panels being arranged side by side so that the respective outer face portions are aligned; arranging the third modular wall

panel opposite and offset from the first and second modular wall panels so that the outer face portion of the third one faces outside; lifting the third modular wall panel to enable the respective engagement devices mounted of the third modular wall panel to be received in respective second slot means of the first one and second one of the plurality of brackets which is mounted to the first and second modular wall panels respectively.

US Patent No: 4,546,590 discloses a modular partition system based on panels which are generally rectangular and have connector members on opposed sides of a central body. Each connector member includes female and male members joined by a stop element which is generally perpendicular to the body. The panels may be connected to one another to form a wall by either an abutting type or overlapping type connection. The modular partition system of US Patent o: 4,546,590 can be assembled or disassembled relatively rapidly, it does require the use of sheet metal screw or similar fastening elements to secure the panels together.

US Patent No: 3,128,851 to Derider et al. relates to metallic structural members adapted to be formed that a plurality of the members may be interlocked. The metallic structural member described is particularly adapted for use as flooring in vehicles such as trucks, railway cars and so forth. For this reason, the structural member is provided with a hole through which a bolt can pass for attachment of the member to an underlying structure.

WO2007/084083 discloses a partition wall unit for receiving utility lines, the partition wall formed in addition to a pre-existing wall of a construction, the partition wall unit formed by at least a first panel, wherein the partition wall unit further includes an attachment means to attach the first panel to a further surface, the protrusion allowing the second surface of the first panel to be positioned spaced apart from the further surface; and wherein the spacing thus formed therebetween the second surface of the panel and the further surface for an enclosure to receive utility lines of a construction.

WO2011/123058 discloses a wall section comprising a ferro concrete member disposed between a first sideboard and a second sideboard. One of the first sideboard and the second sideboard is mechanically fastened to the ferro concrete member. The gap may be filled with insulation material.

In the current method of wall construction, differentiation of load bearing and non-load bearing walls lies in the structural connection of beam/wall and slab/wall joints.

In the conventional structural frame construction, other than RC or precast walls which are designed as integral part of structural frame, masonry walls designed as load bearing walls

have to ensure effective transfer of load from beams and slabs onto the supporting walls below them.

Other than masonry wall design, the current structural wall will dictate use of either reinforced concrete (RC) or precast wall elements which comply to design practices.

- 5 For most commercially available in-fill wall elements, mostly non-load bearing, wall elements have to follow the profile of beam/slab/column. Due to profile of soffits to slabs and beams, wall panels of different heights have to be produced or altered on site to fit into the wall spaces. For practical installation, gaps between soffit and top of wall panels have to be allowed for and later sealed for water tightness. These walls, even having adequate structural capacity, can  
10 never be treated as load bearing walls.

The construction of non-load bearing, in-fill walls is very low in productivity. The walls are treated as part of building work, installation can only commence after all structural works been substantially completed and be inter-phased with M&E and architectural works. Their installations are also very labour intensive as wall elements like panels and blocks need to be  
15 trimmed on site to fill the wall spaces defined by irregular soffit profile.

In view of the above, within current commercially available panels for constructing modular walls that used both in industrial and residential buildings for both internal and external walls, many shortcomings have been found and accordingly, the present method of constructing modular structural connection system has addressed effectively these drawbacks.

## 20 **SUMMARY OF THE INVENTION**

The present invention is provided to settle the above problems encountered with the conventional means, and its object is to provide a method for constructing modular wall by using structural connection system or modular structural connection (hereinafter referred to as MSC) having beams and columns structure or framework with modular wall panels . These  
25 structural beams and columns framework (MSC) is for extending multi-level housing or building from a single storey housing or building.

Yet another object of the present invention is to provide a method for constructing modular wall, wherein interlocking mechanisms such as Rebar or bracket is used to better align all adjacent rectangular modular panels to form modular wall.

- 30 Still a further object of the present invention to provide a method for constructing modular wall by using a plurality of modular wall panels with a structural connection system (known MSC), wherein modular wall panels are obtained by converting non-load bearing into load bearing

panel elements, wherein standard height modular wall panels, and MSC will allow modular wall panels to be installed as structural walls and utilise the excellent structural capacity of modular wall panels to lessen the structural loadings on slab/beam/column designs.

5 Still a further object of the present invention to provide a method for constructing modular wall, wherein the method is cost and time savings in designing and construction of buildings, and the method allows modular wall panels to be installed as structural wall elements in multi storey building construction.

10 Another object of the present invention is to provide a method for constructing modular wall, wherein the MSC can be applied to external or edge beams and internal beams, and it can also apply to upstanding beams and tie beams to separate lifts of modular wall panels to extend beyond a standard height of modular wall panels.

15 Yet another object of the present invention is to provide a method for constructing modular structural connection system, wherein the MSC is to strengthen the connectivity of wall panels to the floors above and below in the form of beam with dimensions meeting design requirements, and the beam will then be tied in to the columns to form structural joints. The MSC of the present invention will help to create a solid wall locking in all individual panels to the floor that is being connected. In addition, as load bearing walls, the panels will be permanently locked in and could not be dismantled without expert supervision.

20 Still a further object of the present invention to provide a method for constructing modular wall, wherein the MSC can also apply to forming of wide span precast panels for PBUs and PPVCs using interlocking modular wall panels, and the modular wall panels with MSC require minimum usage of metal formworks, no heavy investment in formworks, no space constraints as it can be just-in-time casting and no issue of turnover cycle of formworks.

25 Yet another object of the present invention is to provide a method for constructing modular wall, wherein the method is an economical solution for volumetric casting with high productivity in running M&E services within the cavities of interlocking modular wall panels- unique properties of standardised dimensions and thin shell structures, and the cavities can be in-filled with lightweight materials like foam concrete or polyurethane foam to further reduce the overall weigh of precast units.

30 **DESCRIPTION OF THE DRAWINGS**

The foregoing and other objects and features of the invention will become apparent from the following description of preferred embodiments of the invention with reference to the accompanying drawings, in which:

5 FIG. 1 is a perspective view of a modular wall interlocking with modular structural connection (known as MSC) having beams and columns forming a room/floor area in according with the present invention;

FIG. 2A is a plan view (from top) of the structural connection system reinforced with RC column in accordance with the present invention;

10 FIG. 2B is a plan view of the structural connection system in accordance with the present invention, wherein the upper slab and beam are omitted from the connection system;

FIG. 3 is a perspective view (external and interview) of a modular wall in accordance with the present invention;

FIG. 4 is a perspective view sectional view showing assembling modular wall panels along section line A-A of FIG. 3 of the present invention;

15 FIG. 5 is an enlarged view along area marked "A" of FIG. 4 of the present invention; and

FIG. 6 is an enlarged perspective view along area marked "B" of FIG. 4 of the present invention.

#### **DESCRIPTION OF THE PREFERRED EMBODIMENT**

20 Reference be made in detailing the preferred embodiments of the present invention, examples of which are illustrated in the above mentioned drawings. The preferred embodiments of the present invention are not intended to limit the invention in its broadest aspect to these embodiments. On the contrary, the present invention is intended to cover alternatives, modifications and equivalents, which may be included within the spirit and scope of the present invention as defined by the appended claims.

25 FIG. 1 is a perspective view showing a completed modular wall (100) in accordance with the present invention. In the preferred embodiment, there is provided a method for constructing a modular wall (100) by using modular wall panels (12, 22) together with beams (14, 24) and column structure (60) or framework, and interlocking mechanism (45) such as steel rod (Rebar) or brackets, and RC slab for flooring of the upper deck of a building. As shown in the

figure, it forms a room/floor area which allows creation of vertical expansion from a single storey.

FIG. 2A is a top view showing the beams and columns of the connection system (MSC) being reinforced with RC columns (60) in accordance with the present invention. In the figure, the external panel (12) is mounted together with an internal panel (22). FIG. 2B is a plan view of the structural connection system in accordance with the present invention, wherein the upper slab and beam are omitted from the connection system.

FIG. 3 is a perspective view showing the view of the external panel (12) and the internal panel (22) in accordance with the present invention. In the drawing, RC beam is denoted by reference number 50, a RC column is denoted by 60, reference 80 denotes brackets for fastening of the panels (12, 22), and the external panel (12) and internal panel (22) are being denoted as 12, and 22 respectively.

FIG. 4 is a perspective view schematically showing the mounting of the external panel (12) and the internal panel (22) in accordance with the present invention.

FIG. 5 is a perspective view showing the combination of MSC having a RC beam (24) together with the external panel (12) and internal panel (22), and the interlocking mechanism (45) which is a rebar. The interlocking mechanism (45) passes through the hole (44) provided on the external panel (12)

FIG. 6 is a perspective view showing the structural connection system panel with the modular wall panels (12, 22) for upper level of a building.

As shown in FIG. 4, an external modular wall panel (12) and an internal modular wall panel (22) are used as an illustration to show the method of constructing a modular wall (100). The structural connection system (MSC) in accordance with the preferred embodiment of the present invention is the beams and columns structure or framework, and the steps of the construction are being desired hereafter.

The external modular wall panel (12) and the internal modular wall panel (22) are arranged in opposite to each other (refer to FIG. 4). Both the external modular wall panel (12) and the internal modular wall panels (22) are provided with an internal and an external face portion and also, lateral edges (121, 221). A plurality of holes (44) are formed on the lateral edge (121, 221) of the panels (12, 22). The internal face portion of each of the modular wall panels (12, 22) faces each other. The external modular wall panel (12) has a 300 mm additional height as compared to the internal modular wall panel (22) so as to enact the interlocking

position for holding the beams and column structure/framework. Rebar (45) is used to insert through the holes (44) to join the modular wall panels (12, 22) for strength and stability of the modular wall panels (12, 22).

The rebar (45) is shaped structural member selected from the group consisting of a solid rod, a hollow tube, a channel, and an angled member.

In accordance with the present invention, the beams and the column structure/framework (50, 60) see FIG. 3) has a standard height of 375 mm and a width of 300 mm. Two interlocking mechanisms (45) are used. Each beams and column structure/framework (50, 60) has 4 holes (44) to enable the interlocking mechanism (45), for instance, a steel rod, to be inserted through to the modular wall panels (12, 22) for strength and stability. The interlocking mechanism (45) is inserted into the lower left hole of the beam and column structure or framework (50, 60) through the external modular panel (12) to interlock this portion. Likewise, the interlocking mechanism (45) is inserted into the upper left hole of the beams and column framework through the external modular panel (12) for the upper deck of a building. A RC slab is used for reinforcement and is acted as a ceiling and flooring for the upper deck of a floor of a building structure.

As shown in the Figures, the construction of modular wall using modular wall panels (12, 22) is also creating columns, and the columns can be used for extension to build another level.

FIGs. 2A, 2B and 3 show the RC column (60) being integrated with the beams and column structure (50, 60), and FIG. 1 shows the whole floor area with four modular walls of the present invention.

As shown in FIG. 4, the external modular wall panel (12) is interlocked with the structural connection system (MSC) which has a plurality of edges (121, 221), a pair of which being protruded from the back surface of the connection system and at the edge thereof, and a channel being formed between the two protruded edges, wherein both the panels (12, 22) are affixed with the interlocking mechanism (45) known as Rebar to form a beam structure (24, 50).

The internal modular wall panel (22) where the structural connection system panel sits thereon, is 250 mm shorter than the corresponding external modular wall panel (12). This can ensure strength and stability as well as creating seamless in edges of a room or internal wall of space area.

The interlocking mechanism (45) which is a rebar is aligned from both sides of the wall together with the structural connection system (MSC), the entire structure walls both internally and externally is concealed.

The modular wall obtained by the present method not only is suitable for development and construction of single storey residential housing and industrial building but also enables construction of building structure which have 2 or higher storeys height since this newly interlocking mechanism (45) provides a foundation for such vertical expansion of constructing a building. By employing the modular wall panels (12, 22) comes with high quality finish and high acoustic and thermal insulation performance, high end modular wall can be obtained.

The structural connection system (MSC) has a thickness of 300 mm, however various thickness can be created to suit different expectation of the end users and/or architectural requirement.

The installation of light-weight panel (12, 22) (with or without interlocking beam panels) does not require skilled workers; hence, this not only reduces manpower costs but also increase efficiency in construction process. In addition, no wet trade nor plastering for finishing is required during installation which is time-saving and therein, translated as cost saving from material requirement; for instance, using polyurethane infill which can be easily removed by solvent and hence, these panel walls are largely reusable .

In accordance with the present invention, several panels can be casted with minimal manpower involvement with (i) pouring mortar into a plurality of moulds by use of a mixer; (ii) demoulding the panels and transfer to assembly table; (iii) carry out panel assembly process to obtain partition panel, and (iv) storing or delivering such panels.

As a result of employing interlocking mechanisms (45), minimal damage will occur when the panel walls are dismantled. In other words, these panels are reusable and hence, creating an eco-friendly perspective.

The foregoing embodiments are merely exemplary and are not to be construed as limiting the present invention. The present teaching can be readily applied to other types of apparatuses. The description of the present invention is intended to be illustrative, and not to limit the scope of the claims. Many alternatives, modifications, and variations will be apparent to those skilled in the art.

## CLAIMS

1. A method of constructing modular wall using a structural connection system (MSC) having beams and column structure or framework comprising the steps of:
  - (i) arranging an external and internal modular wall panels (12, 22), each of the wall panel (12, 22) having an internal and an external face portion, lateral edges, and a plurality of holes (44) being formed on the lateral edge of the modular wall panels (12, 22), wherein the internal face portion of each of the external and internal modular wall panels (12, 22) faces each other, and the width of the modular wall panels (12, 22) ranges from 300mm to 600mm, and the beam has a height of 375 mm and a width of 300mm;
  - (ii) inserting an interlocking mechanism (45) being a rebar through the holes (44) on each of the modular wall panels (12, 22) for strength and stability of the modular wall panels (12, 22); wherein the interlocking mechanism (45) is shaped structural member selected from the group consisting of: Rebar, a solid rod, a hollow tube, a channel, and an angled member.
  - (iii) reinforcing using RC slabs to act as a ceiling and flooring for the upper deck of a floor of a building structure, whereby the beams and column structure or framework is provided with a plurality of holes (44) to enable the interlocking mechanism to be inserted through the modular panels.
2. The method of constructing modular wall of Claim 1, wherein a multiple levels of modular walls are obtained by employing the steps (i) to (iii) set forth in Claim 1.
3. The method of constructing modular wall of Claim 1, wherein varying thickness of the modular wall is obtained by using variable number of modular wall panels.
4. The method of constructing modular structural connection system of Claim 1, wherein the structural connection system (MSC) is the beam and column structural framework.
5. The method of constructing modular wall of Claim 1, wherein the plurality of holes (44) provided on the edges of the external and internal wall panels (12, 22) are of size permitting the insertion of a Rebar.
6. The method of constructing modular wall of Claim 1, further comprising the step of (iv) fastening the modular structural connection system (MSC) to the modular wall panels (12, 22).