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(54) PREFABRICATED MODULAR CONSTRUCTIVE SYSTEM

(57) The invention relates to a prefabricated modular building system comprising a plurality of structural frames and connection means which horizontally and vertically join the structural frames, where the structural frames are hyperstatic and self-supporting with a closed cross-section and hyperstatic and self-supporting with an open cross-section. A building structure is formed with a plurality of structural frames interconnected horizontally and vertically in assemblies arranged such that, on the same level or on vertically arranged leveld, there is a sequence of assemblies of structural frames and empty spaces. The plurality of structural frames is horizontally and vertically connected and arranged on other structural frames in a vertical sequence of assemblies of structural frames and empty spaces.

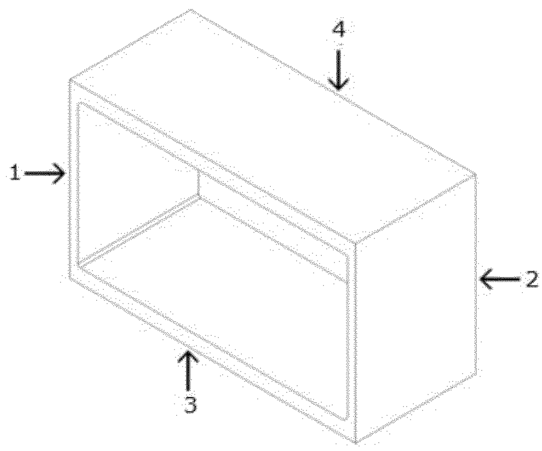

FIG. 1

Description

Field of the invention

[0001] This invention relates generally to the field of prefabricated modular building systems for housing construction and construction projects in general.

Prior art description

[0002] Prior art addresses different proposals of prefabricated modular building systems, developed in order to allow for economical and speedy building construction of modular prefabricated systems. For example, US8397441 relates to buildings made up of recycled intermodal containers, sometimes called maritime containers or ISO containers. For use in buildings, containers require extensive modifications, such as cutting or removing sidewalls in order to allow for windows or doors. In addition, the construction is limited to a width of 2.44 m and a length of 6.06 m or 12.19 m, which in turn limits the room size to fit within these dimensions.

[0003] In general, prefabricated modular building systems are attractive because simplified and repetitive assembly of parts offers the possibility of erecting a construction project quickly while drastically reducing waste, losses, and multiple learning curves common to conventional construction. In spite of this, there is the perception that the quality and versatility of the "prefabricated" buildings is lower to that of buildings manufactured conventionally. This is partly due to the materials used, such as cargo containers, which has created a stigma associated with the construction term "prefabricated modular building systems".

[0004] US7665250 addresses structures assembled from a combination of modules and uses, for the combination of said modules, module framing blocks, corner arch blocks, and other types of elements interlocking with corner blocks, and central blocks, which makes this system and many others in prior art complex systems, given the amount of necessary pieces to form a module.

[0005] This invention overcomes the disadvantages and limitations associated with several floors, modular construction and conventional construction methods to produce an energy efficient structure that can be built on a tight schedule, low cost and continue operating at very low maintenance costs, allowing for flexible construction with few elements to form a module and also allowing quick assembly for multiple purposes with resistant elements.

Brief description of the figures.

[0006]

FIG. 1, shows an isometric view of a complete structural frame having a closed cross-section.

FIG. 2 shows an isometric view of an open cross-section structural frame where the shape of the cross-section cut is an open-perimeter shape having U-shaped curves.

FIG. 3 shows an isometric view of an open cross-section structural frame where the shape of the cross-section cut is an open-perimeter shape having C-shaped curves.

FIG. 4 shows an isometric view of a closed cross-section structural frame formed by the joining of open cross-section structural frames, wherein the cross-section has an open perimeter shape having C-shaped curves.

FIG. 5 shows an isometric view of a closed cross-section structural frame formed by the joining of open cross-section structural frames, wherein the cross-section has an open perimeter shape having U-shaped curves.

FIG. 6 shows an isometric view of an open cross-section structural frame wherein the cross-section cut shape is an open perimeter shape having U-shaped curves, whereby it reduces its weight by means of perforations.

FIG. 7 shows an isometric view of an open cross-section structural frame wherein the cross-section cut shape is an open perimeter shape having C-shaped curves, whereby it reduces its weight by means of perforations.

FIG. 8 shows a side view of a structural frame having a plurality of recesses or structural ribs.

FIG. 9 shows a side view of a structural reinforcement of a floor-type structural frame.

FIG.10 shows a side view of a structural reinforcement of a facility-type structural frame.

FIG. 11 shows an isometric view of a facility-type structural frame with at least one perforation.

FIG. 12 shows an isometric view of a roof-type structural frame located on the second horizontal slab (4) having a sloping surface (16) connected to a drainage channel (17) and water collection ducts (18).

FIG. 13 shows an isometric view of a roof-type structural frame located on the second horizontal slab (4) having two sloping surfaces (16) connected to a drainage channel (17).

FIG. 14 shows different side views of elements from the group from which connecting means that join the structural frames both horizontally and vertically, are selected.

FIG. 15 shows an isometric view of a structural frame wherein the connecting means that horizontally join the structural frames are Z-shaped flat bars.

FIG. 16 shows an isometric view of a Z-shaped flat bar.

FIG. 17 shows an isometric view of a structural frame wherein the connecting means that horizontally and vertically join the structural frames are geometric assemblies formed by supports (31) between slabs on one side of the structural frame.

FIG. 18 shows an isometric view of a structural frame wherein the connecting means that horizontally and vertically join the structural frames are geometric assemblies formed by supports (31) between slabs on both sides of the structural frame.

FIG. 19 shows an isometric view of a structural frame wherein the horizontal connecting means between the structural frames is a flexible element.

FIG. 20 shows an isometric view of a plurality of structural frames using continuous structural elements such as post-stressed metal wires (33) with the joined structural frames.

FIG. 21 shows an isometric view of a plurality of structural frames using continuous structural elements such as post-stressed metal wires (33) without joining the structural frames.

FIG. 22 shows a cut view of a building structure formed by the prefabricated modular building systems.

Brief Description of the Invention

[0007] The subject invention relates to a modular prefabricated building system formed by: a plurality of structural frames; connecting means that connect the structural frames both horizontally and vertically.

[0008] Wherein the structural frames are hyperstatic and self-supporting having a closed cross-section and also hyperstatic and self-supporting having an open cross-section. Said frames do not require additional structures to support each other. One or more structural frames, both individually or collectively.

[0009] Structural frames are connected to each other, both horizontally and vertically, creating modules that make up different types of constructions, structures and buildings of one or more floors.

[0010] Structural frames, in their cut cross section shape, generate a closed perimeter geometrical shape that is selected from the group consisting of parallelograms, circles, polygons, trapezoids, and combinations thereof. This type of structural frame is called a closed cross-section structural frame.

[0011] The subject invention also depicts structural frames in which the geometrical shape of its cut cross section generates an open perimeter shape that is selected from the group consisting of open curves, open polygonal lines and combinations thereof. This type of structural frame is called an open cross-section structural frame.

[0012] The open cross-section structural frames are joined together, forming closed cross-section structural frames.

[0013] The structural frames are connected with a vertical slab and a horizontal slab, thus forming building structures.

[0014] Structural frames are connected both horizontally and vertically, in sets located in such a way that at the same level or height, there is a sequence of sets of structural frames and empty spaces that form a building structure.

[0015] The structural frames are connected both horizontally and vertically, located on other structural frames, in a height-wise sequence of sets of structural frames and empty spaces.

Detailed Description of the Invention

[0016] The subject invention consists of a prefabricated modular building system formed by:

- a plurality of structural frames;
- connecting means that connect both horizontally and vertically the structural frames ;

[0017] Wherein the structural frames are hyperstatic and self-supporting having a closed cross-section and also hyperstatic and self-supporting having an open cross-section, wherein said structural frames do not need additional structures to support each other, either together or individually.

[0018] The structural frames can be connected one over the other, both horizontally and vertically, creating modules that make up different types of constructions, structures and buildings of one or more floors.

[0019] In a non-illustrated embodiment of the invention, the structural frames are connected by connection means to a vertical slab ; and/or

- a horizontal slab ;

[0020] Wherein said connecting means are selected from the group comprising: rigid inner joints (such as reinforced steel welded together , mortar and metal flat bars , mechanical joints through metal rods , mechanical joints through bolts or screws and combinations thereof).

[0021] The following describes in detail each one of the elements listed above:

The structural frames have dimensions that adapt according to the requirements of the architectural project, the requirements of the vehicles to transport said structural frames and the requirements of the machinery used for its transportion and installation on site (e.g. cranes).

[0022] The prefabricated modular building system adopts different geometrical shapes for the structural frames, which allows for the design of modular elements and their connections, according to the formal characteristics required in each construction project.

[0023] The structural frames have a closed perimeter shape in their cross section, which is selected from the group consisting of parallelograms, circles, polygons, trapezoids and combinations thereof. This type of structural frame is called a closed cross-section structural frame.

[0024] Additionally, the invention has structural frames in which the shape of its cross-section is an open-perimeter shape, selected from open curves, open polygonal lines and combinations thereof. This type of structural frame is called an open cross-section structural frame .

[0025] The configuration of the subject invention will be described using Figures 1 to 22, but it should be understood that this may have variations which are not showed herein, as this disclosure is limited to describe the preferred embodiment.

[0026] Referring to FIG. 3, we observed a closed cross-section structural frame comprised of:

- a first vertical slab (1) ;
- a second vertical slab (2);
- a first horizontal slab (3) joined to the first vertical slab (1) and to the second vertical slab (2) at the bottom;
- a second horizontal slab (4) joined to the first vertical slab (1) and the second vertical slab (2) at the top.

[0027] Wherein joining the first horizontal slab (3) with the first vertical slab (1) and with the second vertical slab (2) at the bottom and joining the second horizontal slab (4) to the first vertical slab (1) with the second vertical slab (2) at the top, is made by means of different joining mechanisms such as: welding between metal flat bars, bolt and rod assemblies and tongue and groove joints between parts.

[0028] In an embodiment of the invention, the first horizontal slab (3) joins to the first vertical slab (1) and with the second vertical slab (2) in its bottom and the second horizontal slab (4) joins the first vertical slab (1) and with the second vertical slab (2) at the top, by means of a concrete casting, which make the structural frame a monolithic element. In said concrete casting, the provision of structural reinforcements is made to allow for overlaps between said reinforcements.

[0029] The structural frames define a closed inner space with preferred dimensions, said inner space being established with the first vertical slab (1), with the second vertical slab (2), with the lower horizontal slab (3) and with the upper horizontal slab (4). A single vertical slab and a single horizontal slab can also be used to establish the inner space. The other vertical and horizontal elements can be constructed in other materials such as concrete castings, prefabricated in concrete, masonry in concrete or brick, stone, metal, light modular elements like drywall or the like, wood or metal.

[0030] The dimensions of the structural frames correspond to the proportions proposed for the construction project and change according to the structural calculation, the length of the horizontal slabs, the height of the buildings and the load capacity of the terrain.

[0031] In an embodiment of the invention a structural frame has a dimension of:

- 5.80 meters between the outer surfaces of the first vertical slab (1) and 5.50 meters between the inner surfaces of said slab.
- 5.80 meters between the outer surfaces of the second vertical slab (2) and 5.50 meters between the inner surfaces of said slab.
- 2.80 meters between the outer surfaces of the first horizontal slab (3).
- 2.80 meters between the outer surfaces of the second horizontal slab (4).
- 2.40 meters between the inner surfaces of the first horizontal slab (3).
- 2.40 meters between the inner surfaces of the second horizontal slab (4).

[0032] 2.00 meters between the outer edges of the vertical slabs in the transverse direction, or between the outer edges of the horizontal slabs in the transverse direction.

[0033] Wherein the first vertical slab (1), the second vertical slab (2), the first horizontal slab (3) and the second horizontal slab (4) are 15 centimeters thick for buildings of up to 5 floors high.

[0034] In an embodiment of the invention, the thicknesses of the first vertical slab (1) and the second vertical slab (2) are:

- For buildings up to 5 floors, the thickness is up to 15 centimeters.

- For buildings up to 10 floors, the thickness is up to 18 centimeters.
- For buildings up to 15 floors, the thickness is up to 20 centimeters.
- For buildings up to 20 floors, the thickness is up to 22 centimeters.
- For buildings up to 25 floors, the thickness is up to 25 centimeters.
- For buildings up to 30 floors, the thickness is up to 30 centimeters.

[0035] In an embodiment of the invention, with the first vertical slab (1) and the second vertical slab (2) separated at a distance of up to 6.00 meters, the thickness of the first horizontal slab (3) and the second horizontal slab (4) is up to 20 centimeters and the thickness of the first vertical slab (1) and the second vertical slab (2), in order to support this type of structural frame , is 15 centimeters.

[0036] In an embodiment of the invention, with the first vertical slab (1) and the second vertical slab (2) separated at a distance of 10 meters, the first horizontal slab (3) and the second horizontal slab (3) have a thickness of up to 50 centimeters and the thickness of the first vertical slab (1) and the second vertical slab (2), to support this type of structural frame , is 20 centimeters.

[0037] In an embodiment of the invention, with the first vertical slab (1) and a second vertical slab (2) separated at a distance of 15 meters, the first horizontal slab (3) and the second horizontal slab (3) have a thickness of up to 75 centimeters and the thickness of the first vertical slab (1) and the second vertical slab (2), to support this type of structural frame , is up to 25 centimeters.

[0038] In an embodiment of the invention, with the first vertical slab (1) and a second vertical slab (2) separated at a distance of 20 meters, the first horizontal slab (3) and the second horizontal slab (3) have a thickness of up to 100 centimeters and the thickness of the first vertical slab (1) and the second vertical slab (2), to support this type of structural frame , is up to 30 centimeters.

[0039] In an embodiment of the invention, referring to FIG. 2, note the use of open cross-section structural frames, where the cross section shape of the open cross-section structural frame is an open perimeter shape made of open polygonal U-shaped lines comprising:

- a first vertical slab (5).
- a second vertical slab (6).
- a horizontal slab (7) joined to the first vertical slab (1) and to the second vertical slab (2).

[0040] In an embodiment of the invention, referring to FIG. 3, the open cross-section structural frames , in its cross section have an open perimeter shape made of open polygonal C-shaped lines comprising:

- A first horizontal slab (8)
- A second horizontal slab (9).
- A vertical slab (10) joined to the first horizontal slab (8) and to the second horizontal slab (9).

[0041] In the subject invention, the open cross-section structural frames are joined together, forming closed cross-section structural frames .

[0042] In an embodiment of the invention, with reference to FIG. 4 and FIG. 5, the open cross-section structural frames are joined together to form closed cross-section structural frames ; i.e., in the shape of their cross-section, they have a closed-perimeter shape, said joints are made for example through assemblies between their elements, simple supports, internal or external welding, mechanical fastenings (such as bolts, rods or screws), or through post-stressing of structural wires.

[0043] In an embodiment of the invention the connection between the vertical and horizontal slab or between two open sections of structural frames have a preferred angle of 90°. The ranges of these joints are between 0° and 180°.

[0044] In an embodiment of the invention, the structural frames reduce their weight by combining different textures and shapes, including horizontal or vertical perforations on the surfaces of the structural frames and through the material of which they are made.

[0045] In an embodiment of the invention, referring to FIG. 6 and FIG. 7, alveoli (11) exist within the structural frames , i.e. horizontal or vertical perforations which may pass through or not, in order to lighten the weight of the elements without reducing their carrying capacity.

[0046] Further, the alveoli (11) have curved or straight geometrical shapes and have different dimensions, depending on the thicknesses of the first vertical slab (1), the second vertical slab (2), the first horizontal slab (3) and the second horizontal slab (4).

[0047] In an embodiment of the invention, the size of the alveoli is 15 centimeters in diameter for the first horizontal slab (3) and the second horizontal slab (3) is 20 centimeters thick and 10 centimeters in diameter for the first vertical slab (1) and the second vertical slab (2) is 15 centimeters thick.

[0048] The alveoli are sized proportional to the thickness of the vertical and horizontal slabs. At a minimum, they should be spaced from the edge of their surfaces preferably 2 centimeters.

[0049] In an embodiment of the invention, structural frames have air cavities in the concrete from which they are made, and this way their weight is reduced.

[0050] In an embodiment of the invention, the structural frames have inner expanded polystyrene, thus reducing their weight.

[0051] In an embodiment of the invention, the structural frames are made with cellular concrete, which contains injected air, reducing the density of the structural frames without decreasing their load capacity.

[0052] In a non-illustrated embodiment of the invention, the surfaces of the structural frames have different shapes which can reduce the volume of the material forming them, such as lightening or recesses, which generate textures and reduce the volume of the originally required material without decreasing the load capacity of the structural element.

[0053] In an embodiment of the invention, referring to FIG. 8, the structural frames have a plurality of recesses or structural ribs (12) formed by straight or curved shapes and generate a structural lattice.

[0054] In a non-illustrated embodiment of the invention, in the first horizontal slab (3) and the second horizontal slab (4) and the first vertical slab (1) and the second vertical slab (2) of the structural frames, the recesses or ribs (12) decrease the amount of material with which the structural frames are produced, reduce their weight, increase their rigidity and generate different shapes on the surfaces of said frames.

[0055] In an embodiment of the invention, the spaces between the structural ribs have a curved surface, with a curvature radius of for example between 3 and 15 centimeters.

[0056] The structural frames have structural reinforcements located in the slabs that comprise them.

[0057] Structural reinforcements can be:

- Rigid and continuous, like steel elements that can reinforce a matrix or directly conform the structure of the structural frames .
- Flexible and continuous, like textile reinforcements or metallic wires that are used for structural post-stressing.
- Discontinuous such as fiberglass, steel fibers or nanomaterials integrated into the material matrix with which structural frames are made.

[0058] The structural reinforcements are selected from the group consisting of metal rods , meshes and combinations thereof.

[0059] Meshes, in some embodiments are constructed of polymers, wires, textile reinforcements, natural fibers, fiberglass or synthetic fibers.

[0060] In a non-illustrated embodiment, the structural reinforcements are joined together by elements selected from the group consisting of welding, overlaps, wire mooring and combinations thereof.

[0061] The overlaps in structural reinforcements measure anywhere between 5 and 50 centimeters. These joints is carried out through metal wire mooring that fix the reinforcements together.

[0062] In an embodiment of the invention, reinforcements are also pre-stressing systems that, through stress exerted on wires serving as reinforcement, increase structural strength and reduce the thicknesses of vertical and horizontal slabs.

[0063] These structural reinforcements and their location in the slabs that form the structural frames are determined from aspects such as the size of the structural frames , the loads upon which the structural frames are subject to, and the load capacity of the terrain, among others.

[0064] In a non-illustrated embodiment of the invention, the structural reinforcements copy the shape of the plurality of recesses or structural ribs (12) and adapt to the thickness of the lightened slabs.

[0065] In an embodiment of the invention and taking into account the structural reinforcements, the structural frames are of three types:

- floor-type structural frames ,
- facility-type structural frames,
- roof-type structural frames .

[0066] The floor-type structural frame is installed on the surface of the ground making the the second horizontal slab (4) stay in contact with the ground, it is preferred that the ground be level and improved in its load capacity, according to terrain resistance found and with the specifications established from soil studies and structural designs of the construction project.

[0067] The floor-type structural frame has structural reinforcements in its first horizontal slab (3) so as to support the terrain reaction loads.

[0068] In an embodiment of the invention, the structural reinforcements of the first horizontal slab (3) of the floor type frame have the larger diameter reinforcing elements at the top of the first horizontal slab (3) and the smaller diameter reinforcing elements at the bottom of the horizontal slab (3).

[0069] In an embodiment of the invention, with reference to FIG. 9, the structural reinforcement of the floor type frame in its first horizontal slab (3) is given by:

A steel mesh with dimensions of 1/2"(14) in diameter located on the top of the first horizontal slab (3) and a steel mesh with dimensions of 3/8" (13) in diameter located on the bottom of the first horizontal slab ..

[0070] The first vertical slab (1) and the second vertical slab (2) have a steel mesh reinforcement with a diameter of 1/2" (14).

[0071] In the second horizontal slab (4) which is of structural steel mesh with preferential dimensions of 1/2" (44) in diameter at its bottom. And at the top of the second horizontal slab (4) the preferred reinforcement of this slab is a steel mesh with preferential dimensions of 3/8" (43) in diameter.

[0072] In a non-illustrated embodiment of the invention the meshes are separated from the surface of the structural frame by a distance of for example 2 centimeters.

[0073] In an embodiment of the invention the spacing between the rods forming the structural reinforcement meshes has a preferred dimension of 10 centimeters between them. The ranges of this separation go from 5 x 5 centimeters to 50 x 50 centimeters.

[0074] The Facility-type structural frame is installed on the structural frame of the floor type.

[0075] In an embodiment of the invention and referring to FIG. 10 the structural reinforcement of the facility-type structural frames is made up as follows:

- The first horizontal slab (3) has a steel mesh reinforcement with dimensions of 1/2" (14) in diameter at its bottom. In the top of the first horizontal slab (3) the preferred reinforcement is a steel mesh with dimensions of 3/8" (13) in diameter.

[0076] In a non-illustrated embodiment of the invention, the meshes are separated from the surface of the structural frame by a distance of for example 2 centimeters.

- The second horizontal slab (4) has a preferred steel mesh reinforcement with dimensions of 1/2" (14) in diameter at its bottom. At the top of the second horizontal slab (4) the reinforcement is a structural steel mesh with preferred dimensions of 3/8" (13) in diameter.

[0077] In a non-illustrated embodiment of the invention the meshes are separated from the surface of the structural frame by a distance of for example 2 centimeters

- The first vertical slab (1) and the second vertical slab (2) have a steel mesh reinforcement on their outer and inner faces with a diameter of 1/2" (14).

[0078] In a non-illustrated embodiment of the invention the meshes are separated from the surface of the structural frame by a distance of for example 2 centimeters

[0079] The spacing between the rods that form the structural reinforcement mesh has a preferred of 10 cm between them. The ranges of this separation go from 5 x 5 centimeters to 50 x 50 centimeters.

[0080] In an embodiment of the invention and referring to FIG. 11, the facilities-type structural frames have at least one perforation (15) for the passage of ducts for installation of elements such as pipes, ducts, electrical and hydro-sanitary networks, voice and data networks, and other technical systems required in construction. This drilling is located according to the location of the bathroom, kitchen and clothing spaces of each housing unit. Its location in the upper and lower horizontal slabs can coincide or can be located at two different points between different structural frames, which causes the pipes to be attached to the lower or upper part of the structural frames.

[0081] The hydro-sanitary system works as the set of pipelines for the transport of the water supply to the living spaces (for consumption) and drainage (water used). The openings or perforations for the passage of these ducts or installations, are for example in one of the structural frames that form the modular prefabricated building system,.

[0082] These perforations have for example circular shapes or in parallelepiped shapes, with dimensions of 12 centimeters and a range with diameters or widths from 1 centimeter up to 50 centimeters for locating all the necessary technical ducts.

[0083] In an embodiment of the invention, the roof-type structural frame, located on the second horizontal slab (4), has at least one sloping surface that is connected to a drainage channel and even water collection ducts.

[0084] Referring to FIG. 12, the roof-type structural frame located on the second horizontal slab (4), has a sloping surface (16) which is connected to a drain channel (17) and to water collection ducts (18).

[0085] In an embodiment and referring to FIG. 13 the roof-type structural frame located on the second horizontal slab (4), has two sloping surfaces (16) that connect to a drainage channel (17).

[0086] The preferred diameter for the structural reinforcements of the lower part of the lower and upper horizontal slabs of the roof-type structural frames is 1/2". The preferred diameter for the structural reinforcements of the top part of the lower and upper horizontal slabs of the roof-type is 3/8 ". The range of reinforcement diameters for the horizontal structural slabs of the facilities-type structural frames is between 1/8" and 3".

[0087] The preferred diameter of the structural reinforcements of the vertical slabs for the roof-type structural frames is 1/2". The reinforcements of the vertical structural slabs of the roof-type structural frames have a range from 1/8" to 3".

[0088] The spacing between the rods forming the structural reinforcement mesh for the vertical, upper horizontal and lower horizontal slabs has a preferred dimension of 10 x 10 centimeters and a separation range from 1 x 1 centimeter to 50 x 50 centimeters.

[0089] In an embodiment of the invention, the sloped surfaces of the roof-type structural frames have waterproofing mortars installed on the outer surface of the second horizontal slab (4). These mortars should have a slope for example of 5% towards the drainage channels, but they can range between 1% and 45%.

[0090] The sloping surface is waterproofed.

[0091] In an embodiment of the invention the sloping surfaces have textile waterproofing agents, which are fixed to the outer surface of this structural slab with waterproofing mortars, with heat or with resins.

- The elements for the roof waterproofing can be entirely contained within the materials with which the structural frames are made. They can also be additional elements that are installed in the joints or on the surface of the structural frames. These waterproofing agents can be fluids (waterproofing mortars or silicones), flexible (neoprene, gums or rubbers), or rigid (metal joints or in other solid materials such as polymers) and guarantee water tightness and control of water seepage into the living space and into the structure of the modular structural frames .

[0092] Connection means joining the structural frames both horizontally and vertically:

The connection means joining horizontally and vertically the structural frames, rigidify the joints between the structural frames and in the preferred embodiments of the invention achieve the impermeability between their joints and allow the elaboration of constructive projects joining the structural frames as a modular prefabricated system.

[0093] Referring to FIG. 14, the connecting means joining horizontally and vertically the structural frames are selected from the group comprising inner rigid joints, such as reinforced steel (19) joined with welding (20), overlapped (21), geometrical assemblies, chamfer assemblies (22), tongue and groove (23), with simple supports or with mortar, metal flat bars (24), mechanical joints using metal rods (25), mechanical joints using bolts or screws (26) and combinations thereof.

[0094] In a non-illustrated embodiment of the invention the connecting means joining horizontally and vertically the structural frames are selected from the group comprising plates, bolts, rods or the like, and combinations thereof.

[0095] In an embodiment of the invention are installed at least between two structural frames. The plates and bolts effect a mechanical connection between the structural frames as being a connecting element between them. The rods are installed inside the vertical and horizontal slabs of the structural frames to make an assembly between at least two of them, which is reinforced with welds or with emptying of structural mastics, mortars of high strength or similar.

[0096] In a non-illustrated embodiment of the invention, the connecting means joining horizontally and vertically the structural frames are selected from the group comprising mastics, mortars, concretes or the like and combinations thereof and are used for example without the need to install rigid connectors such as flat bars or the like.

[0097] In an embodiment of the invention and referring to FIG. 14 the connecting means joining horizontally and vertically the structural frames form angles of attachment of 90° with rigid inner joints, such as reinforcing steels (11) joined together by welding (12) or overlapped (13) with a preferred length of 20 centimeters. For the construction of these overlaps between the rigid inner joints has a range between 5 and 50 centimeters.

[0098] In an embodiment of the invention and Referring to FIG. 14 the connecting Means connecting horizontally and vertically the structural frames makes the connections through chamfered assemblies (14) or tongue and groove (15) with simple supports or with mortars of paste.

[0099] In an embodiment of the invention and Referring to FIG. 14 the connecting means joining horizontally and vertically the structural frames makes connections by simple supports between the vertical slabs, i.e. the first vertical slab (1) or the second vertical slab (2) and the horizontal slabs, i.e. the the first horizontal slab (3) or the second horizontal slab (4) and reinforced with mortars of paste between the vertical and horizontal slabs.

[0100] In an embodiment of the invention and Referring to FIG. 14 the connecting means joining horizontally and vertically the structural frames are external joints with metal flat bars (16) with preferred dimensions of 10 x 10 centimeters and calibers of 2 millimeters (ranging from 2 x 2 centimeters to 30 x 30 centimeters of area and calibers between 2 and 10 millimeters).

[0101] In an embodiment of the invention and Referring to FIG. 14 The connecting Means joining horizontally and vertically the structural frames are mechanical joints through metal rods (17) with a preferred diameter of 1/2", with ranges between 1/4" and 2".

[0102] In an embodiment of the invention and Referring to FIG. 14 the connecting means joining horizontally and vertically the structural frames are mechanical joints through bolts or screws (18) with preferred diameters of 1/2", with ranges between 1/4" and 2", and preferred lengths of 10 centimeters, with ranges between 5 and 20 centimeters.

[0103] In an embodiment of the invention and Referring to FIG. 14 The connecting Means joining horizontally and vertically the structural frames are external joints with metal flat bars (16) welded together, with preferred dimensions of 10 x 10 centimeters and calibers of 2 millimeters, with ranges between 2 x 2 centimeters up to 30 x 30 centimeters of area and calibers between 2 and 10 millimeters.

[0104] In an embodiment of the invention and Referring to FIG. 14 The connecting Means joining horizontally and vertically the structural frames are inner joints with reinforcing metal rods (17) overlapped at the corners in the form of hook or cane, welded or joined by structural moorings with metal wires. The preferred length of the overlap is 20 centimeters, with a range between 5 and 50 centimeters.

[0105] In an embodiment of the invention the installation of rigid structural elements such as metal rods (17). are inserted with a depth of 90 centimeters in each structural frame. The depth of these metal rods ranges between 30 and 150 centimeters per structural frame. The diameter is in a range between 3/8" to 3" preferably it is of 1".

[0106] The structural frame that is vertically attached to the lower structural frame must leave perforations in its vertical slabs with a preferred diameter of 1", with ranges between 3/8" and 3" to make the joint with epoxies mastics or high strength mortars which are installed in the perforations of the vertical slabs to increase rigidity.

[0107] In an embodiment of the invention and referring to FIG. 14, the connecting Means joining horizontally and vertically the structural frames are geometrical assemblies, located in the elements edges, which connect the pieces together, stiffening them by friction.

[0108] In an embodiment of the invention and referring to FIG. 14, the connecting Means joining horizontally and vertically the structural frames are geometrical assemblies by a chamfer (14) in the edge of of the structural frames with an angle a range from 15° to 75° preferably 45°.

[0109] In an embodiment of the invention and referring to FIG. 15 the connecting Means joining horizontally the structural frames are flat bars in "Z" (27), which are fixed to the upper structural frames through bolts, screws or welds.

[0110] Referring to FIG. 16 The bonding sheet has three surfaces: an upper vertical (28), a horizontal (29) and a lower vertical (30). Between the upper vertical flap and the horizontal flap, the preferred joint angle is 90° and has a range between 0° and 180° measured from the surfaces of the structural structural frames that are attached. Between the horizontal flap and the lower vertical flap, the preferred attachment angle is 90° and have a range between 0° and -180°, also measured from the surfaces of the structural structural frames which these flaps link.

[0111] The fins forming the bonding sheet have a preferred caliber of 2 millimeters, with a range between 0,5 and 10 millimeters. They can be located in each one of the structural structural frames, to increase the system rigidity. The preferred location of these elements is at the outer edge of each structural frame. The joining sheets may also be at the joining of two structural structural frames, or at any part of the surface of the horizontal slabs of the framing frames. The bonding sheets may be attached to the structural frames through bolts, flat bars, or be embedded in the emptying process.

[0112] The angles of the joints between the structural structural frames are set according to the geometry defined from the architectural designs.

[0113] The dimensions of one of these flat bars referring to FIG. 16 is for example In its upper vertical fin (28), the preferred length of the flat bar in "Z" is 15 centimeters in height. This dimension has ranges between 2 and 30 centimeters in height. On its horizontal flap (29) In its lower vertical flap (30), the preferred length of the flat bar in "Z" is 15 centimeters. This dimension has a range between 2 and 30 centimeters in length. The preferred caliber is 2 millimeters and can be varied in a range of 2 to 10 millimeters, according to the structural calculations performed for each case.

[0114] The dimensions are directly proportional to the thickness of the vertical slabs in the different heights of the system, and for example 2 millimeters more on each side to guarantee the assembly between the flat bars and the slabs of the structural frames.

[0115] In an embodiment of the invention and referring to the Referring to FIGS. 17 and FIG. 18 the connecting means joining horizontally and vertically the structural frames are geometrical assemblies formed by supports (31) between slabs of the structural frame.

[0116] In an embodiment of the invention, the connecting means joining horizontally and vertically the structural frames are a flexible element such as neoprene, rubbers or the like located on the edges of the vertical and horizontal slabs of the structural frames, and they finish adhering by the pressure that is made to join the structural frames together.

[0117] In an embodiment of the invention and referring to FIG. 19, the horizontal connecting means between the structural frames is a flexible element such as neoprene, rubbers or the like (32). These elements are installed on the edges of the vertical and horizontal slabs of the structural frames, and they finish adhering by the pressure that is made to join the structural frames together.

[0118] In an embodiment of the invention and referring to FIG. 19, waterproof elastic gaskets covering a portion of the edge section of a structural frame.

[0119] In an embodiment of the invention, the flexible element (32) is installed between the structural frames with a thickness of between 5 millimeters and 10 millimeters. These seals are located in the edges of the horizontal and vertical structural slabs and adhere to them by the pressure that is made to join the structural frames.

[0120] In an embodiment of the invention and referring to FIG. 20 and FIG. 21, continuous structural elements such as post-tensioning metal wires (33) which are used inside the structural frames in the longitudinal or transverse direction through ducts with a diameter, for example of 1/2", and through the tensions made, join the structural frames with each other.

[0121] For the construction of the buildings and referring to FIG. 22 In the building the support structure is constructed with the arrangement of the structural frames assemblies (34). The structural frames are made in such a way that there is an empty space (35) i.e. Habitable spaces and empty spaces that form for example courtyards between two sets of structural frames and thus form a living space.

[0122] The arrangement of the structural frames is made in such a way that at the same level or in height there is a sequence of sets of structural frames and empty spaces. Structural frame assemblies that are installed on other structural frames also continue the sequence in height of structural and empty frame assemblies. In this way, the structural elements necessary for the construction of a building leave spaces that can be used as living spaces.

[0123] A cover (36) is added between some sets of structural frames, thereby forming a new living space.

[0124] An open section structural frame can also be added where the geometric shape of its cross section in cut of the open section structural frame is an open perimeter geometry formed of open polygonal lines in "U" shape (37) supported on another structural frame, forms a new living space. At the upper level, the voids (6) between the structural frames are covered with a cover (36)

[0125] The facades, which are the front spaces of the structural frames and that are delimited by the vertical and horizontal slabs.

[0126] The facades, interior divisions and roofs are constructed with non-structural elements with various architectural forms and structural or non-structural elements with materials according to the weather, the provision of economic and material resources, or cultural tradition such as: metal sheets, masonry in brick or concrete, concrete emptied or prefabricated soil, metal, glass, wood, dry-wall type light modular divisions or similar, natural or synthetic agglomerates, polymers, among others.

[0127] In an embodiment of the invention in the empty left by the installation of the structural frames located on the top floor of the building, at least one cover will be installed which will carry the rainwater through channels to be carried out. Said cover can be curved, straight or sloping lines or combinations of the above and has a slope for example of 2% and conduits towards channels of rainwater collection and can be metallic, emptied in concrete, constructed with brick, wood, clay tile, concrete blocks or textile materials.

Claims

1. A prefabricated modular building system comprising:

- a plurality of structural frames;
- connecting means that connect the structural frames both horizontally and vertically;

wherein the structural frames are hyperstatic and self-supporting with a closed cross-section and the structural frames are also hyperstatic and self-supporting with an open cross-section.

2. The building system of claim 1, **characterized in that** the structural frame of the shape of the cross-section cut is a closed perimeter geometrical shape which is selected from the group consisting of parallelograms, circles, polygons, trapezoids and combinations thereof.

3. The building system of claim 1, **characterized in that** the structural frame of the shape of the cross-section cut is an open-perimeter geometrical shape which is selected from open curves, open polygonal lines and combinations thereof.

4. The building system of claim 1, wherein the structural frame comprises

- a first vertical slab (1);
- a second vertical slab (2);
- a first horizontal slab (3) joined to the first vertical slab (1) and to the second vertical slab (2) at its bottom;
- a second horizontal slab (4) joined to the first vertical slab (1) and to the second vertical slab (2) at the top.

5. The building system of claim 1, wherein the structural frame is filled with reinforced concrete.

6. The building system of claim 1 wherein the open cross-section structural frame comprises:

- A first vertical slab (5);
- A second vertical slab (6);
- A horizontal slab (7) joined to the first vertical slab (1) and to the second vertical slab (2);

wherein the geometrical shape of the cross section cut of the open cross-section structural frame is an open perimeter geometrical shape formed by open U-shaped polygonal lines.

7. The building system of claim 1, wherein the open cross-section structural frame comprises:

- A first horizontal slab (8);
- A second horizontal slab (9);
- a vertical slab (10) joined to the first horizontal slab (8) and to the second horizontal slab (9);

wherein the geometrical shape of the cross-section cut of the open cross-section structural frame is an open perimeter geometrical shape formed by open C-shaped polygonal lines.

8. The building system of claim 4, wherein the structural frame has structural reinforcements that withstand the terrain reaction loads.

9. The building system of claim 1, wherein two open cross-section structural frames are joined together to form closed cross-section structural frames.

10. The building system of claim 1, wherein the structural frames have horizontal or vertical perforations.

11. The building system of claim 1, wherein the structural frames have air cavities within the structural frames.

12. The building system of claim 1, wherein the structural frames have polystyrene expanded within said structural frames.

13. The building system of claim 1, wherein the structural frames are made of cellular concrete.

14. The building system of claim 1, wherein the structural frames have a plurality of recesses forming structural ribs.

15. The building system of claim 1, **characterized in that** the structural frames are connected by connection means to:

- a vertical slab;
- a horizontal slab.

16. The building system of claim 1, wherein the structural frames have structural reinforcements that are selected from the group consisting of metal rods, meshes and combinations thereof.

17. The building system of claim 16, wherein the structural reinforcements are joined together by elements selected from the group consisting of welding, overlaps, wire mooring and combinations thereof.

18. The building system of claim 16, wherein the structural reinforcements are prestressed systems.

19. The building system of claim 1, wherein the structural frames have reinforcements that withstand the terrain reaction loads.

20. The building system of claim 4, wherein a structural frame has structural reinforcements in the first horizontal slab (3), with reinforcing elements having a greater diameter at the top of the first horizontal slab (3) and reinforcing elements having a lesser diameter at the bottom of the first horizontal slab (3).

21. The building system of claim 4, wherein a structural frame has structural reinforcements at the top of the first horizontal slab (3), comprising a ½" size diameter steel mesh (14) and structural reinforcements at the bottom of the first horizontal slab (3), comprising a 3/8" size diameter steel mesh (13).

22. The building system of claim 4, wherein a structural frame has structural reinforcements in the first vertical slab (1) and in the second vertical slab (2), comprising a ½" structural steel mesh (14).

23. The building system of claim 4, wherein a structural frame has structural reinforcements in the second horizontal slab (4), that is a preferred ½" bottom diameter structural steel mesh (44). And in the top of the second horizontal slab (4) the preferred reinforcement of this slab is a preferred 3/8" diameter structural steel mesh (43).

24. The building system of claim 4, wherein a structural frame has structural reinforcements in the first horizontal slab (3), that is a ½" bottom diameter structural steel mesh (14). In the top of the first horizontal slap (3) the preferred reinforcement is a preferred 3/8" diameter structural steel mesh (13).

25. The building system of claim 4, wherein a structural frame has structural reinforcements in the

26. The building system of claim 4, located on the second horizontal slab (4), having at least one sloping surface which connects to a drainage channel, and water collection ducts.

27. The building system of claim 26, wherein the sloping surface is waterproofed.

28. The building system of claim 1, wherein the connecting means that join the structural frames both horizontally and vertically, are selected from the group consisting of inner rigid bonds, such as reinforced steel rods (19) joint with welded (20), overlapped (21), geometric assemblies, chamfer assemblies (22), tongue and groove (23) assemblies, both with single supports or with mortar, metal flat bars (24), metal rod mechanical joints (25), bolt or screw mechanical joints (26), and combinations thereof.

29. The building system of claim 1, wherein the connecting means that join the structural frames both horizontally and vertically, are selected from the group consisting of flat bars, bolts, rods or the like, and combinations thereof.

30. The building system of claim 1, wherein the connecting means that join the structural frames both horizontally and vertically, are selected from the group consisting of mastics, mortars, concretes or the like, and combinations thereof.

31. The building system of claim 1, wherein the connecting means that join the structural frames both horizontally and vertically, is a flexible element.

32. The building system of claim 4, wherein the connecting means that join the structural frames both horizontally and vertically, is a flexible element located on the structural frame slab edges, which finish adhering by means of the pressure made in order to join the structural frames together.

33. The building system of claim 31, wherein the flexible element is selected from the group comprising neoprene, rubbers, plastics, elastic packaging and combinations thereof.

34. The building system of claim 1, wherein the connecting means that join both horizontally and vertically, are post-stressed metal wires (33).

35. A building structure comprising a plurality of structural frames interconnected both horizontally and vertically in assemblies, located in such a manner that at the same level or height, a sequence of sets of structural frames and void spaces exists.

36. The building structure of claim 34, wherein the plurality of structural frames connected both horizontally and vertically, are located on other structural frames in a height sequence of frames and void spaces.

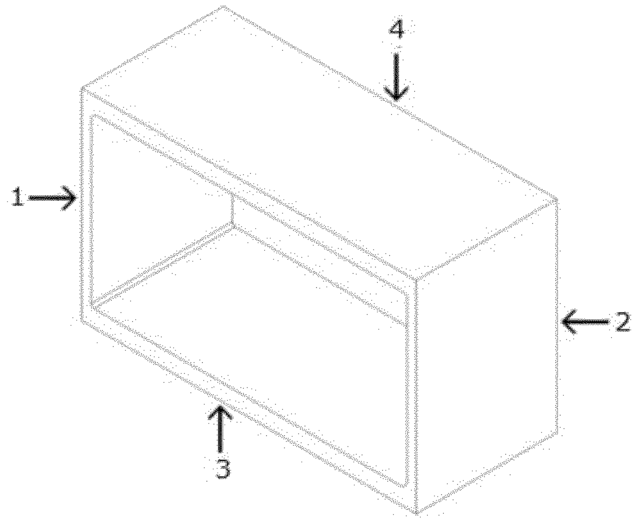

FIG. 1

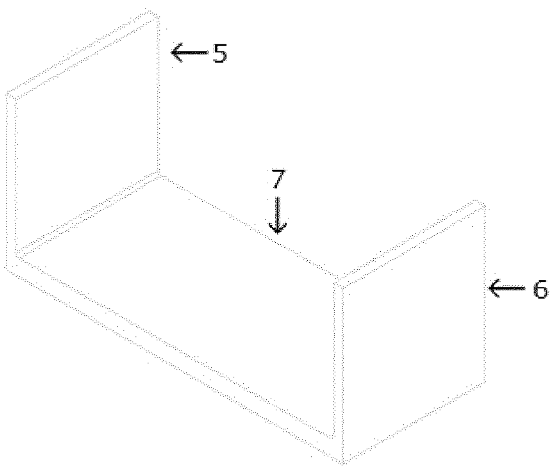

FIG. 2

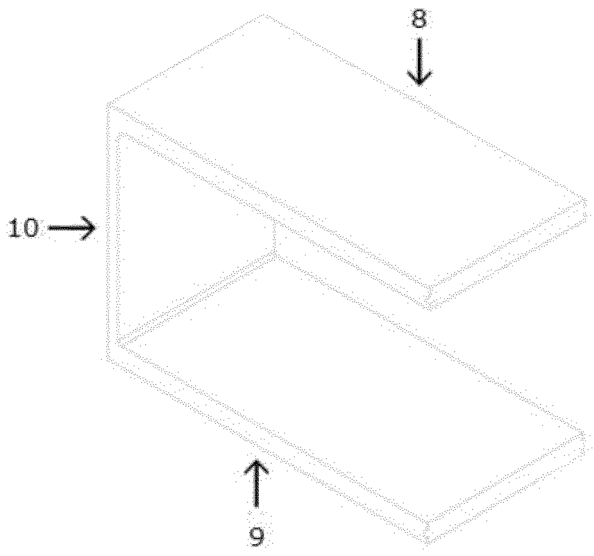

FIG. 3

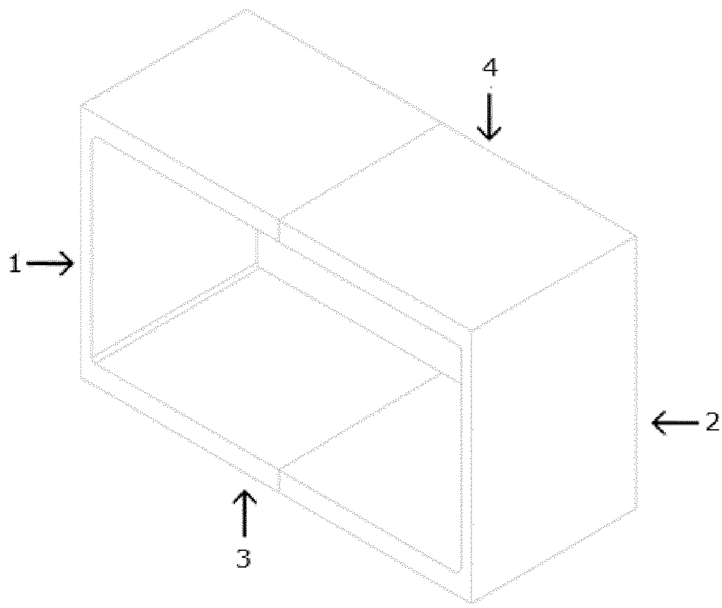

FIG. 4

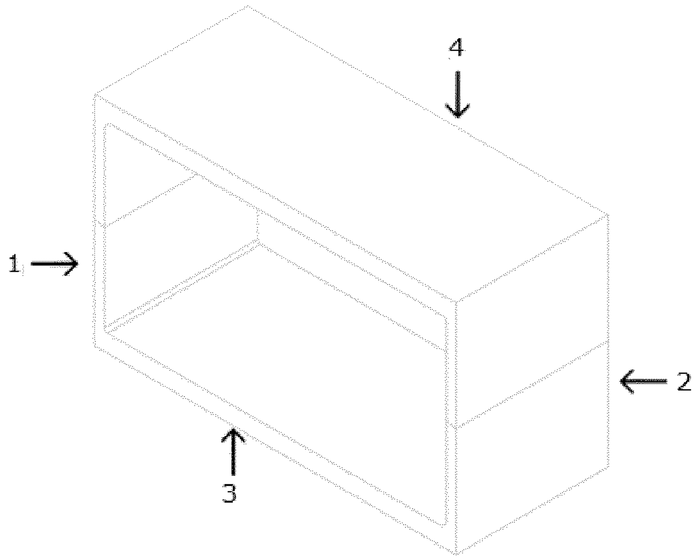

FIG. 5

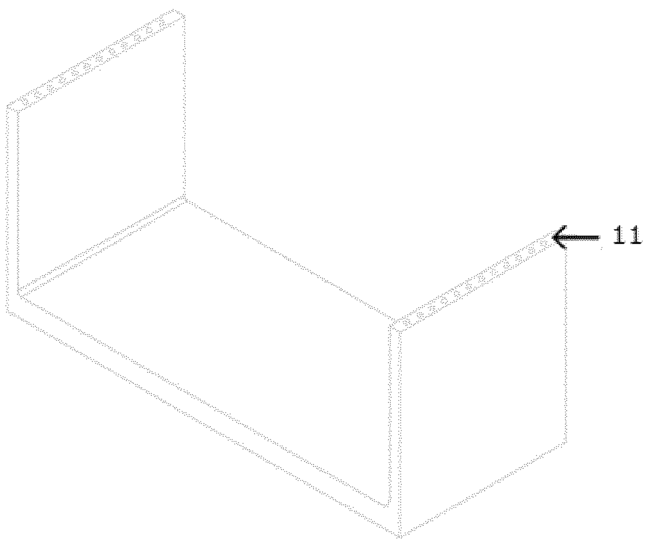

FIG. 6

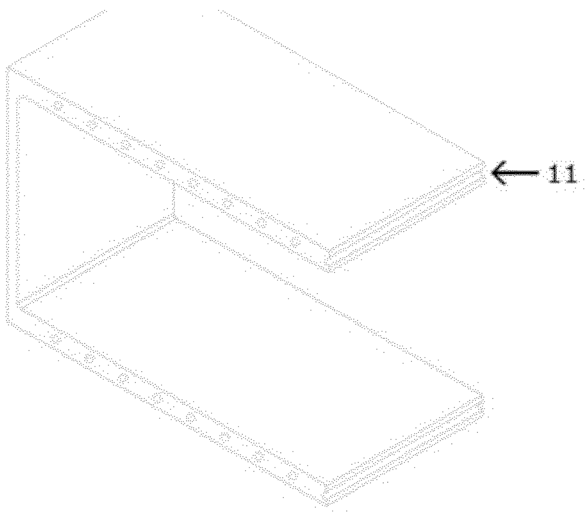

FIG. 7

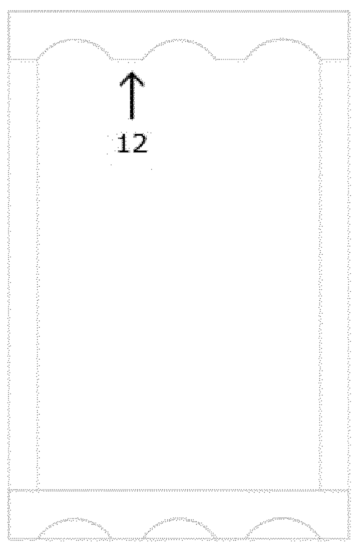

FIG. 8

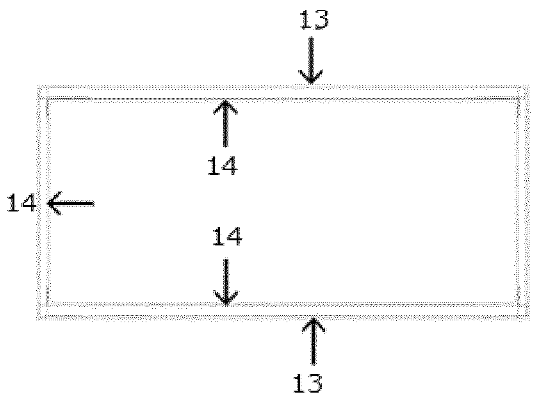

FIG. 9

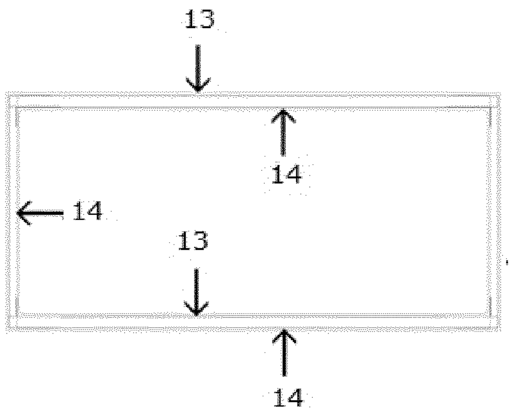

FIG. 10

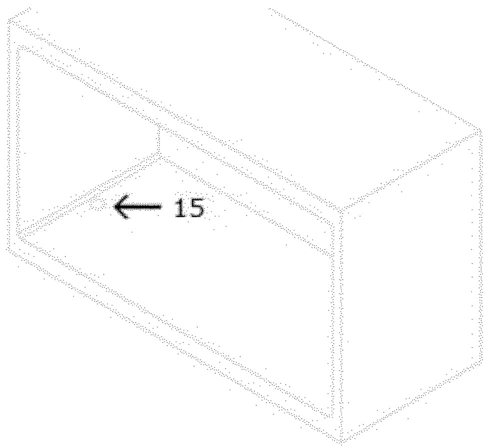

FIG. 11

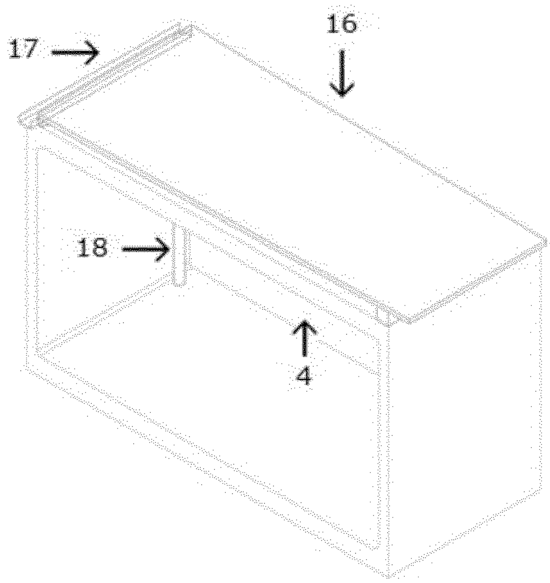

FIG. 12

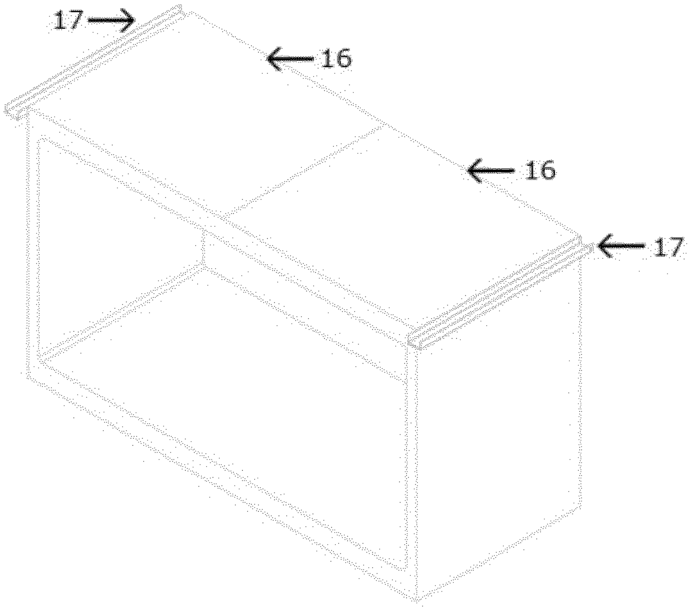

FIG. 13

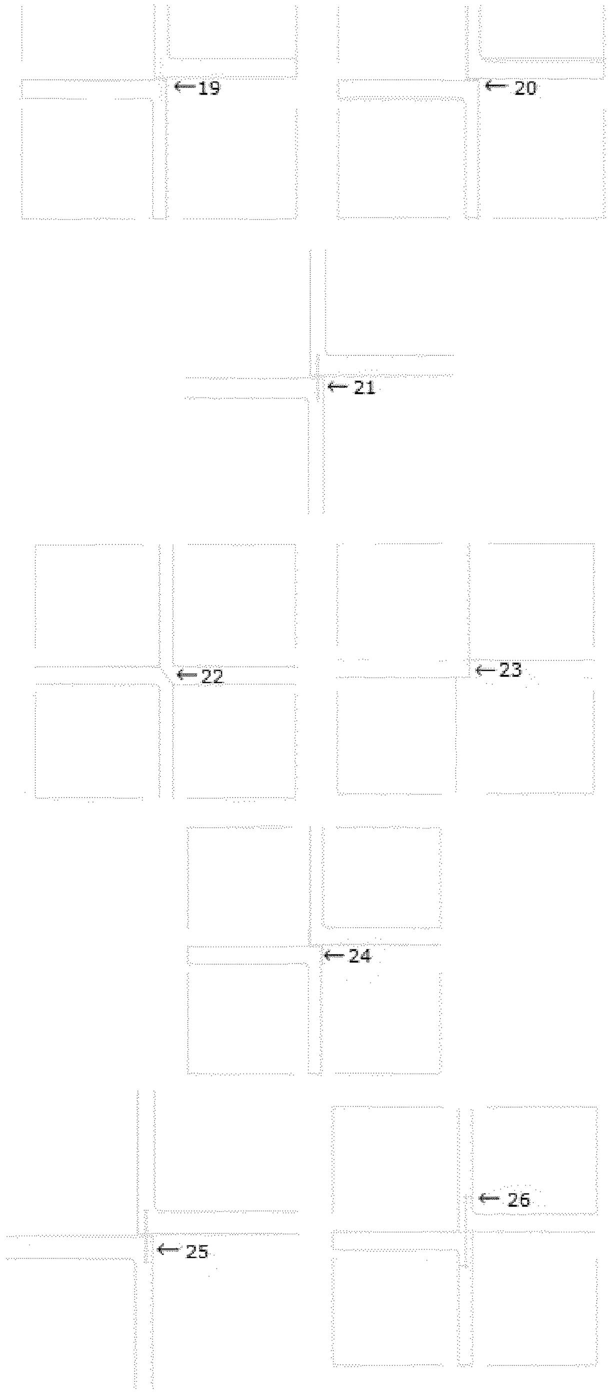

FIG. 14

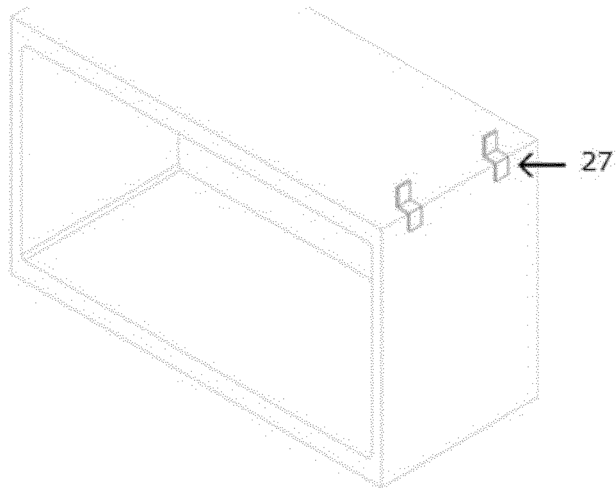

FIG. 15

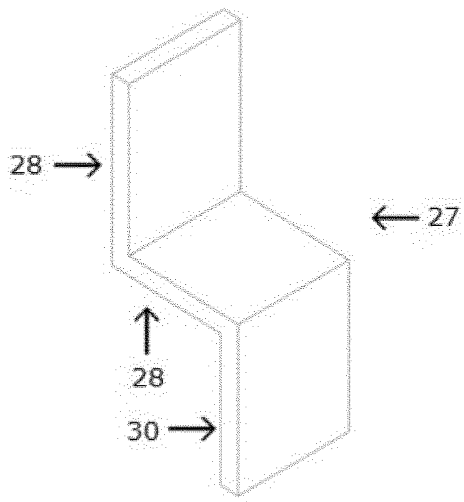

FIG. 16

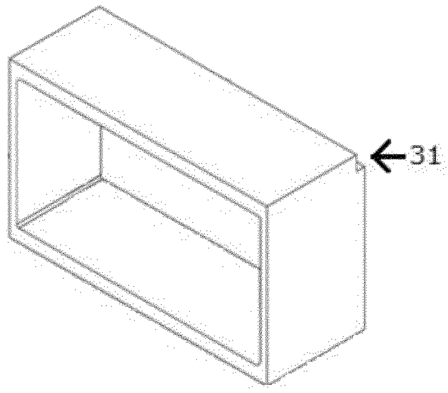

FIG. 17

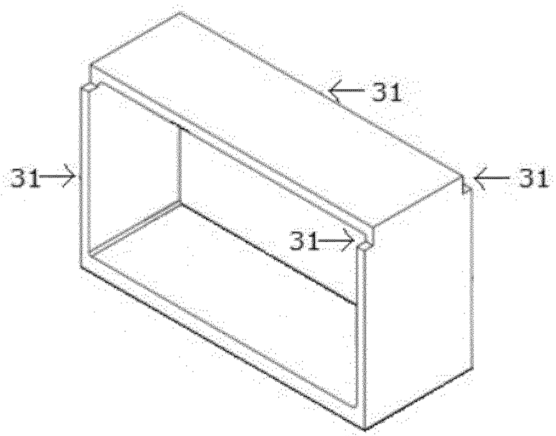

FIG. 18

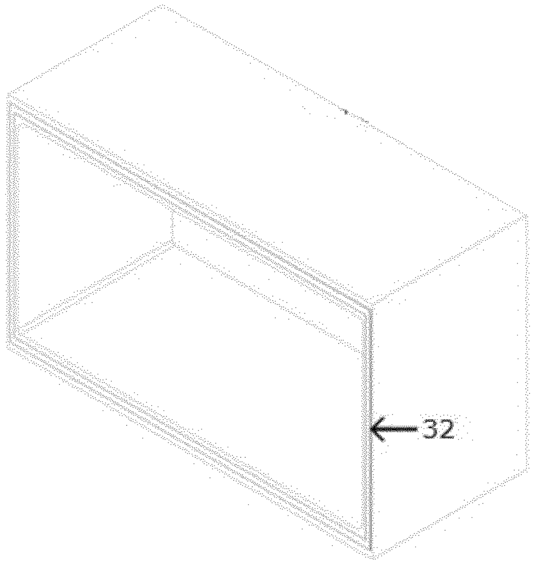

FIG. 19

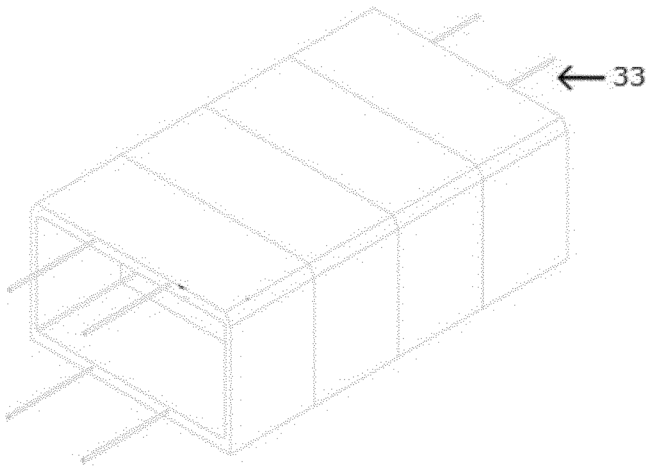

FIG. 20

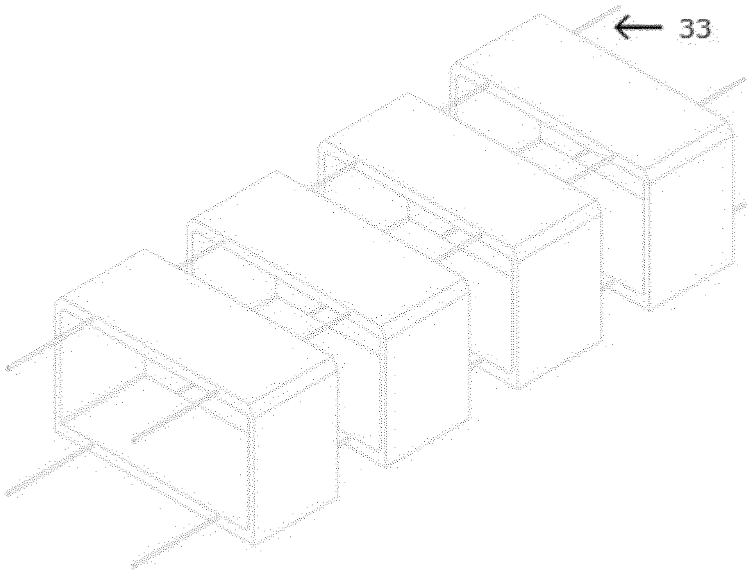

FIG. 21

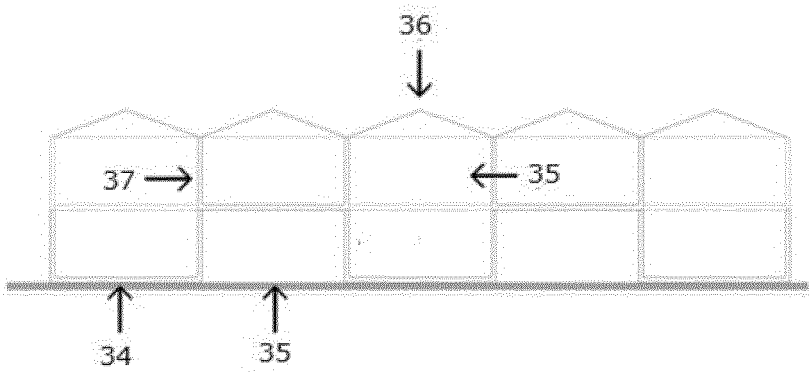

FIG. 22

INTERNATIONAL SEARCH REPORT

International application No.
PCT/IB2016/052421

A. CLASSIFICATION OF SUBJECT MATTER

(CIP) E04B1/348 (2016.01).

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)

(CIP) E04B1/348 / (CPC) E04B1/348, 1/34823.

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

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

EPOQUE, ESP@CENET, GOOGLE PATENT.

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US4073102A (FISHER, JOHN SERGIO), 14-02-1978. abstract, columns 5, 6 claims, figuras	1 - 35.
X	US20150033644A1 (KILONEWTON CONSULTORES DE ENGENHARIA LDA), 05-02-2015. abstract, paragraphs [0001], [0005] to [0012], [0017] to [0019], [0022] to [0027], [0036], [0037], figuras	1 - 35.
X	US4050215A (FISHER, JOHN SERGIO), 27-09-1977. abstract, column 5 lines 45 to 68, column 8 lines 3 to 23, 50 to 68, column 9 lines 1 to 9, 23 to 26, 50, 51 column 13 lines 5 to 7, figuras	1 - 35.
A	US3894373A (WILLINGHAM, JOHN H), 15-07-1975. the whole document	
A	US4228623A (MENOSSO ENNIO), 21-10-1980. the whole document	

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

* Special categories of cited documents:
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"O" document referring to an oral disclosure, use, exhibition or other means
"P" document published prior to the international filing date but later than the priority date claimed
"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention
"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone
"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art
"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
15 June 2016 (15.06.2016)	21 July 2016 (21.07.2016)
Name and mailing address of the ISA/	Authorized officer
Facsimile No.	Telephone No.

Form PCT/ISA/210 (second sheet) (January 2015)

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.
PCT/IB2016/052421

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		ES473920A1	01-05-1979
		IT1104959B	28-10-1985

Form PCT/ISA/210 (patent family annex) (January 2015)

REFERENCES CITED IN THE DESCRIPTION

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- US 8397441 B **[0002]**
- US 7665250 B **[0004]**