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(54) SELF-SUPPORTING STRUCTURAL PANELS AND RESPECTIVE SYSTEM OF SELF-SUPPORTING STRUCTURAL PANELS

(57) This invention relates to self-supporting structural panels with built-in infrastructure and the respective system of self-supporting structural panels. The system of panels which is the object of this invention consists of a plurality of panels (P), however it is essential that it comprises at least two panels (P), which are connected and fixed, shiftedly arranged with respect to each other as often as the idealised construction requires, and will be finalised by means of preferred embodiments of the panels, in particular, capping panels for façade fixing (PRF) (floors and ceilings) and façade panels (PF) (for exterior walls). In this way it is possible not only to execute the interior walls, but also to perform the exterior finishes and final and ground floors, as well as the façades.

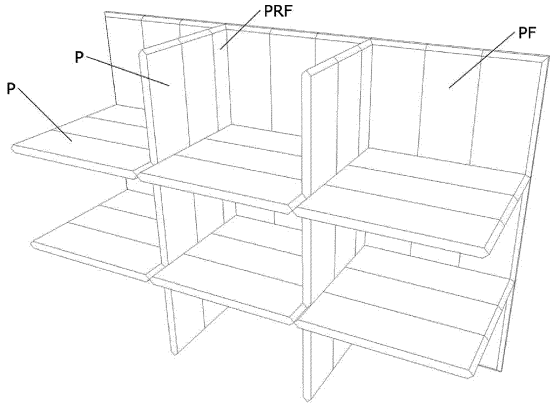

Figure 15

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Description

TECHNICAL FIELD OF THE INVENTION

[0001] This invention falls within the building sector, specifically in the area of self-supporting sandwich panels with quick and innovative fittings and thoroughly equipped with means for installation, namely water, electricity and telecommunications networks.

SCOPE AND BACKGROUND OF THE INVENTION

[0002] The development of new construction methods is becoming increasingly necessary, focusing on three essential dimensions: maximising the comfort and well-being of users; minimising environmental impacts (in the construction, use and final recycling phases of the product); and reducing resources and costs, promoting savings and return on investment.

[0003] Over the last 200 years, the construction of buildings has been characterised by remarkable developments that try to make architecture compatible with functionality and economy. At the beginning of the 20th century, with the need to create buildings with a higher number of floors and with resistance to seismic events and/or wind, the construction sector evolved towards the use of reinforced concrete structures complemented with brick and mortar masonry. This solution is still in use today. Construction technology has evolved with the introduction of new materials and techniques that try to promote the profitability of the necessary human resources. The incidence of human resources "in situ" in this type of construction is very significant, requiring very strict control of its planning, which results in longer execution times than the solutions that have been developed, particularly over the last 50 years.

[0004] In a first phase, prefabrication solutions were invented which, even today, are reflected in the construction sector in Portugal, with a greater incidence in industrial buildings and/or warehouses. It is a pre-established set of different structural elements in reinforced concrete which are manufactured by groups, in factory environment, on a suitable installation, based upon large moulds. Already on site, the prefabricated elements are simply assembled according to the envisaged sequence, with the use of lifting means, which as a general rule are very powerful, depending on the weight of the components and, therefore, quite expensive. There are numerous patented systems for this type of construction, although they are increasingly falling into disuse in residential buildings and even in the industrial sector, among which are the following patent documents: WO2017/182946, WO2015050502, US6412243, US2003033769 and US4267679.

[0005] The advantage of a fast construction "in situ" is nullified by the cost of the means involved and, above all, by the massive use of concrete, which is comprised of cement, one of the world's largest polluters - the third largest emitter of greenhouse gases.

[0006] As a result of an increased accessibility to "steel" construction material, alternative steel structures have been developed, together with a greater overall lightness of buildings with positive repercussion as regards the action of earthquakes in tall buildings. The exterior walls can be the traditional ones (masonry) or they can be made up of panels produced through industrialised processes of significant durability, where thermal and acoustic insulation are essential. Interior walls and partitions are, as a general rule and depending on the vocation of the building, executed by conventional processes and/or by more evolved processes (plasterboard with acoustic insulation, etc.).

[0007] This type of structures requires a fire protection treatment that is carried out by carefully spraying an intumescent paint which delays the effect of fire by about 90 minutes. This is a demanding and expensive activity. More recently, constructive models have been adapted, based on wooden structures lined with more or less complex panel systems of materials, depending on the level of comfort and safety required for each specific case. These structures have been replaced by light metal profiles which gave rise to the technological name of LSF (Light Steel Frame). This is a much specialised activity, although very simple, fast, versatile and presenting huge advantages in terms of the weight of buildings whose height, in general, do not exceed three storeys.

[0008] The activities relating to wall, ceiling and floor coverings are similar to all other systems of the same kind, particularly in what concerns the implementation of electricity, water and sewage infrastructures, i.e. through the opening and subsequent covering of grooves, a process which involves the destruction of walls for the passage of such infrastructures and their subsequent reconstruction.

[0009] Depending on the needs (e.g. mass social housing), symbioses of systems such as metal structures and prefabricated concrete panels can be created and installed using cranes. More recently, the characteristics of materials with more than 40 years of existence have been used, but without much success due to the initial inability to stabilise the material (then known as YTONG) and prefabricated panels in AAC (Autoclaved Aerated Concrete) have thus been created, which present a resistant function, low weight, thermal comfort and fire resistance. With an apparent success in terms of speed and quality, it has been found that the amount of material waste was enormous, with an unsustainable environmental impact.

[0010] The patent document WO 2017/182946 discloses a panel system based on the use of calcium silicate panels together with a "filling" of "styrofoam" balls with a cement grout, thus obtaining a panel with a generous thickness (about 15 cm), which are interesting weight characteristics associated to a good thermal insulation. Equipped with a tongue-and-groove type fitting devices, the system is, however, not self-supporting, al-

ways requiring additional assembling and fastening arrangements based on starter rails and "gluing" of the panels with cement slurry.

[0011] At the same time, new construction methods of buildings of up to three floors have begun to be developed using "modular construction". The houses are built in a factory environment (not subject to the weather), completely finished, painted and provided with infrastructures, with the exception of the connection points to the adjacent modules. All the modules are, as soon as they are ready to be delivered, transported to the worksite and assembled in such a way that the building takes the form and functionality previously defined. From the end user's point of view, the building has a short construction time. However, the process was lengthy, and the final quality of the product will have its limitations concerning thermal and acoustic comfort, as it has not been tested on-site, but built in a protected environment.

[0012] There are also modular constructions based on wooden sandwich panels with an extruded polystyrene inner insulation of between 40mm and 120mm. The panel assembly procedure is fast and requires a good preparation of all activities. The infrastructure is already embedded in the panels, so only the necessary connections will have to be made for them to accomplish their functionality.

[0013] Other innovative systems are based on modular containerised processes, produced in a factory environment, where the structure of each module is self-supporting and will allow exterior and interior sandwich panels to be used. With these systems, the coupling of several modules can be performed, thus obtaining complete buildings with the most varied finishes, according to the architecture's requirements.

[0014] This invention solves all the technical problems identified, since it relates to lightweight, highly durable, modular sandwich self-supporting panels, with certain specificities described throughout this patent document.

[0015] Therefore, this invention has the following advantages comparatively to the state of the art:

- Drastic reduction of the ecological footprint produced per square meter of construction;
- Simplicity of the construction system and architectural and functional versatility of the buildings;
- Increased thermal and acoustic comfort, as well as higher quality of air;
- Optimization of energy and water consumption;
- Higher resistance to seismic events and to winds resulting from climate change;
- Durability and possibility of moving the buildings to other locations;
- Shorter construction time and less human resources, through the reduction of functions and respective technological specialization;
- Savings in the costs per square meter of construction.

SUMMARY OF THE INVENTION

[0016] This invention relates to self-supporting structural panels with built-in infrastructure and the respective system of self-supporting structural panels. The system of panels which is the object of this invention consists of a plurality of panels, however it is essential that it comprises at least two panels (P) which are connected and fixed, in such a way that they are shiftedly arranged with respect to each other as often as required by the idealised construction, and will be finalised by means of the preferred embodiments of the panels, in particular, capping panels for façade fixing (PRF) (floors and ceilings) and vertical panels for façade fixing (VPFF) (for exterior walls). In this way it is possible not only to execute the interior walls, but also to perform the exterior finishes and final and ground floors, as well as the façades.

[0017] The system which is the object of this invention consists of at least two panels (P), wherein each of the panels (P) comprises:

- two surfaces (1) parallel to each other, embedded in a perimetral and outer metal structure consisting of two outer metal stringers (2a);
- two connecting ends (5), welded to the outer metal stringers (2a);
- at least one infrastructure pipe (6), located between the outer stringers (2a) and the faces (1) ;
- at least one wedge (7) on at least one of the connecting ends (5);
- filler material (3) inside it, filling the volume between the outer stringers (2a), the connecting ends (5) and the faces (1);
- at least one fastening element (4), to which at least two fixing screws (8) will be attached.

DESCRIPTION OF THE FIGURES

[0018]

Figure 1 - representation of a panel (P) where the following components are visible: face (1); outer metal stringer (2a); wedge (7).

Figure 2 - exploded view of a panel structure (P) where the following components are visible: face (1); outer metal stringer (2a); inner metal stringer (2b); filler material (3); connecting ends (5); wedges (7), fastening elements (4).

Figure 3 - detailed representation of the exploded view of the structure of a top panel (P), where the preferred perpendicularity between the fixing screws (9) of preceding and subsequent fastening elements (4), if applicable, at the connecting ends (5) is illustrated.

Figure 4 - detailed representation of the fastening

element (4) and fixing screws (8).

Figure 5 - detailed representation of a connecting end (5).

Figure 6 - detailed representation of an outer metal stringer (2a).

Figure 7 - detailed representation of an infrastructure pipe (6), located between the outer stringers (2a), and in this case also the inner stringers (2b) and the faces (1).

Figure 8 - representation of the assembly sequence with panels, starting with the placement of a first panel in the lower vertical position (VP1), then one adjacent inferior to the first one in the vertical position (VP2), followed by a panel in the horizontal position (HP3) and then another panel in the horizontal position (HP4) sequentially to the length of the previous one in the horizontal position (HP3). This is followed by one panel in the vertical position (VP5), and another two panels in the horizontal position (HP6) (HP7) sequentially. This set is fixed with one panel in the vertical position (VP8).

Figure 9 - representation of the already fitted panels (P) of Figure 8, wherein a wedge (7) and a fastening element (4) are shown on each side, herein circumscribed in a detail A, to be detailed in Figure 10.

Figure 10 - representation of detail A of Figure 9.

Figure 11 - representation of a capping panel for façade fixing (PRF), where the wedges (7) and the fastening elements (4) can be viewed, without perpendicularity between the fixing screws (8) of preceding and subsequent fastening elements (4).

Figure 12 - representation of façade panels (PF), which comprise an inverted wedge (9) in one of the connecting ends (5).

Figure 13 - detailed representation of the inverted wedge (9).

Figure 14 - representation of the facades' capping by means of façade panels (PF) which fit together through wedges (7) and inverted wedges (9), which fit together and are fixed through panels (P).

Figure 15 - representation of different types of panels (P) for horizontal and vertical positioning and their variants for façade panels (PF) and capping panels for façade fixing (PRF).

Figures 16 and 17 - representation of different combinations of panels (P) where it is shown that there will always be a mismatch between the perpendicularity of the panels positioned vertically and horizontally, and therefore the need for them to be capped at some time in the future.

Figure 18 - representation of the next step of Figure 17, in which the façade capping panels (FRP) placed horizontally are already illustrated.

Figure 19 - representation of the next step of Figure 18, in which the vertically placed façade capping panels (FRP) are already illustrated.

Figure 20 - representation of the next step of Figure 19, in which the façade panels (PF) are already illustrated, as well as a detail B.

Figure 21 - detailed representation of detail B of Figure 20 in the connection of the various panels.

Figure 22 - representation of the construction of a six-storey building, where four stages of its construction are shown: A, B, C and D.

Figure 23 - representation of the potential for horizontal expansion, presenting three possible scenarios: A, B and C.

Figure 24 - representation of a potential for vertical expansion.

DETAILED DESCRIPTION OF THE INVENTION

[0019] This invention relates to self-supporting structural panels with built-in infrastructure and the respective system of self-supporting structural panels. The system of panels which is the object of this invention consists of a plurality of panels (P), however it is essential that it comprises at least two panels (P), which are connected and fixed, in such a way that they are shiftedly arranged with respect to each other as often as the idealised construction requires, and will be finalised by means of preferred embodiments of the panels, in particular, capping panels for façade fixing (PRF) (floors and ceilings) and façade vertical panels (PVF) (for exterior walls). In this way it is possible not only to execute the interior walls, but also to perform the exterior finishes and final and ground floors, as well as the façades.

[0020] Therefore, there are at least three preferred embodiments of the panels (P) which constitute the panel system object of this invention: panel (P) either for vertical (VP) or horizontal (HP) positioning, capping panel for façade fixing (PRF) (floors and ceilings) and façade vertical panel (PVF) (for exterior walls).

[0021] In general, the panels (P) have two faces (1), which preferably will be in magnesium oxide as it is a non-flammable and highly resistant material with fire protection. Other finishing materials such as wood, plaster-

board, ceramics, etc., can also be used. These two faces (1) are parallel to each other. Their fixation is carried out by two outer metal stringers (2a) on the sides and two connecting ends (5) on the top and bottom ends.

[0022] The panels comprise at least one connecting end (5), on which at least one wedge is located (7). In case there is only one wedge (7), it means that it is a capping panel for façade fixing (PRF) and aimed at being vertically positioned.

[0023] All these elements are welded together and form the metal structure of the panel. The components of the aforementioned metal structure are preferably galvanised steel.

[0024] The panels comprise fastening elements (4), which promote the fitting between panels, either along the outer stringers (2a) or at their connecting ends (5), through the wedges (7). These fastening elements (4) can be located between the wedges (7) and/or at the ends of the wedges (7), but also along the outer stringers (2a); if they are located along the outer stringers (2a), then it is a capping panel for façade fixing (PRF) aimed at being horizontally positioned.

[0025] In a preferred embodiment, the outer stringers (2a) comprise on their outer faces a recess (10), or an indentation, for placing the sealant. The purpose of this sealant is to ensure a thermal, acoustic and hydraulic insulation between panels.

[0026] Depending on the stability required, or on the size of the panel, the panels may have inside, between the two outer stringers (2a), some inner stringers (2b). These inner stringers (2b) are aimed at increasing the panels' resistance, so they may or may not have this component, and if they do, they can have a number of inner stringers which is suitable for the length of the panel. These stringers will be used and sized according to the gaps to be bridged, especially in slab panels.

[0027] The inner stringers (2b) can preferably be trusses, as illustrated in the Figures, or they can have another configuration (not illustrated).

[0028] It should also be noted that in order for the panels to be self-supporting, and that due to their use in the construction of buildings, the said step of opening and covering of grooves can be eliminated, the panels comprise infrastructure pipes (6), in the amount of at least one, but they can comprise a plurality thereof, depending on the building's needs (plumbing, telecommunications, electricity, domotics). These pipes (6) are attached to the metallic structure and bores are made in the stringers, and are located between the outer stringers (2a) and the faces (1).

[0029] The interior of this metallic structure, stringers (2a) (2b), connecting ends (5), infrastructure pipes and faces (1), is filled with low density material, called filler (3), which is injected in a liquid state and that, when applied to the mould, expands and solidifies, giving the panel an increased rigidity. The filler (3) is preferably non-petroleum-based polyurethane foam. It should be added that, this type of filler, besides having a high thermal and acoustic performance, does not contain volatile organic compounds, nor does it contribute to global warming and ozone layer's depletion.

[0030] In this perspective of promoting high thermal and acoustic insulation performance, combined with greater strength and stability of the built structure, the panels have, in a preferred configuration, a thickness of at least 15 cm. These numbers are higher than those used in the state of the art, and there is an optimisation of stability as from 15 cm of thickness, and in an even more preferred embodiment, with 20 cm of thickness, their performance in terms of insulation and structure is also more significant.

[0031] The panels are fixed to each other by means of parts designated as fastening elements (4), located either between the wedges (7) and/or at the ends of the wedges (7) at the connecting ends (5), but also along the outer stringers (2a), and are attached to these elements by welding. Each panel can have a variety of fastening elements (4), which must be located in at least one outer stringer (2a) or one connecting end (5).

[0032] The panels can also comprise in one of the connecting ends (5) an inverted wedge (9) to be fitted into the wedges (7), these panels being the ones to be used in the facades, the so-called façade panels (PF).

[0033] In a preferred embodiment, the panels comprise two fastening elements (4) in at least one connecting end (5) and located in the outer ends of at least one wedge (7), and an inverted wedge (9) in the other connecting end (5); these will be the capping panels for façade fixing (PRF) to be vertically positioned and whose width must be at least equal to half the width of the panels (P).

[0034] In another preferred embodiment, the panel (P) has at least three fastening elements (4) in at least one connecting end (5) and two fastening elements (4) located in the two outer ends of the two wedges (7) and a third fastening element (4) between the two wedges (7). In an even more preferred embodiment, the panel (P) comprises at least one fastening element (4) located in at least one outer stringer (2a); these will be the capping panels for façade fixing (PRF) and aimed at being horizontally positioned. In yet an even more preferred embodiment, the fastening elements (4) are located at a distance of 60 cm between them.

[0035] In order to guarantee the stability of the construction, the fastening elements (4) have at least two holes to receive at least two fixing screws (8).

[0036] These fastening elements (4) are the elements that allow the panels to be joined together, and this fitting between panels can be performed either horizontally or vertically.

[0037] In a preferred embodiment, the fastening elements (4), located in the connecting ends (5) must be positioned in such a way that the screws (8) of each fastening element (4) have a rotation of 90° relative to the fixing screws (8) of the fastening elements which are respectively the subsequent and the preceding one, in case

they are located in the connecting ends (5).

[0038] The configuration of each typology of each panel implies that its placement is sequential, so that all the panels are fixed, these being shiftedly placed with respect to each other, i.e., with the outer stringers (2a) of the vertical and horizontal panels, in all their preferred embodiments, being positioned discontinuously, there being no room for fragilities in the buildings, but also allowing their subsequent reorganization or reconfiguration and expansion. A preferred sequence is shown in the Figures. This shifted arrangement, relative to its perpendicular positioning, i.e. with the outer stringers (2a) of the panels placed in a vertical position and in a horizontal position, in all their preferred embodiments, and being positioned discontinuously, implies that the end of each row of panels (P) placed vertically must end with a capping panel for façade fixing (PRF) which must be at least half the width of the panels (P).

[0039] With these panels, which are the object of this invention, it is possible to execute a variety of constructions, among which a six-storey building is presented in the figures for illustrative purposes, with the potential for horizontal expansion and vertical expansion.

[0040] As will be evident to a person skilled in the art, the present invention should not be limited to the embodiments described herein, with a number of changes being possible, which remain within the scope of this invention. There are several configurations which are not herein illustrated but are understood by a person skilled in the art.

[0041] Of course, the preferred embodiments above described are combinable in the different possible forms, the repetition of all such combinations being herein avoided.

Claims

1. Self-supporting structural panels (P) (PRF) (PF) comprising two faces (1) parallel to each other and fixed to each other by means of two outer metal stringers (2a) located on the sides of the faces (1), by two connecting ends (5) located on the upper and lower ends of the faces (1), and between the outer stringers (2a) and the faces (1) the panel is filled with a low density filler material (3) wherein:

   a) the connecting ends (5) comprising at least one wedge (7) to fit between the panels (P)(PRF)(PF);
   b) the panels (P)(PRF)(PF) comprising a plurality of fastening elements (4), promoting the vertical and horizontal fitting between panels, are located along at least an outer stringer (2a) and/or at least a connecting end (5);
   c) between the outer stringers (2a) and the faces (1), the panels (P) (PRF) (PF) comprise at least one infrastructure pipe (6).

2. A panel according to the previous claim where in the panel (P) (PRF) (PF) comprises at at least one connecting end (5) one inverted wedge (9) fitable into at least one wedge (7) .

3. A panel according to claim 1 wherein the fastening elements (4) comprise at least two holes to receive at least two fixing screws (8).

4. A panel according to the previous claims wherein the fastening elements (4) are located between the wedges (7) and/or at the ends of the wedges (7).

5. A panel according to the previous claim wherein the fastening elements (4) are positioned in such a way that the fixing screws (8) of each fastening element (4) have a rotation of 90° relative to the fixing screws (8) of the fastening element which is respectively the subsequent and the preceding one.

6. A panel according to the previous claims wherein the fastening elements (4) are located at a distance of 60 cm from each other.

7. A panel according to the previous claims wherein the panel (P) (PRF) (PF) comprises two fastening elements (4) at at least one connecting end (5), said fastening elements (4) being located at the outer ends of at least one wedge (7) and the panel (P)(PRF)(PF) comprising one inverted wedge (9) in the other connecting end (5).

8. A panel according to the previous claim wherein the panel (P)(PRF)(PF) has a width which is equal to at least half the width of the panels (P).

9. A panel according to the previous claims wherein comprises at least three fastening elements (4) on at least one connecting end (5), two of these fastening elements (4) being located at the two outer ends of two wedges (7) and the third fastening element (4) located between the two wedges (7).

10. A panel according to the previous claims, wherein the faces (1) are in magnesium oxide.

11. A panel according to the previous claims, wherein the faces (1) are in wood, plasterboard or ceramics.

12. A panel according to the previous claims, wherein the outer stringers (2a) comprise a recess (10) on their outer faces, forming a continuous recess (10) throughout the lateral perimeter of the panel for placing sealant.

13. A panel according to the previous claims, wherein it further comprises at least one inner stringer (2b) located between the two outer stringers (2a).

14. A panel according to the previous claims, wherein the inner stringers (2b) are trusses.

15. A panel according to the previous claims, wherein the outer metal stringers (2a), the connecting ends (5) and the inner stringers (2b) are made of galvanised steel.

16. A panel according to the previous claims, wherein the filler (3) is non-petroleum-based polyurethane foam.

17. A panel according to the previous claims, wherein the panels have a thickness of at least 15 cm, preferably of 20 cm.

18. A self-supporting structural panel system comprising at least two panels (P)(PRF)(PF) as described in claims 1 to 17 wherein:

a) at least one panel comprising a plurality of fastening elements (4), each of said fastening elements (4) receiving at least two fixing screws (8), the said plurality of fastening elements (4) being located at least at one connecting end (5) and/or along at least one outer stringer (2a); and
b) at least one other panel compriseing at least one wedge (7) and/or one inverted wedge (9), both being located at the opposite connecting ends (5) thus promoting the fitting between the two panels;
and in that
c) the outer stringers (2a) of the perpendicularly positioned panels are discontinuously positioned.

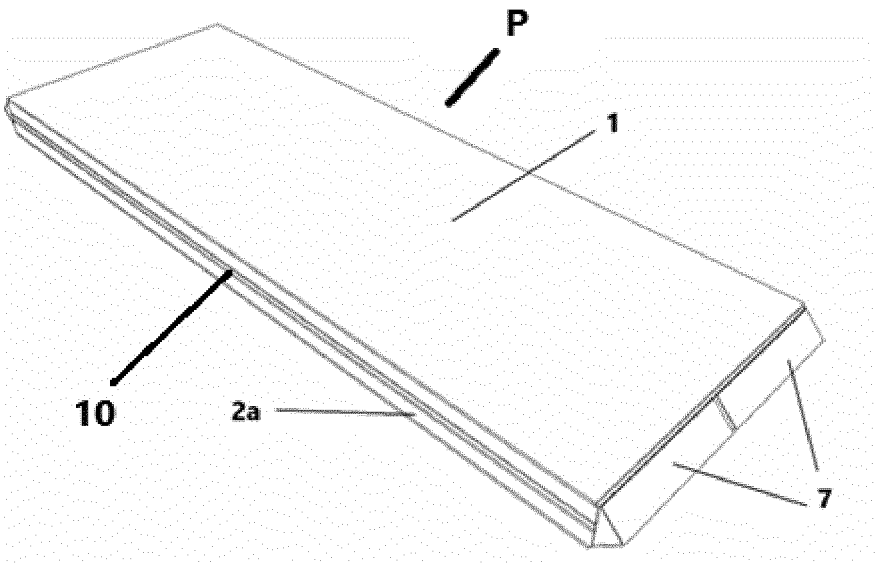


Figure 1

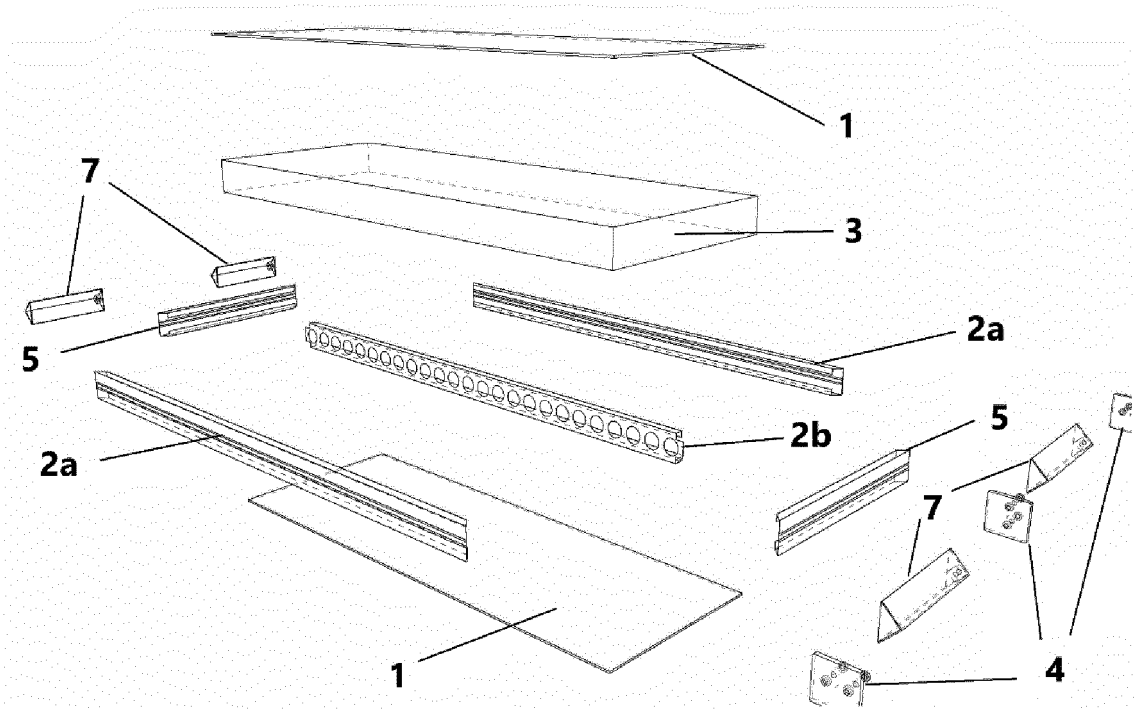


Figure 2

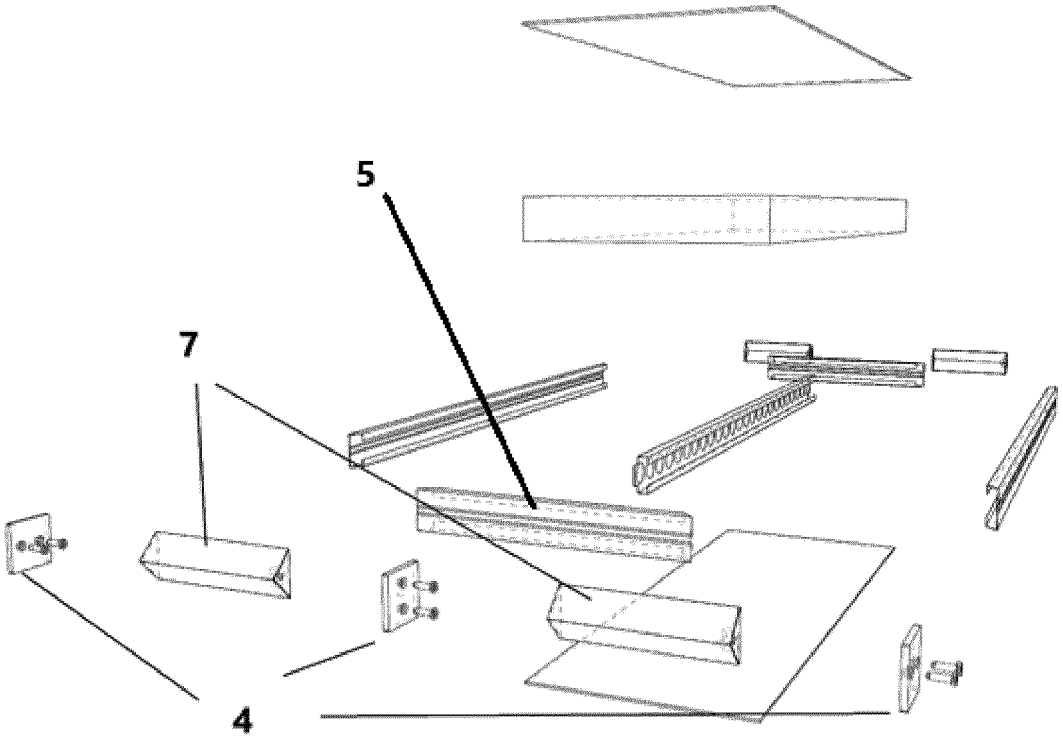


Figure 3

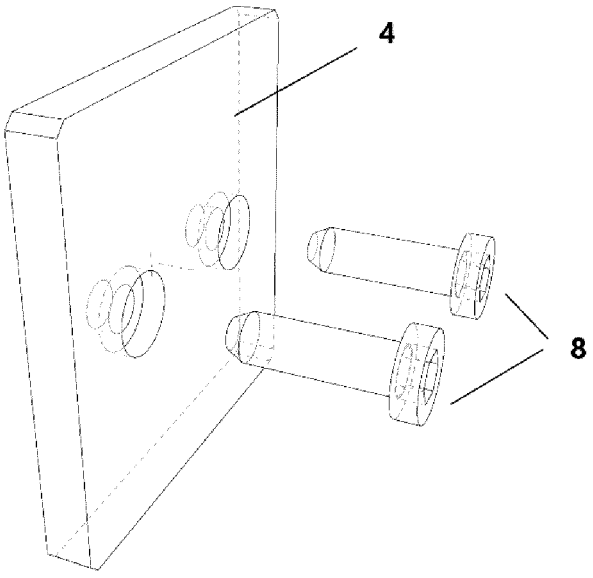


Figure 4

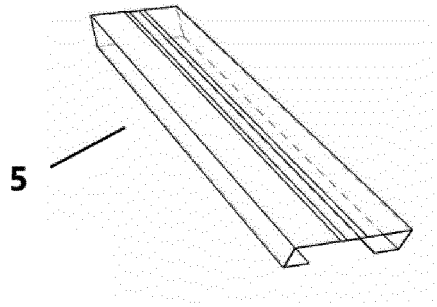


Figure 5

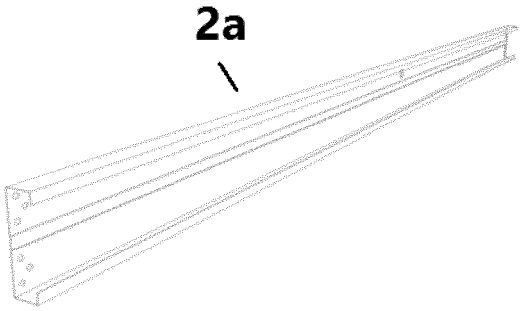


Figure 6

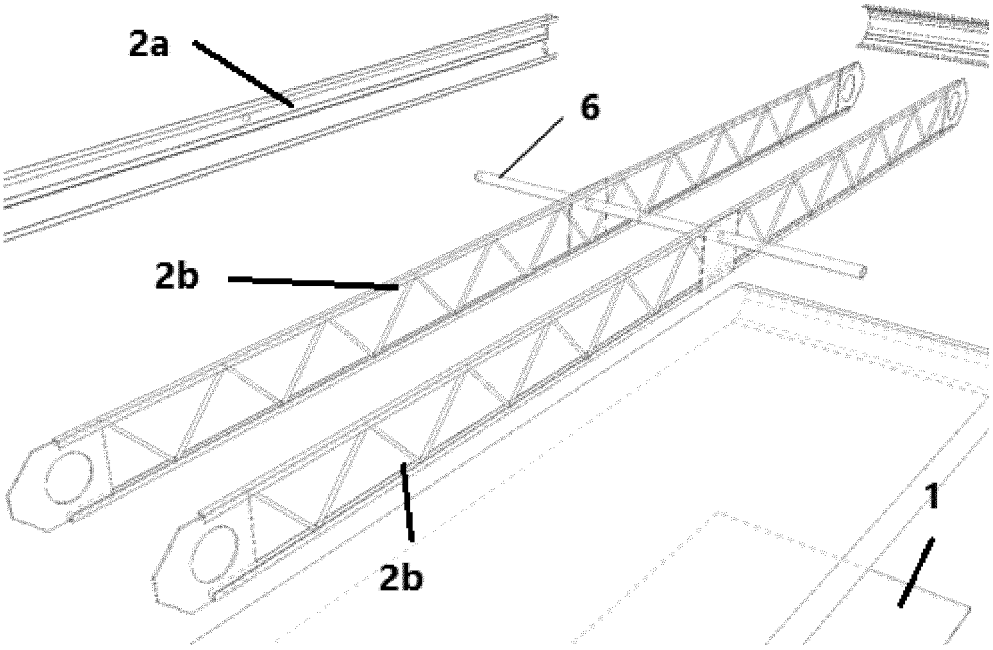


Figure 7

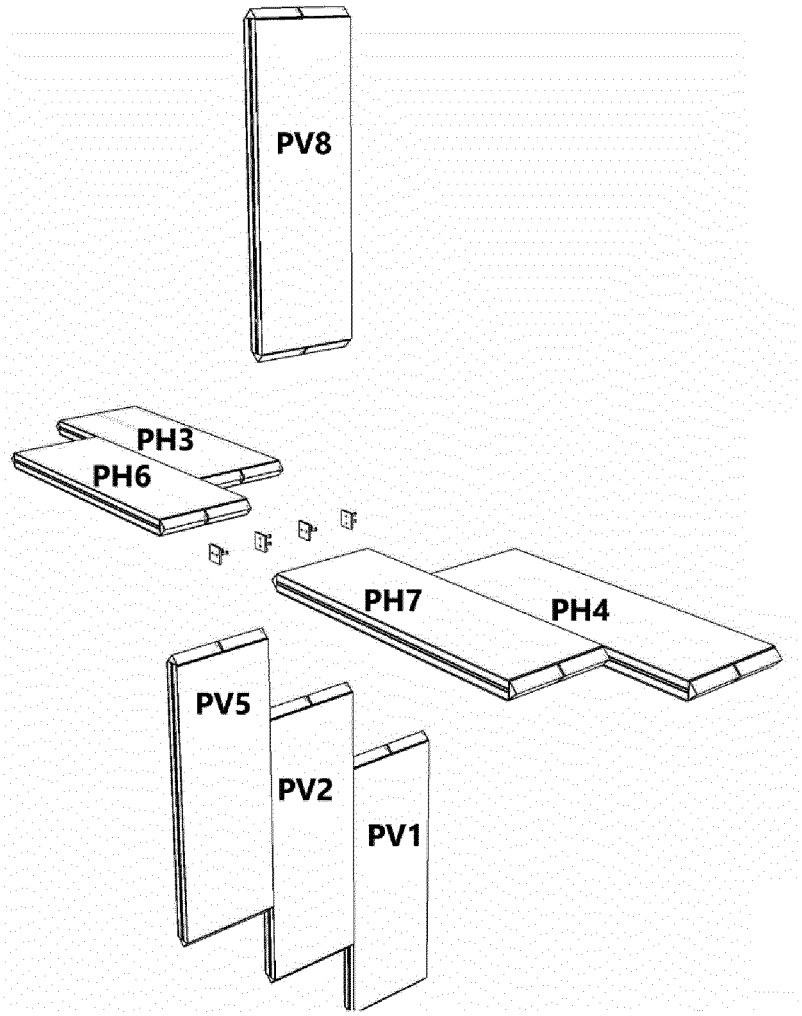
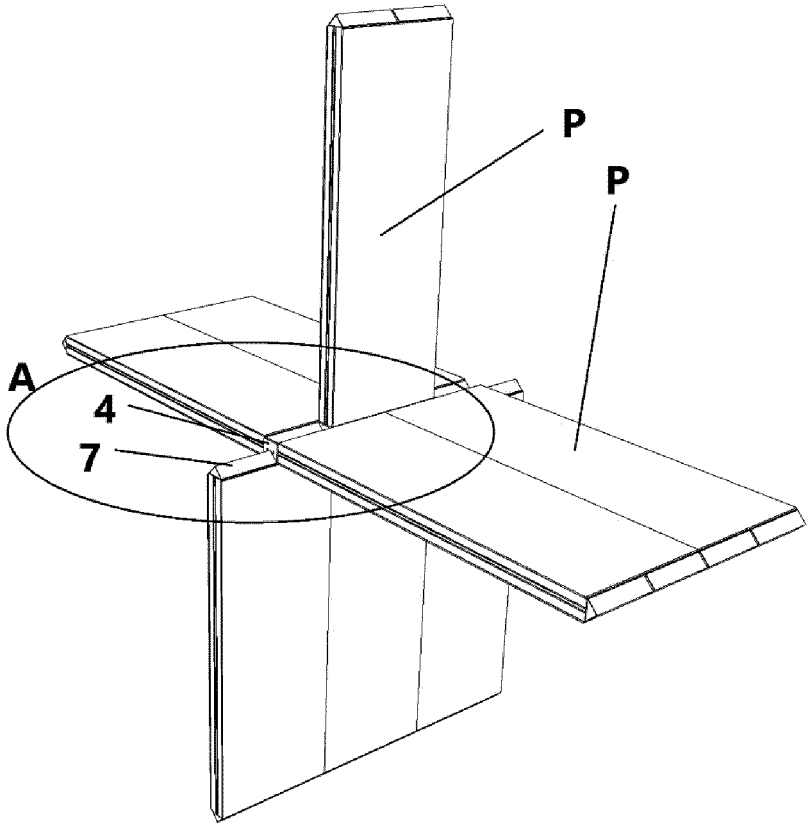


Figure 8



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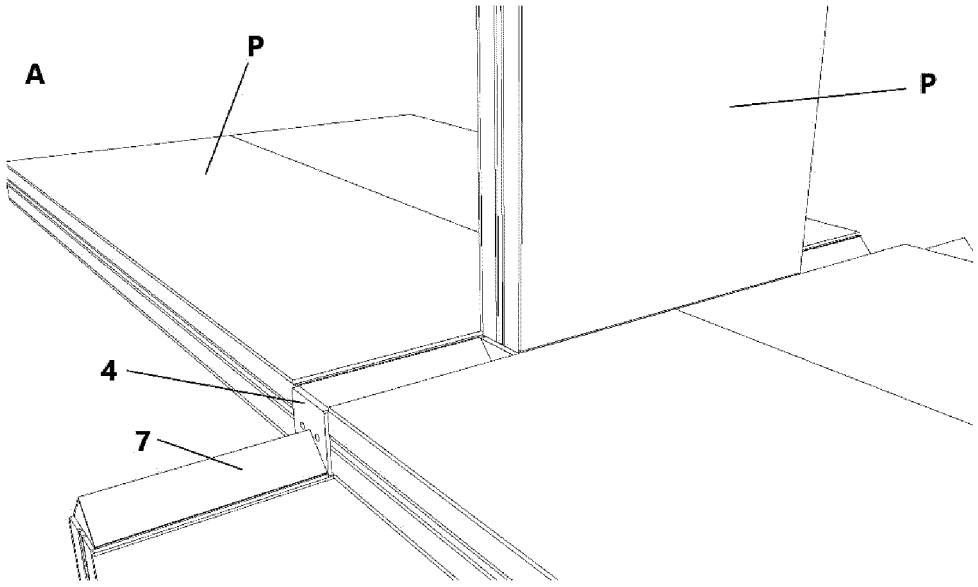

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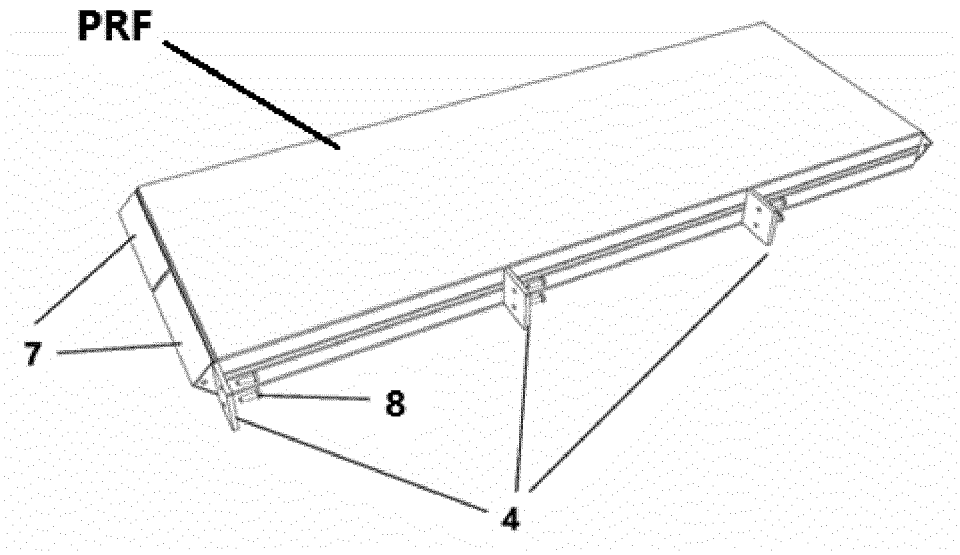

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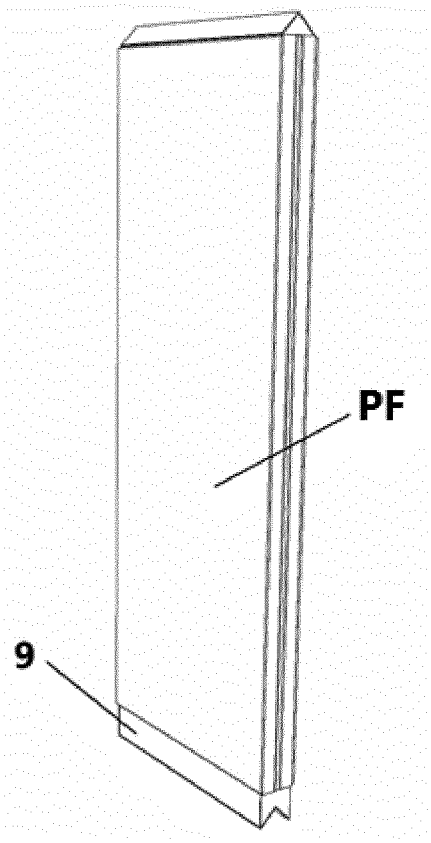

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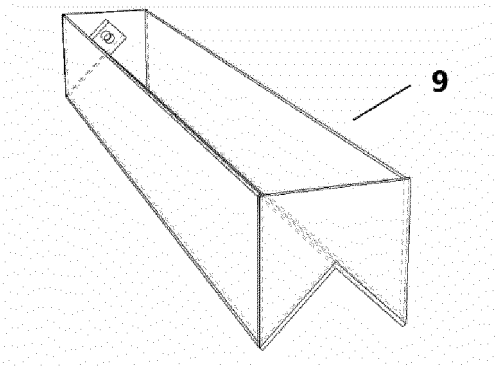

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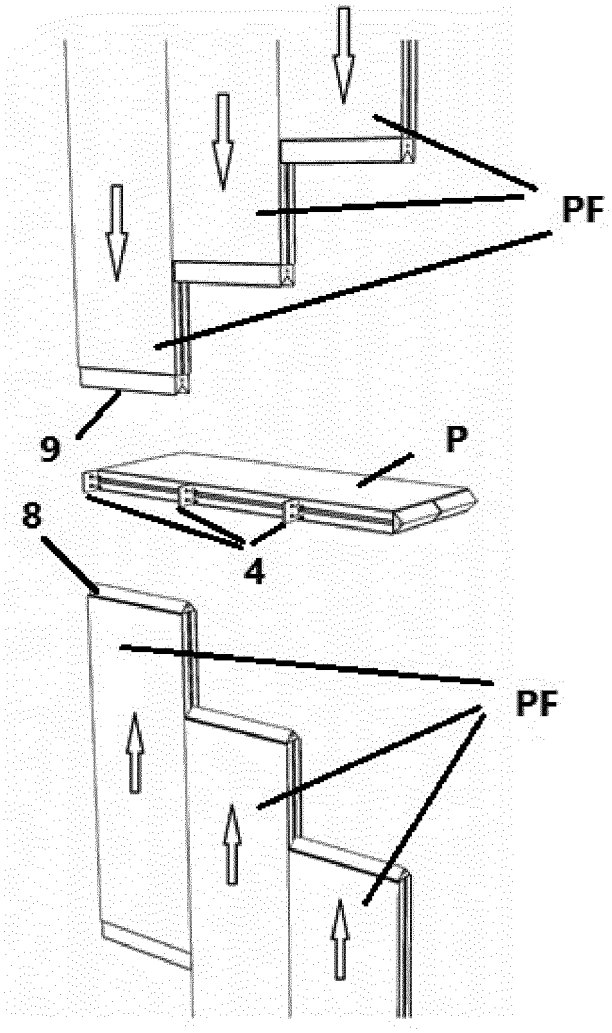

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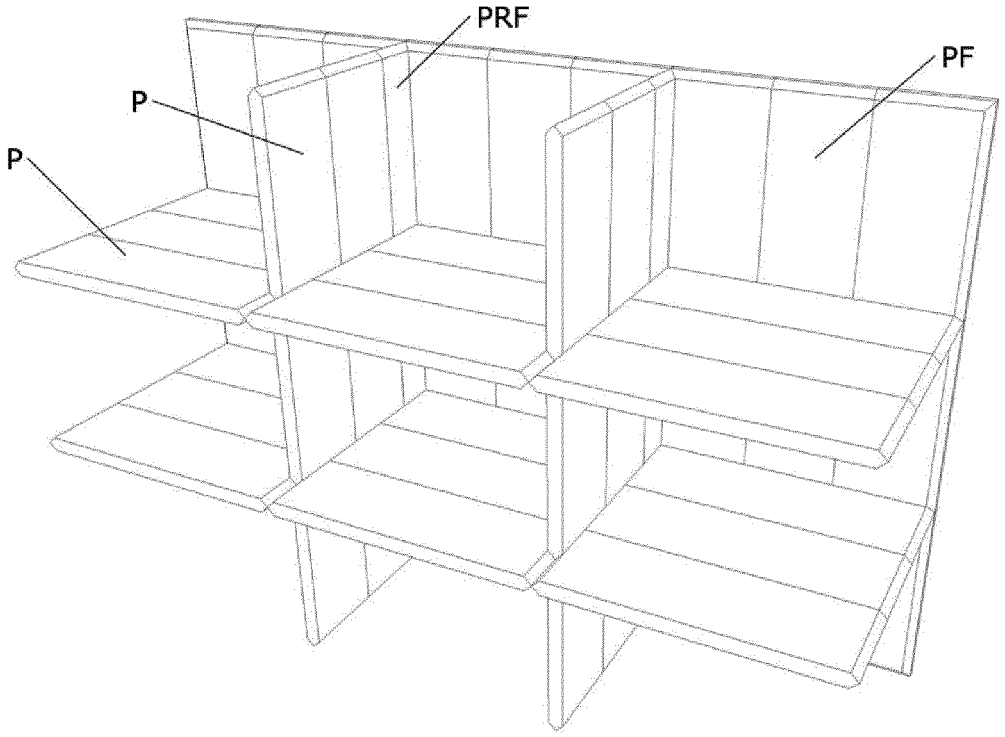

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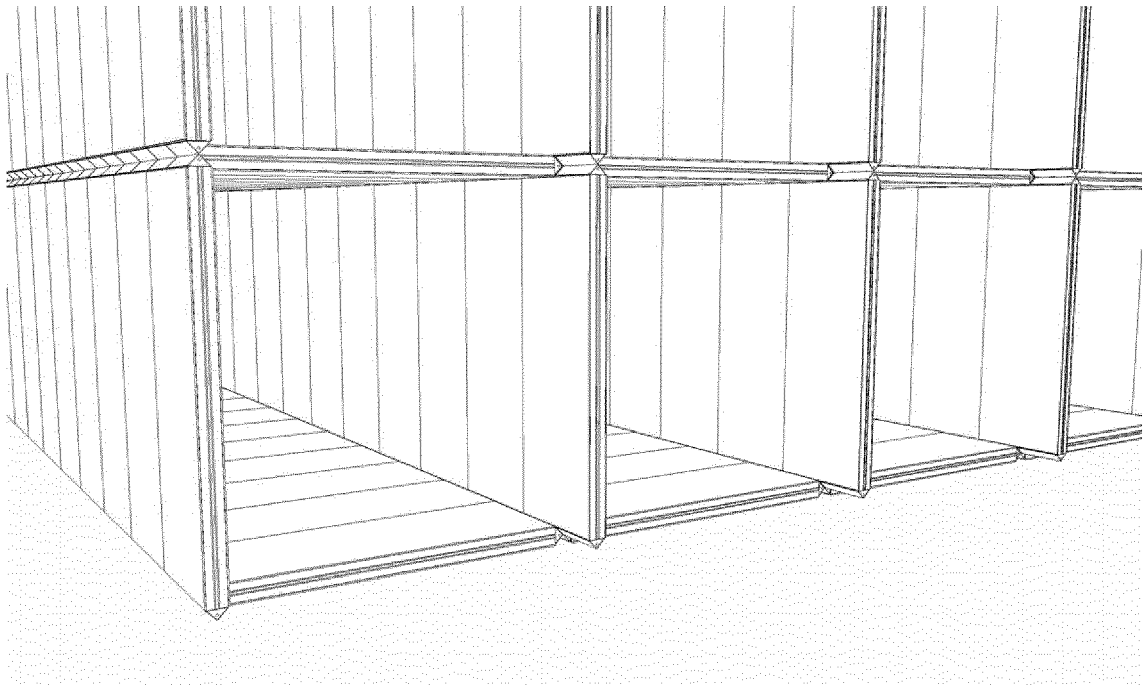

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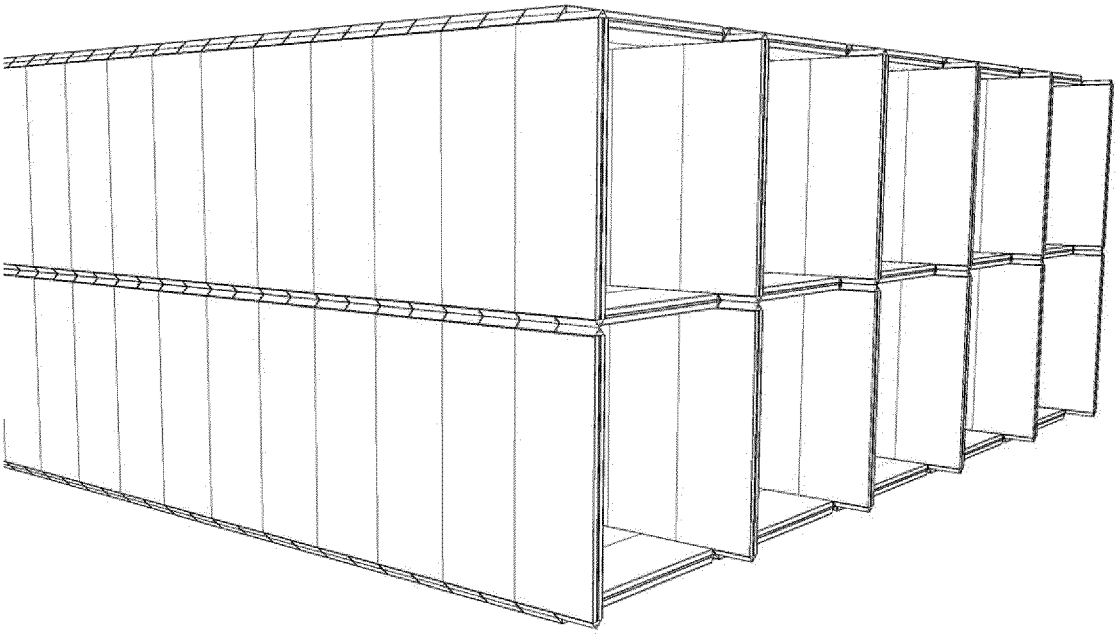

Figure 17

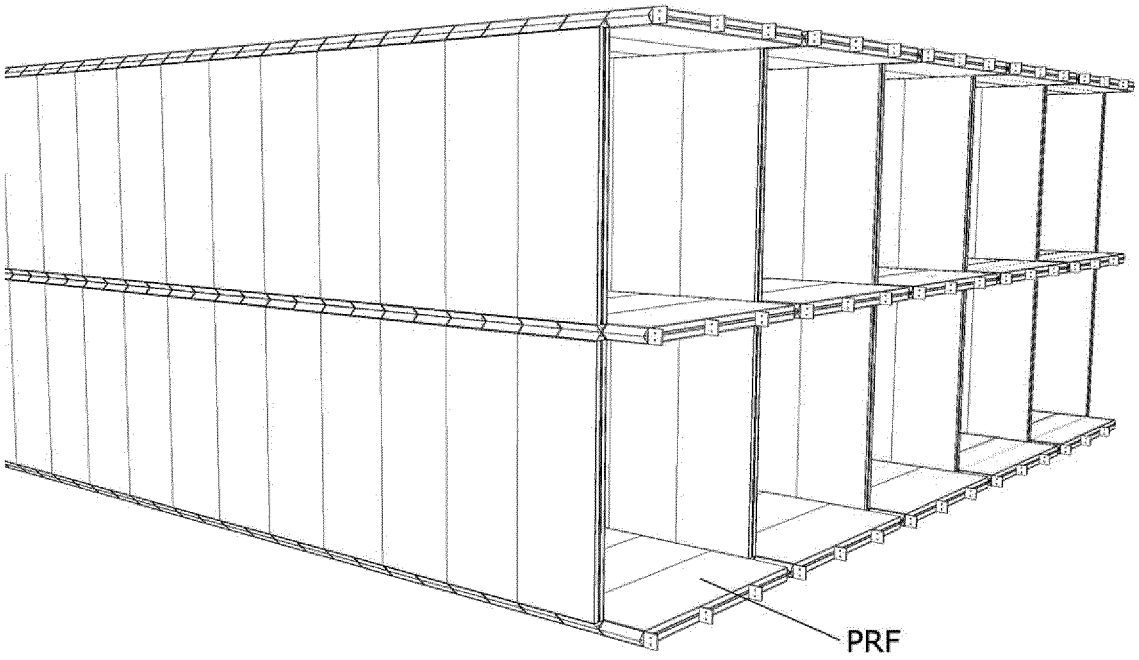

Figure 18

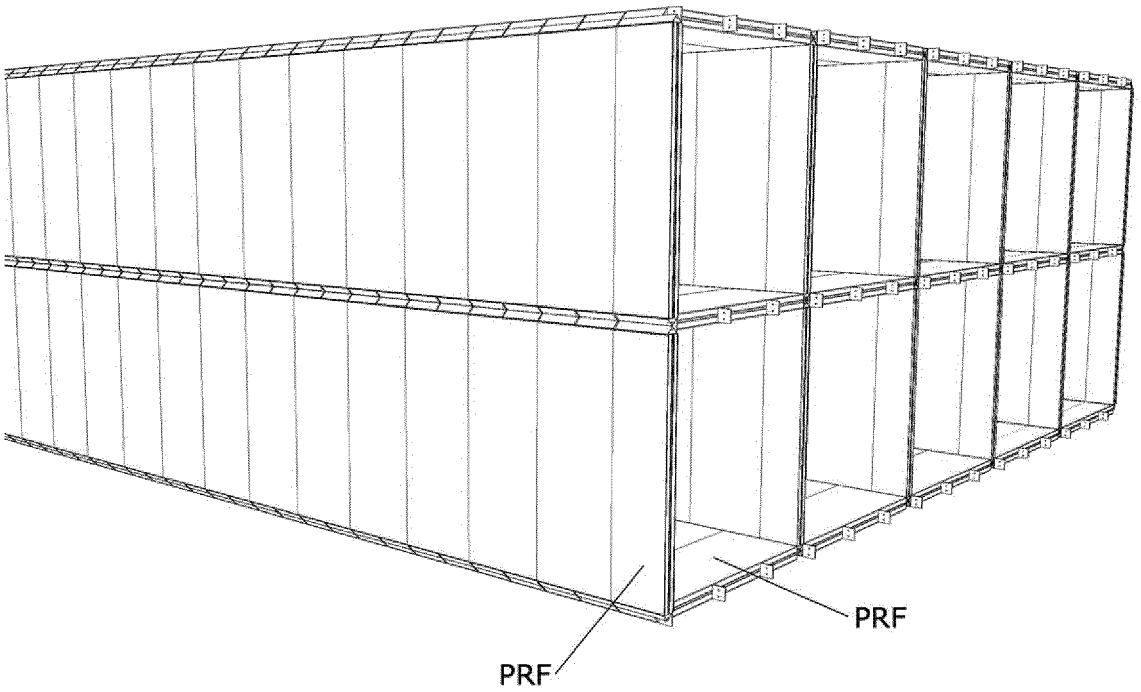

Figure 19

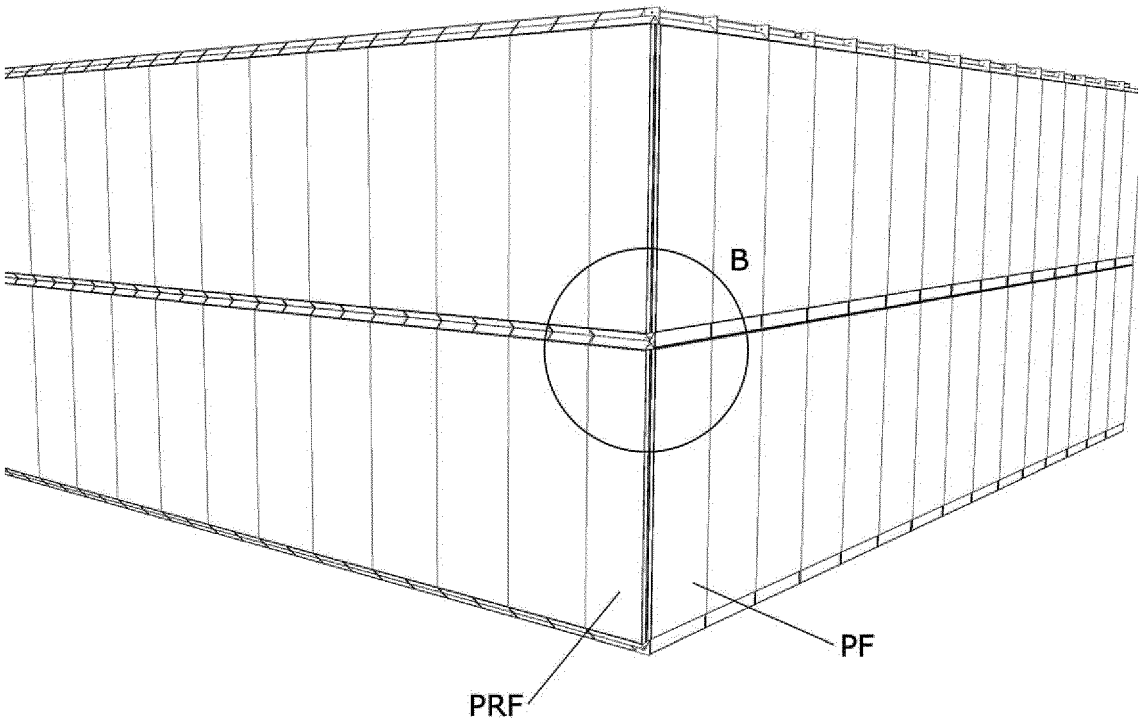

Figure 20

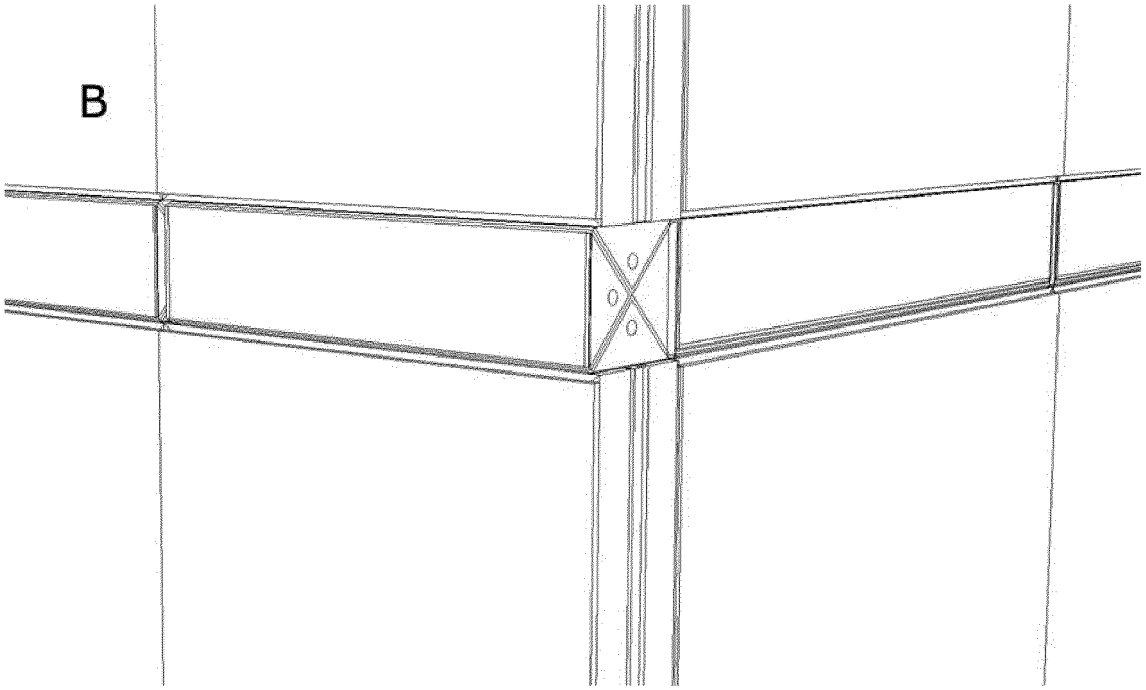

Figure 21

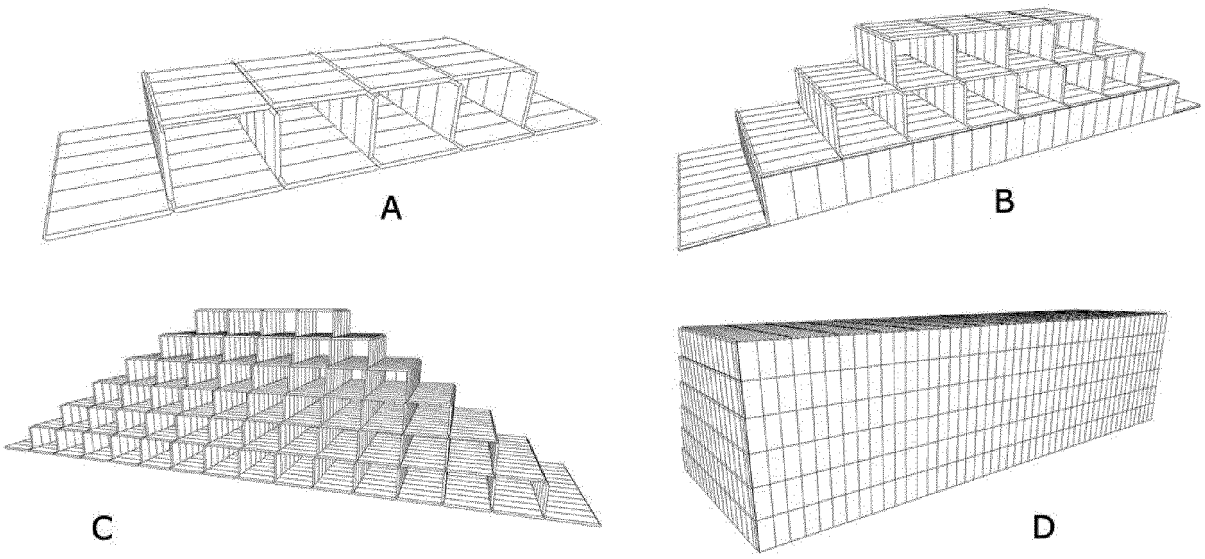

Figure 22

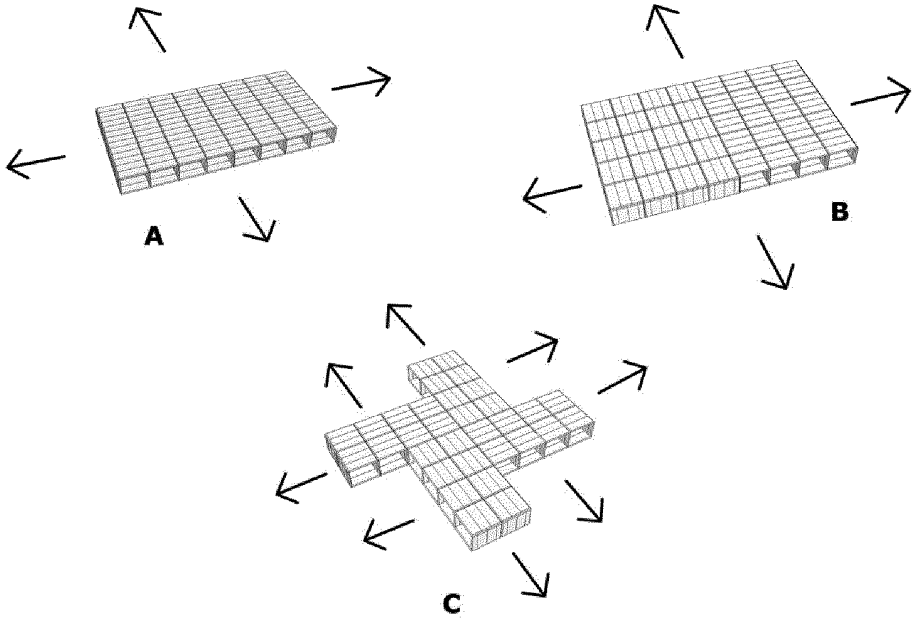

Figure 23

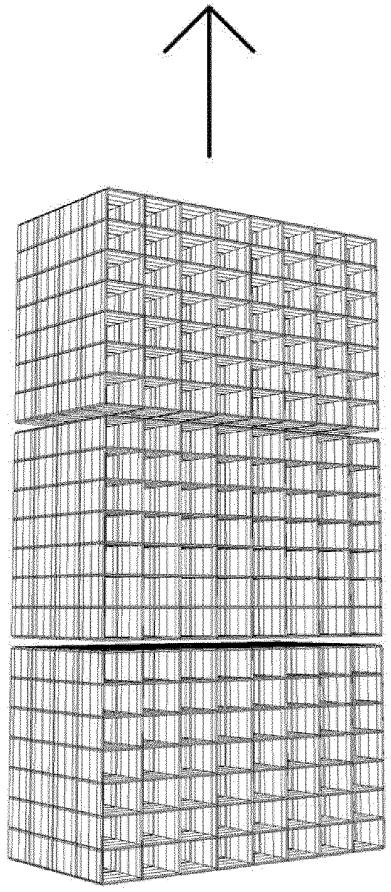

Figure 24

INTERNATIONAL SEARCH REPORT

International application No
PCT/PT2020/050030

A. CLASSIFICATION OF SUBJECT MATTER
INV. E04C2/24 E04C2/38 E04C2/52 E04B2/00 E04B5/02
E04C2/296 E04C2/288
ADD. E04C2/00
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)
E04C

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)
EPO-Internal

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	EP 0 009 009 A2 (MURIOTTO ANGELO) 19 March 1980 (1980-03-19) pages 16-17	1-18
X	US 4 125 984 A (JONAS GERALD L) 21 November 1978 (1978-11-21) columns 3-4	1-18
A	DE 36 25 645 C1 (HN WERBUNG HANS NOWAK) 3 December 1987 (1987-12-03) paragraphs [0023] - [0028]	1-18

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Date of the actual completion of the international search	Date of mailing of the international search report
14 May 2021	26/05/2021

Name and mailing address of the ISA/	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016	Saretta, Guido

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No
PCT/PT2020/050030

Patent document cited in search report	Publication date	Patent family member(s)	Publication date
EP 0009009 A2	19-03-1980	AR 219590 A1	29-08-1980
		AU 4589779 A	25-10-1979
		BR 7902337 A	23-10-1979
		CA 1098729 A	07-04-1981
		DK 154679 A	19-10-1979
		EP 0009009 A2	19-03-1980
		ES 250479 U	01-12-1981
		ES 253216 U	01-04-1981
		IL 57093 A	30-10-1981
		IT 1094069 B	26-07-1985
		JP S54139628 A	30-10-1979
		US 4255915 A	17-03-1981
		ZA 791624 B	30-04-1980
US 4125984 A	21-11-1978	NONE	
DE 3625645 C1	03-12-1987	NONE	

Form PCT/ISA/210 (patent family annex) (April 2005)

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- WO 2017182946 A **[0004] [0010]**
- WO 2015050502 A **[0004]**
- US 6412243 B **[0004]**
- US 2003033769 A **[0004]**
- US 4267679 A **[0004]**