(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 4 442 919 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
09.10.2024 Bulletin 2024/41

(21) Application number: **23461552.4**

(22) Date of filing: **07.04.2023**

(51) International Patent Classification (IPC):
E04B 2/50 *(2006.01)* ***E04C 3/34*** *(2006.01)*
E04B 2/64 *(2006.01)* ***E04C 2/04*** *(2006.01)*
E04B 2/56 *(2006.01)* *E04C 2/00 (2006.01)*

(52) Cooperative Patent Classification (CPC):
E04B 2/50; E04C 2/044; E04C 3/34;
E04C 2002/004

(84) Designated Contracting States:
AL AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HR HU IE IS IT LI LT LU LV MC ME MK MT NL NO PL PT RO RS SE SI SK SM TR
Designated Extension States:
BA
Designated Validation States:
KH MA MD TN

(71) Applicant: **Red Point Sp. z o.o.**
05-410 Józefów (PL)

(72) Inventor: **JASTRZEBSKI, Arkadiusz**
05-410 Jozefow (PL)

(74) Representative: **AOMB Polska Sp. z.o.o.**
ul. Rondo Ignacego Daszynskiego 1
00-843 Warsaw (PL)

Remarks:
Amended claims in accordance with Rule 137(2) EPC.

(54) STRUCTURAL ELEMENT, LAYOUT AND WALL FOR ARCHITECTURAL CONSTRUCTION, ESPECIALLY FRAME HOUSES

(57) The invention relates to the field of construction and, more specifically, to the structural elements used in the concrete frame technique in the construction of frame houses, without the use of a crane. The object of the invention is a structural element (1) in the form of a column, for architectural construction, especially of frame walls of buildings, which includes: a shaft (2) in the form of a vertical support beam, which shaft (2) has a bottom contact surface (2b) on its lower side; a head (3), which on the top surface of the head (3b) has at least two tongues (6), which on the top have a top contact surface (6a) and are located essentially at the edges (3c) of the head (3), and at least two grooves (5), which on the bottom have a bottom contact surface (5a), which grooves (5) are located essentially at the center of the top surface of the head (3b) and the shape of the individual tongue (6) corresponds to the shape of the individual groove (5).

The invention also includes an arrangement for building a wall including structural elements (1).

The invention also relates to a wall of buildings constructed using structural elements (1).

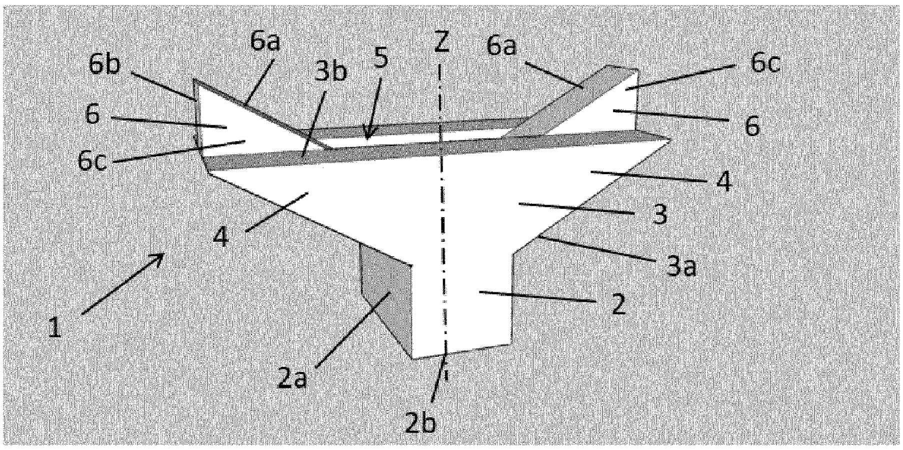

Fig. 1

Processed by Luminess, 75001 PARIS (FR)

Description

Field of technology

[0001] The invention relates to the field of construction, and more specifically to the structural elements used in the technique of building frame houses from prefabricated (ready-made) structural elements, and to the system containing these structural elements and the wall built from these structural elements.

State of the art

[0002] Frame houses have been known in the state of the art for a long time. Frame technology refers to the way walls are constructed. In this construction technique, a load-bearing skeleton of the building is first being created, which is then filled with other building materials, such as bricks or insulation materials, to create a full (not openwork) wall.

[0003] An advantageous feature of frame houses is the possibility of achieving very good thermal insulation of the walls, which is achieved because the space of the frame can be filled mainly or exclusively with insulating material. In masonry buildings with solid load-bearing walls, insulating materials can be placed only on the outside of the wall or on the inside of the wall.

[0004] In frame building construction technology, the skeleton of a building is most often formed on the construction site by assembling smaller prefabricated structural elements. In this way, timber frame or metal frame buildings are constructed.

[0005] The skeleton of a building can also be formed as a monolithic concrete frame. In this technology, the building skeleton is cast on site from concrete using formwork and reinforcement. Such a method of construction is not quite an actual alternative to wood or metal framing due to the much larger distances between the structural elements of the monolithic concrete frame, which de facto makes it impossible to fill such a frame with only insulating materials.

<u>Timber frame technology</u>

[0006] The most popular and well-known is timber frame construction. A timber frame wall consists mainly of wooden vertical beams and horizontal beams. Vertical structural beams are long and narrow - they are at least as long as one floor of the building (that is, about 3-4m) and have a relatively small cross section (50-150mm in single-family buildings). The main task of vertical beams is to transfer vertical pressure forces. Horizontal beams are long or short (40-60 cm) and the main task of horizontal elements - shorter beams and connectors, is to stiffen the structure by connecting them to vertical beams. Specially prepared wood is used to produce the frame elements. The stiffness of the timber frame structure is further ensured by attaching sheathing to the frame in the form of boards such as OSB, gypsum board, etc. The wall structure prepared in this way is filled with insulating material, usually mineral wool. A wall made with this technology has many other layers, such as wind insulation, vapor insulation, grates for the installation of additional external insulation or facade. Many variants of timber frame house construction are known. These include Canadian, Scandinavian and German houses. They differ in the method of construction, the layout of the wall layers, but the general structural principle is similar in these construction systems.

[0007] The main advantages of timber frame technology:

- low construction weight,
- dry construction technology,
- good thermal insulation of walls.

[0008] Disadvantages of timber frame technology:

- the flammability of the structure,
- lack of resistance to moisture and biological hazards of the skeleton (the skeleton is exposed to worms, fungi, etc.),
- relatively low durability (up to 100 years),
- high labor intensity of execution (the wall includes many elements and layers),
- the need for access to good quality wood, which is limited in many areas of the world,
- lack of full airtightness of the walls.

[0009] One significant disadvantage of timber frame technology is the need to ensure that the timber frame is protected from moisture, due to the fact that wood tolerates moisture poorly. This requires the construction of multiple layers of wall and the use of more expensive insulation materials, such as mineral wool instead of Styrofoam, which is cheaper. In addition, in timber frame technology it is very difficult to achieve full air-tightness of the walls, which is required for energy-efficient and passive houses. Uncontrolled escape of air from inside the building causes energy losses and increases the use of energy for heating and cooling.

<u>Metal frame technology</u>

[0010] Metal framing technology is very similar to wood framing technology except that the construction material instead of wood is steel protected against corrosion. Metal framing eliminates some of the disadvantages of wood framing technology such as flammability. The main disadvantage is the risk of corrosion of metal structures, especially at joints, which are difficult to protect well against rust. Metallic structures are usually more expensive than wooden ones. This causes metal framing technology to be used much less frequently than wood framing technology.

Monolithic concrete frame technology

[0011] In this technology, the skeleton of the building is formed from cast concrete columns and floors reinforced with steel. The advantages of this technology are the high strength of the structure. Disadvantages of this technology include:

- very heavy construction weight,
- the need for a large amount of steel for reinforcement,
- the need to use formwork during construction,
- a complicated construction process requiring heavy equipment (e.g., the need for concrete pumps, often cranes),
- the need to take care of the concrete after it is poured by irrigation (a lot of water is needed, especially in hot climates this is a problem),
- the need to fill the framework with bricks or other building materials due to the large distances between the structural elements of the framework.

[0012] Despite many disadvantages of this technology, it is often used especially in countries where structural timber is hard to come by - for example, in southern Europe.

[0013] The state of the art has not yet developed a method of building frame houses from concrete elements that can be assembled into a structural frame by hand on the construction site without the use of cranes, as is the case, for example, with timber frame technology.

[0014] Consequently, concrete frame house construction technology has not been developed as an alternative to timber frame technology in terms of construction process and wall performance, due to the following technical problems:

- concrete is relatively brittle thus requiring reinforcement (steel) and a minimum thickness to be adequately rigid,
- concrete is very heavy (1 m^3 weighs about 2.3 tons) - steel reinforcements increase this weight,
- concrete elements are difficult to connect to each other on a small contact area (and in frame buildings the contact area of the elements is small in relation to their dimensions, especially length).

[0015] Because of these problems, the method of building concrete frame houses from prefabricated concrete elements (as an alternative to timber frame technology) has not been developed. A long vertical beam made of concrete instead of wood has a greater thickness and weight than a wooden beam. It will not be possible to move it without using a crane. The connection of such a beam to other framing elements is very complicated due to the small contact area of structural elements in frame technology.

The essence of the invention

[0016] The purpose of the invention is to enable low-cost and fast construction of structural walls of buildings that can have high thermal insulation, which is necessary for the construction of energy-efficient and passive buildings.

[0017] The purpose of the invention is achieved by making it possible to quickly erect frame walls from prefabricated elements without the need for a crane, even by a single person.

[0018] The purpose of the invention is to develop a construction method that eliminates the disadvantages of timber frame technology and gives the structural walls additional desirable performance characteristics. The invention makes it possible to build cheaper and warmer walls compared to those currently used in timber frame construction technology.

[0019] The purpose of the invention is to provide such structural elements and such wall construction technology that will allow easy and quick erection and construction of frame walls, including structural walls, from ready-made structural and insulation elements without the need for cranes (even by a single person).

[0020] The essence of the invention is to solve the problem of efficiently and quickly joining prefabricated concrete elements, including those of low weight (up to 30 kg) and small size, in order to create a frame structure based on such elements.

[0021] The invention makes it possible to easily and quickly insulate the resulting wall skeleton or give it other desired functional characteristics by using specially designed insulating bricks matched to the wall skeleton. In addition, the invention makes it easy to give different functional characteristics to different parts of the wall, which will also facilitate the construction of intelligent buildings.

[0022] The invention enables low-cost construction of frame wall structures around the world, including in places where timber-frame technology cannot be used due to the lack of wood.

[0023] Structural element 1 in the form of a column, for architectural construction of frame walls of buildings, containing:

- shaft 2 in the form of a vertical support beam, which shaft 2 has a bottom contact surface 2b on the lower side ;
- head 3 connected to the upper part of the shaft 2 , which head 3 extends essentially horizontally, perpendicular to the Z-axis of the shaft 2 and symmetrical with respect to the shaft 2 , in at least two opposite directions to form at least two side arms 4 , and from above the head 3 contains the upper surface of the head 3b ;

characterized in that the head 3 on the top surface of the head 3b has at least two tongues 6 , which on the top have a top contact surface 6a and are located substantially at the edges 3c of the head 3 and at least two grooves 5 , which on the bottom have a bottom contact surface 5a , which grooves 5 are located substantially in the center of the top surface of the head 3b and the shape of the individual tongues 6 corresponds to the shape of the individual groove 5 .

[0024] Advantageously, the tongues 6 have the profile of a right-angled triangle, in which one of the right-angle side surfaces 6b of the tongue 6 is perpendicular to the upper surface of the head 3b .

[0025] Advantageously, the upper contact surface 6a forms an angle of 30° with respect to the horizontal or the upper surface of the head 3b and/or the lower contact surface 5a forms an angle of 30° with the upper surface of the head 3b and the head 3 has a lower plane 3a , which the lower plane 3a forms with the Z axis of the shaft 2 an obtuse angle advantageously an angle of 120°.

[0026] Advantageously, at least two grooves 5 are connected to each other and form one double groove.

[0027] Advantageously, the thickness of the tongue 6 is essentially equal to the thickness calculated according to the formula:

$$\frac{\tan x^\circ \times 0{,}5 \times y}{2} \times \cos x^\circ = G$$

Where x is the value of the inclination of the upper contact surface 6a relative to the shaft 2,
y is the dimension width of the structural element 1,
G is the thickness of the tongue 6 .

[0028] Advantageously, the two tongues 6 either extend beyond the edges of the head 3 or do not extend beyond the edges of the head 3 or do not touch them.

[0029] Advantageously, the shaft 2 is essentially cuboid, cube or cylinder in shape and advantageously has in addition holes 7 adapted for placing elements therein and/or the side surface 2a of the shaft 2 together with the lower surface 3a of the head 3 form an arc.

[0030] Advantageously, the dimensions of the structural element 1 are: maximum width of 40cm, maximum height of 40cm, maximum thickness of 20cm and the maximum weight of the structural element 1 is 30kg and is made of concrete, gypsum, ceramic, polymer or composite.

[0031] Advantageously constructed from two structural elements 1 connected by bottom contact surfaces 2b to form a column-shaped element with two heads that are advantageously shaped like arches.

[0032] Advantageously, it has more than two tongues and more than two grooves and replicates the structural element in any direction.

[0033] The invention also includes an arrangement for the construction of a frame house wall frame comprising at least two structural elements 1 configured to be aligned vertically and horizontally with respect to each other, advantageously the arrangement additionally comprises a structural or insulating part configured to be placed in the hollow space between the structural elements 1 in the form of an insulating brick 8, advantageously in the shape of a substantially hexagon, regular hexagon, circle or ellipse, which insulating brick 8 is advantageously made of insulating materials for example Styrofoam.

[0034] The invention also includes a frame wall of a house, characterized in that it contains at least two structural elements 1 are connected to each other horizontally by means of the right-angle side surfaces 6b of the tongues 6, and vertically by means of the upper surfaces of the head 3b and the lower contact surfaces 5a connected to the upper contact surfaces 6a .

[0035] Advantageously it contains structural elements 1 advantageously arranged between starting element 12 and ending element 13 and/or system lintels 9, side elements 10 and vertical beams 11.

[0036] Advantageously, the joints of the structural elements 1 are reinforced with bonding and/or reinforcement and/or assembly elements.

[0037] Advantageously it additionally includes a structural or insulating part in the form of an insulating brick 8 , which advantageously is configured as a finished exterior façade element of a building.

Beneficial effects of the invention

[0038]

1. The presented object of the invention allows the rapid and efficient erection of skeletal structures of buildings made of prefabricated elements (advantageously concrete), without the use of additional supports, formwork and without the need for cranes. Construction of the described structure is possible even by one person.
2. The presented method allows quick and easy joining of system elements into a larger structure that is rigid and stable. If necessary, it is possible to add additional horizontal and vertical reinforcements, which further increases the strength of the created skeleton.
3. The presented invention makes it possible to

quickly and easily insulate the resulting structure with this technology to create an airtight wall with a very low heat transfer coefficient. Such walls are essential for the construction of energy-efficient and passive buildings.

4. The invention makes it possible, thanks to the self-supporting frame structure, to easily erect walls from the bottom up by building successive layers of the frame. In the presented construction method, it is not necessary to plumb the structural beams or corners as is the case with timber frame technology, which will enable even one person to build the frame.

5. The shape of the system's structural elements causes them to self-clamp and fit the framing elements under the influence of gravity, which reduces the risk of errors during construction.

6. The structural components included in the invention fit together which eliminates the need to cut them on site. This results in time and labor savings and minimizes waste.

7. The structural skeleton resulting from the invention has regular and repeatable shapes. It consists of openings of the same size throughout the wall. This division of the wall into smaller regular spaces makes it possible to standardize the size of the insulation elements (or other building materials) with which the skeleton will then be filled. This makes it possible to fill the frame easily and quickly with them.

8. The repetitive arrangement of the skeleton's voids makes it easy to give different parts of the wall different performance characteristics. Parts of the wall closer to the ground can be filled with moisture-resistant insulating bricks, and the upper parts can be filled with vaporpermeable insulation.

9. The structural skeleton (advantageously made of concrete elements) that is formed by the invention is characterized by high durability compared to alternative construction methods, that is, to wood and metal framed walls. Concrete is a noncombustible, non-corrosive material, is not subject to biological hazards and has a greater durability than wood and steel.

10. The use of concrete as a prefabricated component for structural framing results in lower construction costs, as concrete as a raw material is cheaper than steel and wood and is available worldwide.

11. The invention makes it possible to use concrete elements for structural framing, as it solves the technical problem of joining smaller concrete elements into a larger frame. The contact (bonding) area of the structural elements that are the subject of the invention is comparable to the bonding area of bricks in masonry buildings despite the fact that the resulting structure is a skeleton structure. This is due to the proper design of the bonding method and the appropriate shapes of the skeleton elements.

Brief description of figures drawings

[0039]

Fig. 1 shows the structural element in an isometric view.

Fig. 2 shows an inverted structural element in an isometric view.

Fig. 3 shows a structural element with holes for reinforcement in an isometric view.

Fig 4 shows the layout of the structural elements arranged side by side horizontally.

Fig. 5 shows an arrangement of structural elements aligned horizontally next to each other along with a structural element aligned vertically.

Fig. 6 shows the layout of the structural elements arranged side by side horizontally and vertically.

Fig 7 shows a wall formed from structural elements.

Fig. 8 shows a wall formed from the structural elements from the second execution example.

Fig. 9 shows a cross-section of the structural element.

Fig. 10 shows a cross-section through the wall with the transmitted forces.

Fig. 11 shows a wall formed by structural elements, the empty openings of which form a circle.

Fig. 12 shows a wall skeleton with a door opening.

Fig. 13 shows an insulating brick.

Fig. 14 shows a wall frame partially filled with insulating bricks in a view from the outside of the building.

Fig. 15 shows a wall frame partially filled with insulating bricks from the inside of the building.

Fig. 16 shows a comparison of the contact surfaces for different angles of the tongues.

Fig. 17 shows a comparison of contact surfaces for various traditional building materials.

Fig. 18 shows either the starting or ending element in isometric view.

Fig. 19 shows either the starting or ending element from below in isometric view.

Fig. 20 shows the side element in isometric view.

Fig. 21 shows the vertical beam in isometric view.

A detailed description of a favorable example of the execution of the invention

[0040] The invention will be described below with reference to the figures and the references therein. The invention presented herein relates to, among other things, the structural element 1 shown in Fig. 1, which is used in the erection of frame structures made of prefabricated elements (advantageously made of concrete) without the use of additional supports, formwork and without the need for cranes. Thanks to a design that uses, among other things, the principles of physics (architecture) involving the transfer of forces by means of architectural (structural) columns and arches, Fig. 10, smaller structural elements 1 are easily connected to form a larger structure - a wall that is rigid and stable. The contact surface (joining force) of structural elements 1 is comparable to that found in masonry buildings, which provides high rigidity to the framework. This is because each structural element 1 transfers forces from its own Z-axis to the two Z-axes of two other structural elements 1, at the same time it accepts force from two Z-axes of two other structural elements, through groove 5 on its own Z-axis. This mutual transmission of forces is made possible by the large contact surface of the elements, which at the same time ensures that they are firmly and stably connected.

[0041] An example of the execution of the invention is a structural element 1, in the form of a column, which is intended for the construction of frame walls of buildings. The structural element 1, in the form of a column, includes a shaft 2 and a head 3.

[0042] The elements, from which the object of the invention is constructed, are shown in Fig. 1-5. The shaft 2 is in the form of an elongated vertical beam, which has a bottom contact surface 2b on its lower, free side. In this example, the shaft 2 is substantially cuboidal in shape, and in other examples of execution it may be substantially cube or cylinder in shape. The shaft 2 has a Z-axis, shown in Fig. 1, which marks the center of symmetry of such shaft 2.

[0043] The shaft 2 can vary in height, but it cannot, including the height of the head 3, exceed the overall width of structural element 1, since such structural element 1 must be stable when the structure is being assembled. The overall width in this example is understood to be the largest dimension of the entire structural element 1 in the direction perpendicular to the Z axis.

[0044] The head 3 is permanently connected to the top of the shaft 2 and forms one rigid unit with it, i.e. it forms a column.

[0045] The head 3 extends essentially horizontally (essentially perpendicular with respect to the Z-axis), symmetrically with respect to the shaft 2, in at least two opposite directions to form two side arms, which arms are inscribed in the construction of a tensile-reinforced structural (architectural) arch, Fig. 10. Visible in Fig. 1 structural elements that are inscribed in the (architectural) arch are the two tongues 6 and the groove 5. The arch is tensile reinforced by the upper part of the head 3b with the top surface of the head 3b also constituting the only, essentially, horizontal element of the head structure. The head 3 (advantageously including tongues, grooves and the top surface 3b and the surface 3a) with the top surface of the head 3b, in addition to the function of tensile reinforcement of the arch, performs a stabilizing function, making it easy to stack the structural elements 1 on top of each other. The top surface of the head 3b can also serve as a base for the installation of additional reinforcement (reinforcement bars) of the wall horizontally, if necessary.

[0046] The head 3 has at least two tongues 6 on the top surface of the head 3b, which tongues 6 are placed symmetrically on both opposite arms of the head 3, at the end of these arms. The tongues 6 are the ends of the structural arch (Fig. 10) that crowns the head 3 and are the vertical-most parts of the head 3. The tongues 6 transfer forces in the skeleton from the Z-axis of the structural element 1 to the Z-axis of the next two structural elements 1, which are arranged as another layer of the skeleton. Each of the tongues 6 has an upper contact surface 6a. The tongues 6 are located at the edges 3c of the head 3 as shown in Figs. 1 and 2 (fitting together with the groove 5 into the cross-section of the structural arch, Fig 10).

[0047] In the upper part of the head, there is also a groove 5, which has a lower contact surface 5a on the bottom. The groove 5 is located symmetrically (centrally) with respect to the shaft 2, in the upper part of the head 3 on the upper surface of the head 3b and between the tongues 6. In this example of execution, there are at least two grooves 5 on the upper surface of the head 3b. The shape of the two tongues 6 corresponds to the shape of the same number of grooves 5, such that the tongues 6 fill the grooves 5. The grooves 6 may be separated from each other (not shown in the pictures). Advantageously, the grooves 5 merge into one double groove consisting of two grooves 5, it is advantageous if the grooves 5 merge into one double groove, because then, when assembled, the tongues 6 of adjacent elements 1 are in contact with the surfaces 6b and transfer loads to each other. The groove 5 transfers the forces from the Z-axis of the structural element 1 to the ends of the structural arc, which are the tongues 6, of the subsequent structural element 1. The upper contact surface 6a of the tongue 6 corresponds to the lower contact surface 5a of the groove 5 as seen in Fig. 9.

[0048] In this example of execution, the tongues 6 have the shape of a right triangle. A connoisseur of the field will know, based on their knowledge, that it is possible to use tongues 6 of another shape such as a rectangle, square or semicircle. The rectangular triangle shape is the most optimal. It is important that the tongues 6 including the groove 5 fit into the cross-section of the structural arch (Fig 10). In this execution example, one of the right-angle side surfaces 6b, visible in Figs. 1 and 2, is vertical - it is perpendicular to the top surface of the head 3b, it is in line with the direction determined by the Z-axis, which makes it easier to fit the skeleton elements when laying it out as can be seen in Fig. 4.

[0049] In this example, shown in Figs. 1 and 2, the upper contact surface 6a of the tongues 6 forms an angle of 30° with the upper surface of the head 3b, with respect to the horizontal - perpendicular to the Z axis. The angle is shown in Fig. 9. The horizontal is determined by the top surface of the head 3b, perpendicular to the Z axis, which is defined as the plane perpendicular to the direction of gravity on or near the surface of the celestial body. Such an angle of inclination ensures the least weight of the structural element 1 and optimal stability of the structural element 1 during stacking of successive structural elements 1. Optimal stability and rigidity of the structure is achieved with an angle of inclination of the upper contact surfaces 6a of 30° with respect to the horizontal - perpendicular to the Z axis, because in such an arrangement the contact area of the structural elements 1 in relation to their total area (mass) is the largest. Thus, the structure is the strongest. Other than 30° angle of inclination (both smaller and larger) results in a worse ratio of the contact area of structural elements 1 to their total area (mass). Thus, a greater than 30° angle of inclination lengthens the element 1 vertically causes it to be less stable and heavier, or while keeping the same height of the element increases its weight. In both cases, the ratio of the contact area of structural element 1 to its weight (total mass) deteriorates.

[0050] A comparison of contact surfaces (other than vertical) for different angles of inclination of the tongues 6 of the structural element 1 is shown in the table in Fig. 16. Vertical contact surfaces were not considered for these calculations because vertical surfaces do not transmit gravitational force. At an angle of 30°, the structural element 1 has the smallest weight and the largest contact area. At a larger angle - 45°, the performance is worse. At a smaller angle - 0°, the parameters also deteriorate. With an angle of 0°, the tongues 6 and groove 5 are completely eliminated, which further results in the instability of such structural elements 1 during laying. The contact surface is the surfaces of the structural element 1 (other than vertical) that are in contact with the surfaces of subsequent structural element 1 laid on top of it. The front surface is the surface that is visible when looking from the front at the structural element 1 laid out in the skeleton. The front surface does not include the surface of the tongues, since the tongues are not visible when assembled into a skeleton.

[0051] A comparison of the contact area for different traditional building materials is shown in the table in Fig. 17. Double structural element 1 (2x structural element 1) has a very high contact area to front area ratio. It is inferior only to traditional flat brick, which has the best ratio of all building materials because it is the flattest. In addition, the structural element 1 is the only one in the list to have grooves 5 and tongues 6. The other building materials analyzed have a flat surface. The table shows that the design of the structural element 1 solves well the technical problem of low tangency of structural elements, which occurs in frame structures.

[0052] In the optimal execution example, the lower contact surface 5a of the groove 5 forms an angle of 30° with the upper surface of the head 3b, with the horizontal. Maintaining the same angles of the groove 5 and the tongues 6 allows the tongues 6 to fit properly into the groove 5 and fill them completely when assembling structural elements 1, resulting in a structure with greater strength, as can be seen in Fig. 5. Figs. 1 and 2 show an example of execution where the tongues 6 fill the groove 5 completely.

[0053] The optimal thickness of tongues 6 is indicated in Fig. 9 by the reference designation G. The optimal thickness of the tongues is calculated from the formula:

$$\frac{(\tan x) \times (0{,}5 \times y)}{2} \times \cos x = G$$

Where x is the value of the inclination of the upper contact surface 6a with respect to the level determined by the top surface of the head 3b, perpendicular to the Z axis,

y is the overall width of the structural element 1.

[0054] Realistically, the thickness of the tongues may deviate from the calculated result by

The optimal thickness of the tongues 6 ensures full filling of the groove 5.

[0055] The optimal thickness of tongues 6 depends on the overall dimensional width of the entire structural element 1 and the angle of inclination of the upper contact surface 6a with respect to the Z axis of shaft 2. The greater the dimensional width of the structural element 1, the greater the thickness of tongues 6. The thickness of tongues 6 is not related to the thickness of shaft 2. The shaft 2 can have a smaller or larger thickness with the same thickness of tongues 6.

[0056] In one example of the design of Fig. 2, the head 3 has a lower surface 3a, symmetrical (or symmetrically arranged) with respect to the shaft 2, which forms an obtuse angle with the Z-axis of the shaft 2 as seen in Figs. 1 and 2. In one example of Fig. 5, Fig. 6, Fig. 7 and Fig. 8, the obtuse angle is 120°. In yet another example of the design of Fig. 11, the lower surface 3a of the head 3 forms an arc together with the side surface 2a of the shaft 2, Fig. 11. Such a design is heavier than the design with a 120° obtuse angle, but it is also more robust. The obtuse angle design is optimal considering the ratio of weight to the contact surfaces of the structural element 1.

[0057] Fig. 3 shows an example where the bottom contact surface 2b has holes 7 adapted to accommodate elements therein, which are reinforcement bars that can serve both to join two elements 1 together and can also serve as additional reinforcement for the skeleton vertically.

[0058] All parts of the structural element 1 can be formed from the same material or from a combination of different materials into a single unit. In the case of the same material in different examples of execution, it can be concrete (including reinforced), ceramic, polymer or composite. Currently, concrete is the cheapest material due to its low cost.

[0059] In this example of execution, the dimensions of the structural element 1 advantageously are: 40 cm wide, 37 cm high and 15 cm thick. The height should not be greater than the width so that the structural element 1 is stable during laying. The thickness must ensure stability during laying and be proportional to the element's width. In a favorable example, the mass of the entire structural element 1 made of concrete is less than 15 kg. This mass allows the structural element 1 to be carried without the use of a crane or other auxiliary machinery.

[0060] In another favorable design example, shown in part in Fig. 8, the structural element 1 is built from two structural elements 1 connected to each other with bottom contact surfaces 2b into a single unit, forming a structural element 1 with the shape of a column with two heads - Fig. 10. The structural element 1 in this shape is optimal from the point of view of speed and simplicity of construction of the structural skeleton.

[0061] The application discloses an arrangement for constructing a frame wall of a frame house using a structural element 1. The arrangement includes at least two interconnected structural elements 1 that are stacked on top of each other and side by side as shown in Fig. 4 -8.

[0062] The structural elements 1 are connected horizontally to each other in the direction perpendicular to the Z-axis by means of contact surfaces, which consist of the lower contact surface 5a of the groove 5, the upper contact surface 6a of the tongues 6, and the upper surface of the head 3b.

[0063] Structural elements 1 arranged horizontally next to each other adhere to each other with their perpendicular surfaces 6b and lean against each other.

[0064] The structural elements 1 are connected to each other by the upper surfaces of the head 3b and the lower contact surfaces 5a of the groove 5, which are in contact with the upper contact surfaces 6a of the tongues 6. The vertical contact surfaces of the components are the right-angle arm surface 6b of the tongue 6 and the side surface 6c of the tongue and the side surface 5b of the groove 5.

[0065] Superimposed structural elements 1 press the structural elements 1 of the lower layer against each other. One structural element 1 is laid on top of two structural elements 1 arranged next to each other horizontally. This position allows the two structural elements 1 arranged next to each other horizontally to be pressed against each other by properly aligning the tongues 6 with the grooves 5. A well-fitted and stable structure in all directions is formed. Thanks to the structure, according to the favorable example of execution, the elements will stick to each other even without glue or mortar.

[0066] The stacked structural elements 1 transfer vertical forces from the Z-axis of one structural element 1 to the Z-axes of two more structural elements 1 as shown in Fig. 10.

[0067] In the illustrated execution examples, the connected structural elements 1 into a wall, form between the side surfaces 2a of the shaft 2 together with the bottom surfaces 3a of the head 3 a hollow space in the shape of a substantially hexagonal, regular hexagon, circle or ellipse, as can be seen in Figs. 6-8 and 10-11. The arrangement in another execution example includes a structural or insulating part that is configured to be placed in the created voids of the structural framework formed by the arrangement of the structural elements 1. In other execution examples, the structural part of the wall or insulating part is an insulating brick 8, as seen in Fig. 13, made of insulating materials for example Styrofoam.

[0068] Fig. 12 shows a wall, which is the subject of the invention, using structural elements 1. In addition to the arrangement of elements 1 described above, the wall includes starting elements 12 and ending elements 13. Starting elements 12 and ending elements 13 contain some features of structural element 1, at least grooves 5 and tongues 6. Starting elements 12 and ending elements 13 in this example of execution have the same geometry and can be seen in Figs. 18 and 19. In other execution examples, the wall includes a system lintel 9, side elements 10 and vertical beams 11. Fig. 20 shows an example of the execution of side element 10, and Fig. 21 shows an example of the execution of vertical beam 11. Fig. 14 shows such a wall from the outside of the building with insulating bricks 8 filled in. Some openings can be left open for ventilation of the building. The wall from the outside can be covered with a thin-coat facade plaster, or it can be already finished insulating bricks 8 that are also a facade.

[0069] Fig. 15 shows the wall from the inside. The wall from the inside can be finished in any way, for example, with plaster on a grid or with gypsum boards. Additional layers of thermal or acoustic insulation can be applied to the wall.

[0070] An additional important feature of the presented wall erection technique is the fact that the spaces of the structural frame have regular, repeating shapes which makes the insulating bricks 8 used to fill them also the same size. This speeds up the process of insulating the building and eliminates waste. In addition, insulating bricks 8 can have different insulation and water vapor permeability parameters. Depending on the needs, the same wall can be insulated with insulating bricks 8 made of different materials. For example, at the ground of the wall can be insulated with insulating bricks 8 resistant to moisture. At the top of the wall, water vapor permeable bricks can be placed. This is a unique property of the wall based on the presented construction not available in alternative wall construction systems, including frame wall construction.

Claims

1. Structural element (1) in the form of a column, for architectural construction of frame walls of buildings, containing:

    - shaft (2) in the form of a vertical support beam, which shaft (2) has a bottom contact surface (2b) on the lower side;
    - head (3) connected to the top of the shaft (2), which head (3) extends substantially horizontally, perpendicular to the Z-axis of the shaft (2) and symmetrical with respect to the shaft (2), in at least two opposite directions forming at least two side arms (4), and from above the head (3) includes the top surface of the head (3b);

    characterized in that the head (3) on the top surface of the head (3b) has at least two tongues (6), which on the top have an upper contact surface (6a) and are located essentially at the edges (3c) of the head (3), and at least two grooves (5), which on the bottom have a bottom contact surface (5a), which grooves (5) are located essentially at the center of the top surface of the head (3b) and the shape of the individual tongue (6) corresponds to the shape of the individual groove (5).

2. Structural element (1) according to claim 1, **characterized by the fact that** the tongues (6) have the profile of a right triangle, in which one of the right-angle side surfaces (6b) of the tongue (6) is perpendicular to the upper surface of the head (3b).

3. Structural element (1) according to claim 1 or 2, **characterized in that** the upper contact surface (6a) forms an angle of 30° with respect to the horizontal or the upper surface of the head (3b) and/or the lower contact surface (5a) forms an angle of 30° with the upper surface of the head (3b) and the head (3) has a lower surface (3a), which lower surface (3a) forms an obtuse angle with the Z axis of the shaft (2) preferably an angle of 120°.

4. Structural element (1) according to any of the claims from 1 to 3, **characterized in that** at least two grooves (5) are connected to each other and form one double groove.

5. Structural element (1) according to any of the claims from 1 to 4, **characterized in that** the thickness of the tongue (6) is substantially equal to the thickness calculated according to the formula:

$$\frac{(\tan x^\circ) \times (0{,}5 \times y)}{2} \times \cos x^\circ = G$$

    Where x is the value of the inclination of the upper contact surface (6a) relative to the shaft (2), y is the overall width of the structural element (1), G is the thickness of the tongues (6).

6. Structural element (1) according to any of the claims from 1 to 5, **characterized in that the** two tongues (6) either extend beyond the edges of the head (3) or do not extend beyond the edges of the head (3) nor contact them.

7. Structural element (1) according to any of the claims from 1 to 6, **characterized in that** the shaft (2) is essentially cuboidal, cube or cylindrical in shape and advantageously has additionally holes (7) adapted for placing elements therein and/or the side surface (2a) of the shaft (2) together with the lower surface (3a) of the head (3) form an arc.

8. Structural element (1) according to any of the claims from 1 to 7, **characterized in that** the dimensions of the structural element (1) are: maximum width of 40 cm, maximum height of 40cm, maximum thickness of 20 cm and the maximum weight of the structural element (1) is 30 kg and it is made of concrete, gypsum, ceramic, polymer or composite.

9. Structural element (1) according to any of the claims from1 to 8, **characterized in that it is** built of two structural elements (1) connected by bottom contact surfaces (2b) to form a column-shaped element with two heads, which advantageously have an arche-like shape.

10. Structural element (1) according to any of the claims from 1 to 9, **characterized in that** it has more than two tongues and more than two grooves and is a duplication of the structural element in any direction.

11. An arrangement for the construction of a frame house wall frame comprising at least two structural elements (1) according to claims 1-10, configured to be aligned vertically and horizontally with respect to each other, advantageously the arrangement additionally comprises a structural or insulating part configured to be inserted in the hollow space between the structural elements (1) in the form of an insulating brick (8), advantageously in the shape of a substantially hexagonal, regular hexagon, circle or ellipse, which insulating brick (8) is advantageously made of insulating materials for example Styrofoam.

12. A frame wall of a house **characterized in that it** contains at least two structural elements (1) accord-

ing to claims 1-10 are connected to each other horizontally by means of the right-angle arm surfaces (6b) of the tongues (6), and vertically by means of the upper head surfaces (3b) and lower contact surfaces (5a) connected to the upper contact surfaces (6a).

13. House frame wall according to claim 12, **characterized in that it** contains structural elements (1) according to claims 1-10 advantageously arranged between starting elements (12) and ending elements (13) and/or system lintels (9), side elements (10) and vertical beams (11).

14. A frame wall of a house according to claim 12 or 13, **characterized in that the** joints of the structural elements (1) are reinforced by means of bonding and/or reinforcement and/or assembly elements.

15. A frame wall of a house according to claim 12, 13 or 14, **characterized in that it** additionally includes a structural or insulating part in the form of an insulating brick (8), which is advantageously configured as a finished exterior facade element of the building.

Amended claims in accordance with Rule 137(2) EPC.

1. Structural element (1) in the form of a column, for architectural construction of frame walls of buildings, containing:

- shaft (2) in the form of a vertical support beam, which shaft (2) has a bottom contact surface (2b) on the lower side;
- head (3) connected to the top of the shaft (2), which head (3) extends substantially horizontally, perpendicular to the Z-axis of the shaft (2) and symmetrical with respect to the shaft (2), in at least two opposite directions forming at least two side arms (4), and from above the head (3) includes the top surface of the head (3b);

characterized in that the head (3) on the top surface of the head (3b) has at least two tongues (6), which on the top have an upper contact surface (6a) and are located essentially at the edges (3c) of the head (3), and at least two grooves (5), which on the bottom have a bottom contact surface (5a), which grooves (5) are located essentially at the center of the top surface of the head (3b) and the shape of the individual tongue (6) corresponds to the shape of the individual groove (5).

2. Structural element (1) according to claim 1, **characterized by the fact that** the tongues (6) have the profile of a right triangle, in which one of the right-angle side surfaces (6b) of the tongue (6) is perpendicular to the upper surface of the head (3b).

3. Structural element (1) according to claim 1 or 2, **characterized in that** the upper contact surface (6a) forms an angle of 30° with respect to the horizontal or the upper surface of the head (3b) and/or the lower contact surface (5a) forms an angle of 30° with the upper surface of the head (3b) and the head (3) has a lower surface (3a), which lower surface (3a) forms an obtuse angle with the Z axis of the shaft (2) preferably an angle of 120°.

4. Structural element (1) according to any of the claims from 1 to 3, **characterized in that** at least two grooves (5) are connected to each other and form one double groove.

5. Structural element (1) according to any of the claims from 1 to 4, **characterized in that** the thickness of the tongue (6) is substantially equal to the thickness calculated according to the formula:

$$\frac{(\tan x°) \times (0{,}5 \times y)}{2} \times \cos x° = G$$

Where x is the value of the inclination of the upper contact surface (6a) relative to the shaft (2), y is the overall width of the structural element (1), G is the thickness of the tongues (6).

6. Structural element (1) according to any of the claims from 1 to 5, **characterized in that the** two tongues (6) either extend beyond the edges of the head (3) or do not extend beyond the edges of the head (3) nor contact them.

7. Structural element (1) according to any of the claims from 1 to 6, **characterized in that** the shaft (2) is essentially cuboidal, cube or cylindrical in shape and advantageously has additionally holes (7) adapted for placing elements therein and/or the side surface (2a) of the shaft (2) together with the lower surface (3a) of the head (3) form an arc.

8. Structural element (1) according to any of the claims from 1 to 7, **characterized in that** the dimensions of the structural element (1) are: maximum width of 40 cm, maximum height of 40cm, maximum thickness of 20 cm and the maximum weight of the structural element (1) is 30 kg and it is made of concrete, gypsum, ceramic, polymer or composite.

9. Structural element (1) according to any of the claims from1 to 8, **characterized in that it is** built of two structural elements (1) which are in accordance with claim 1 connected by bottom contact surfaces (2b) to form a column-shaped element with two heads.

10. An arrangement for the construction of a frame house wall frame comprising at least two structural elements (1) according to claims 1-9, configured to be aligned vertically and horizontally with respect to each other, advantageously the arrangement additionally comprises a structural or insulating part configured to be inserted in the hollow space between the structural elements (1) in the form of an insulating brick (8), advantageously in the shape of a substantially hexagonal, regular hexagon, circle or ellipse, which insulating brick (8) is advantageously made of insulating materials for example Styrofoam.

11. A frame wall of a house **characterized in that it** contains at least two structural elements (1) according to claims 1-9 are connected to each other horizontally by means of the right-angle arm surfaces (6b) of the tongues (6), and vertically by means of the upper head surfaces (3b) and lower contact surfaces (5a) connected to the upper contact surfaces (6a).

12. House frame wall according to claim 11, **characterized in that it** contains structural elements (1) according to claims 1-9 advantageously arranged between starting elements (12) and ending elements (13) and/or system lintels (9), side elements (10) and vertical beams (11).

13. A frame wall of a house according to claim 11 or 12, **characterized in that the** joints of the structural elements (1) are reinforced by means of bonding and/or reinforcement and/or assembly elements.

14. A frame wall of a house according to claim 11, 12 or 13, **characterized in that it** additionally includes a structural or insulating part in the form of an insulating brick (8), which is advantageously configured as a finished exterior facade element of the building.

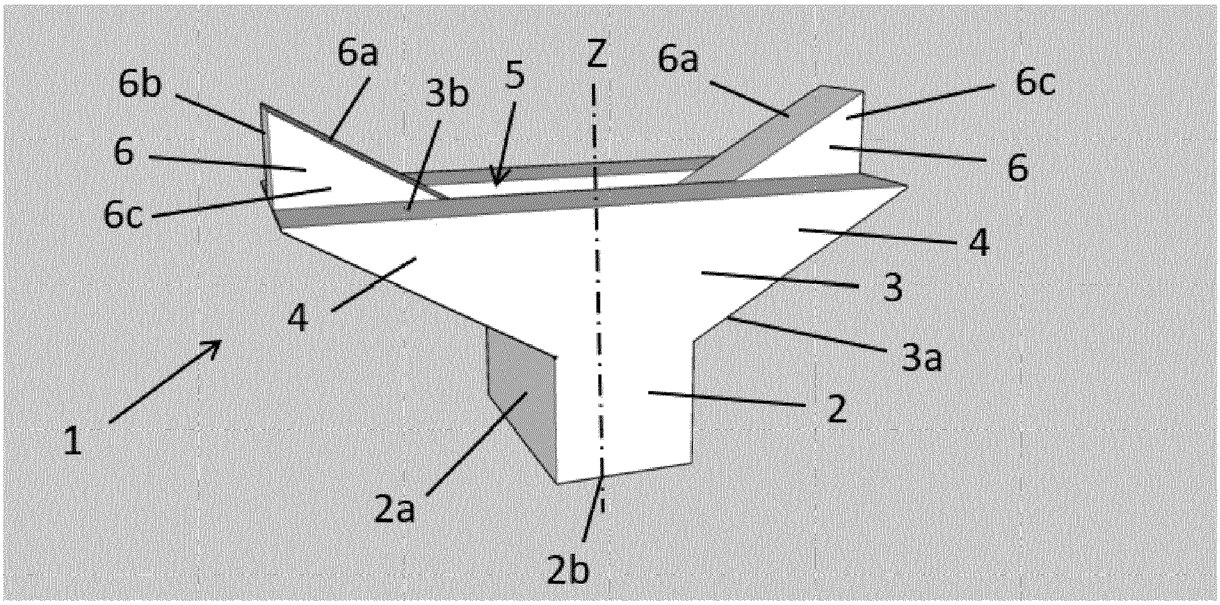
6a
6b
3b
5
Z
6a
6c
6
6c
6
4
4
3
3a
1
2
2a
2b

Fig. 1

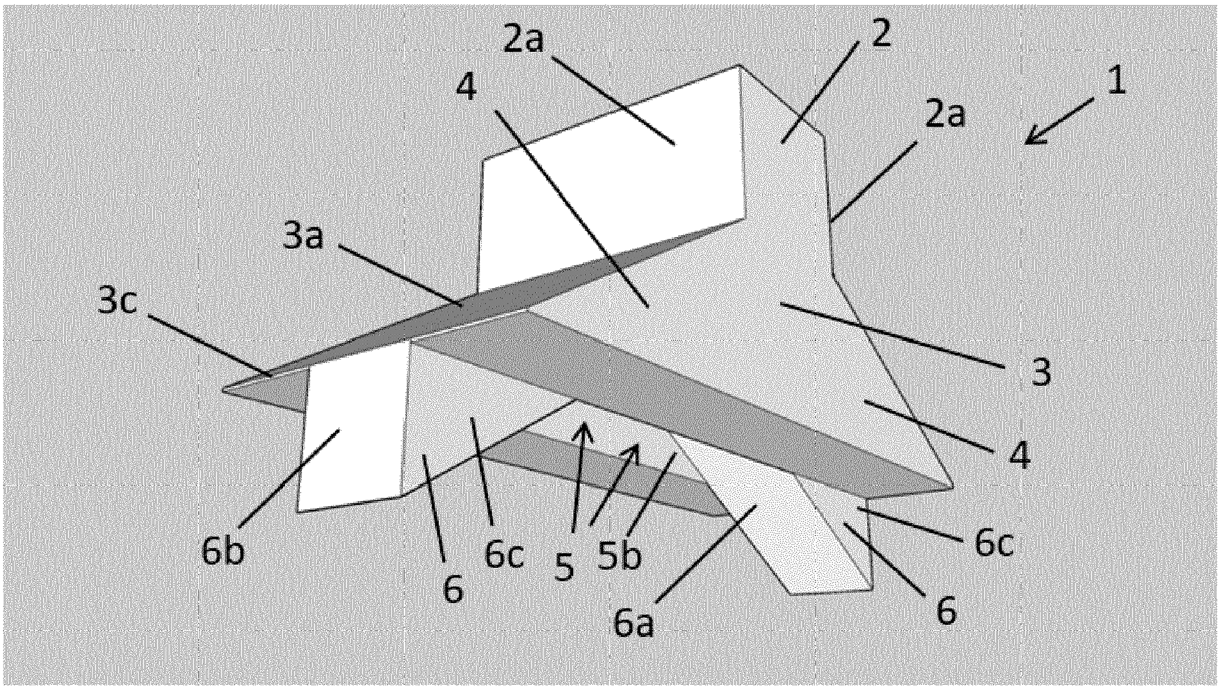
2a
2
4
1
2a
3a
3c
3
4
6c
6b
6
6c
5
5b
6
6a

Fig. 2

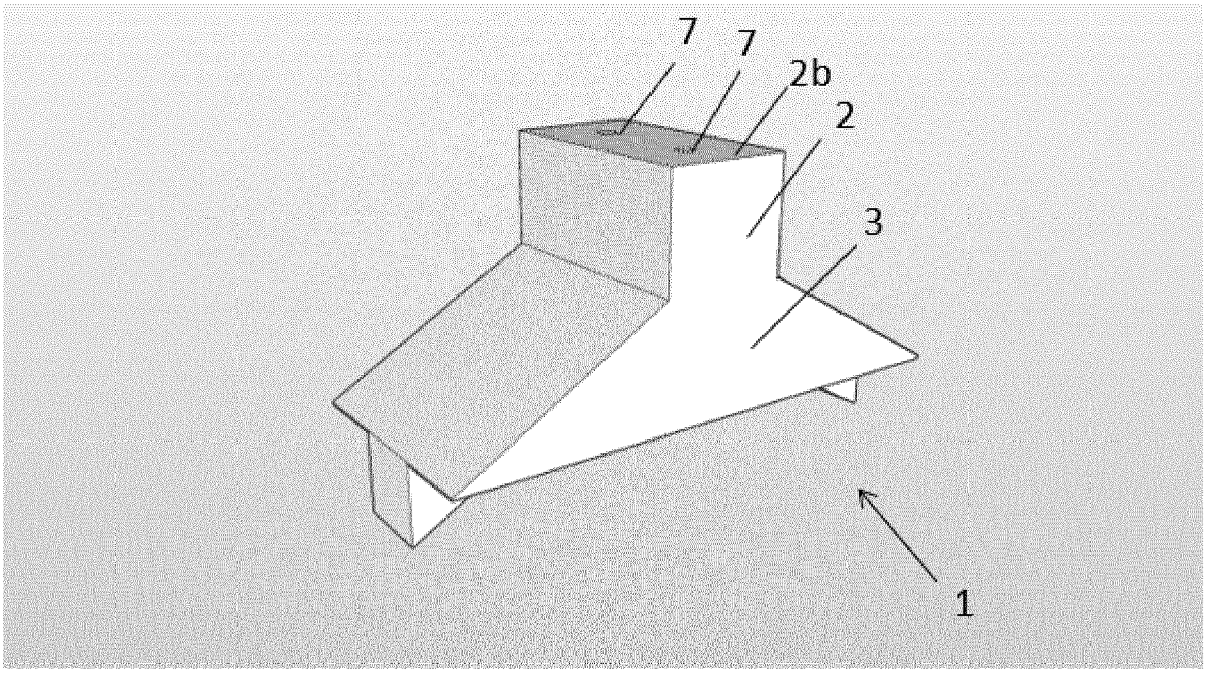

Fig. 3

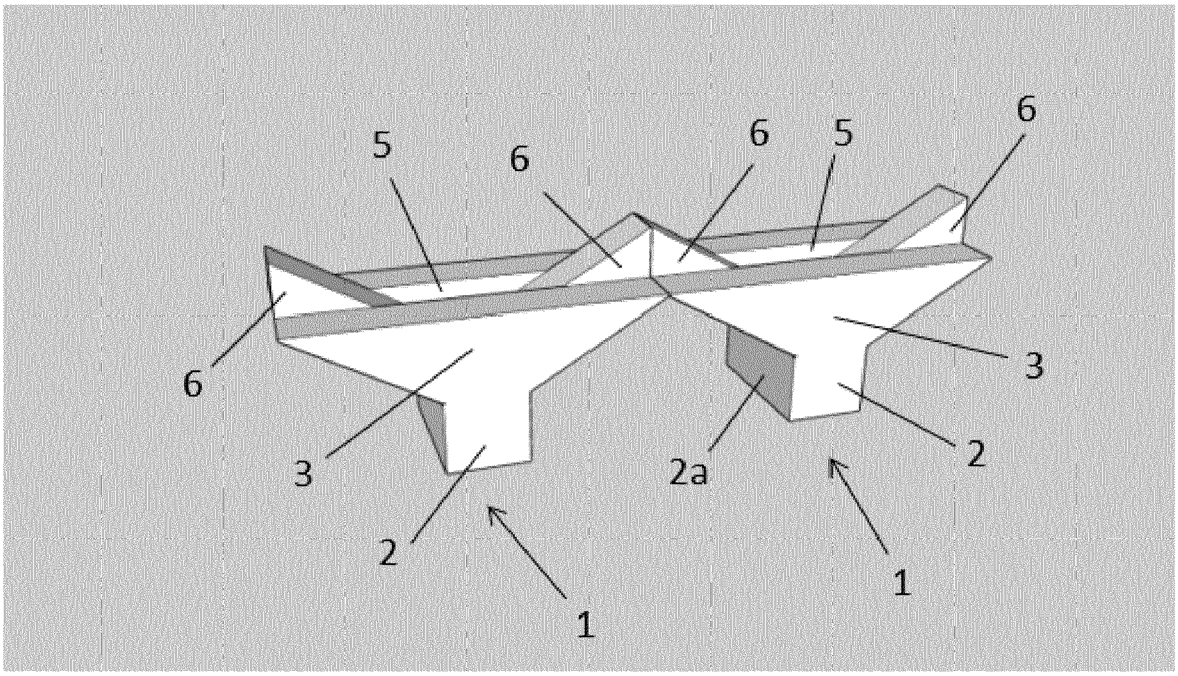

Fig. 4

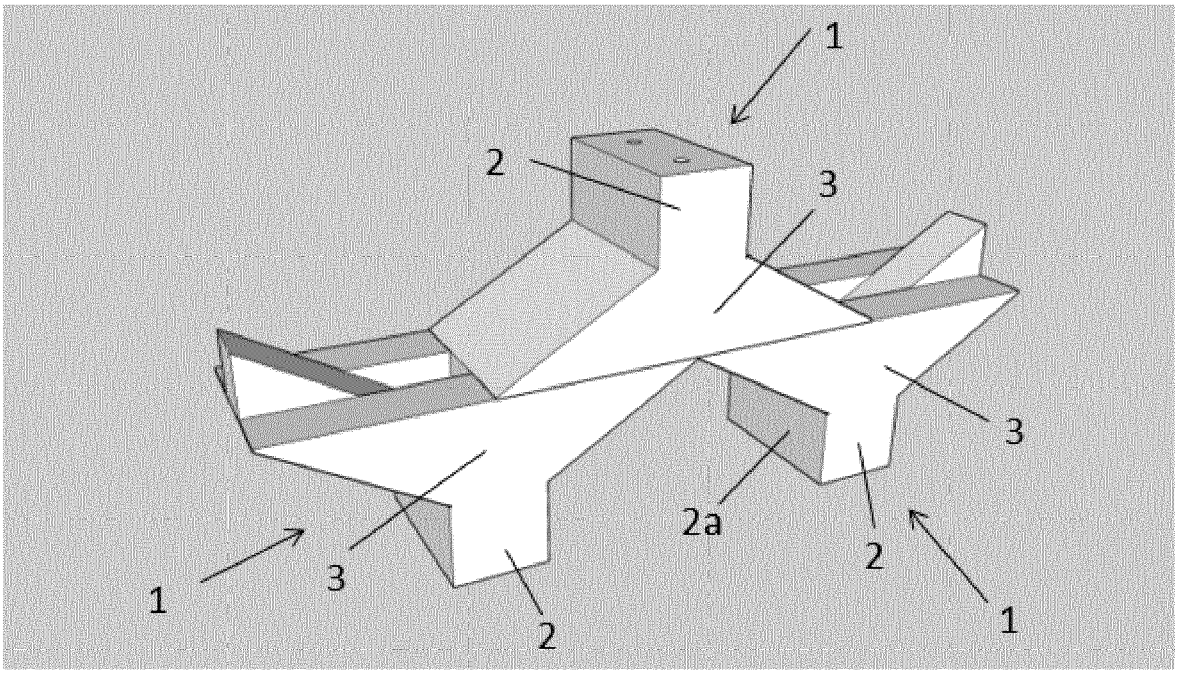

Fig. 5

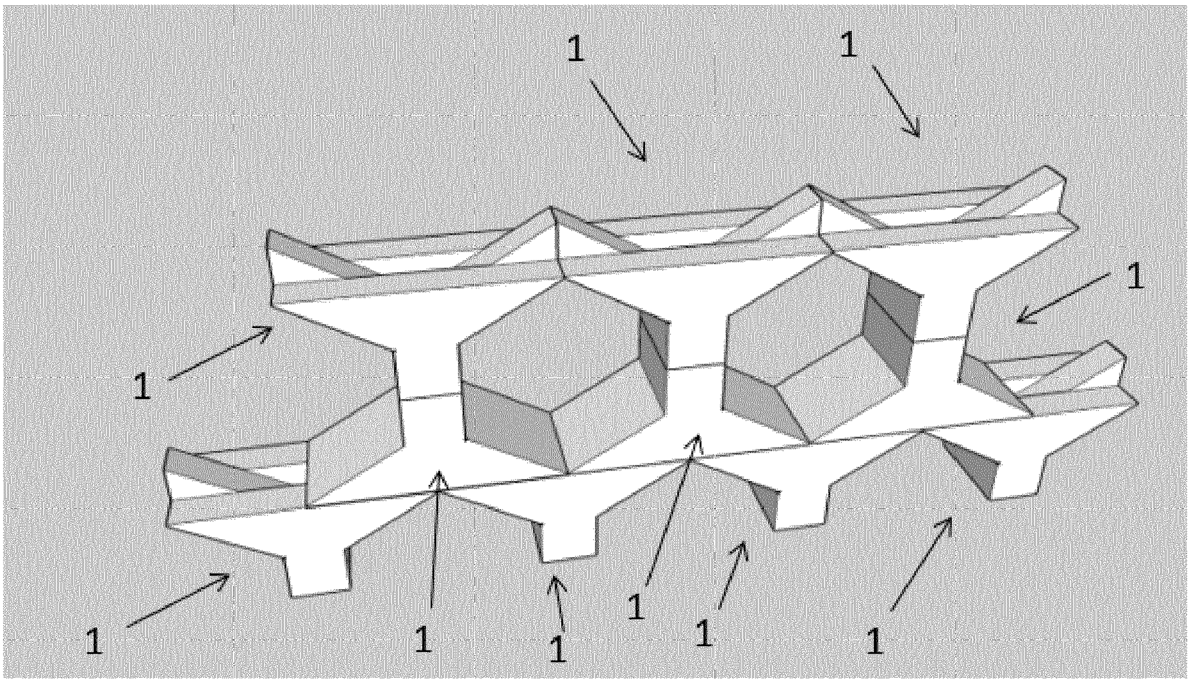

Fig. 6

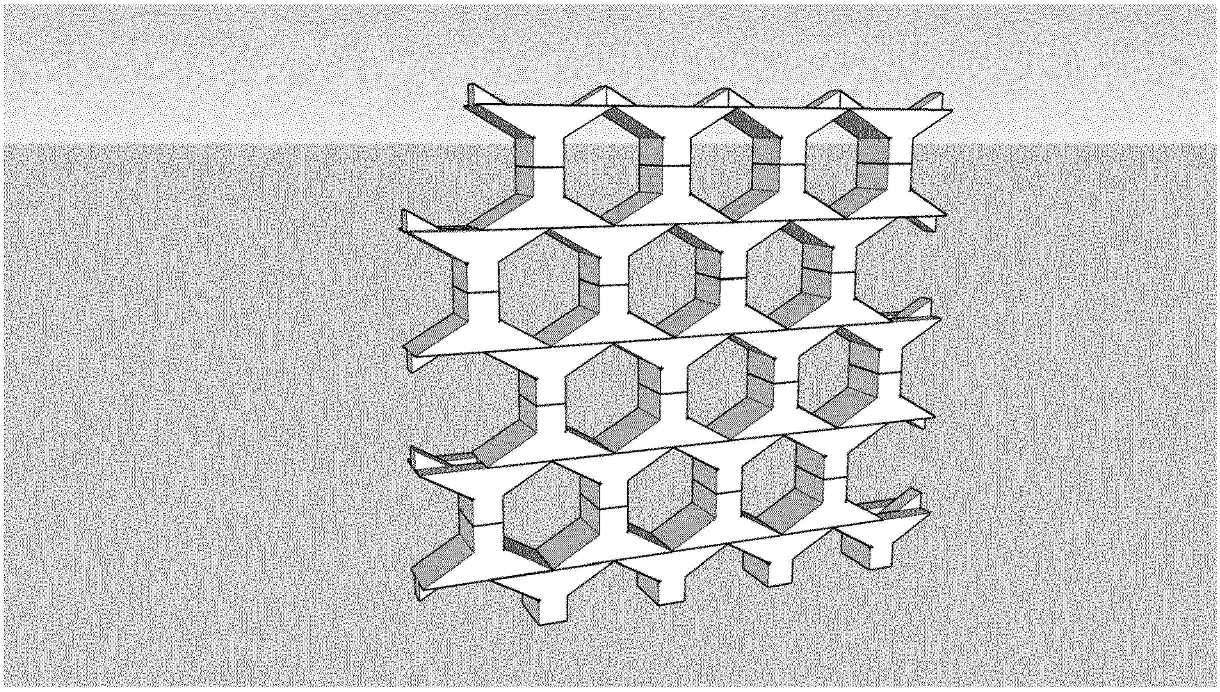

Fig. 7

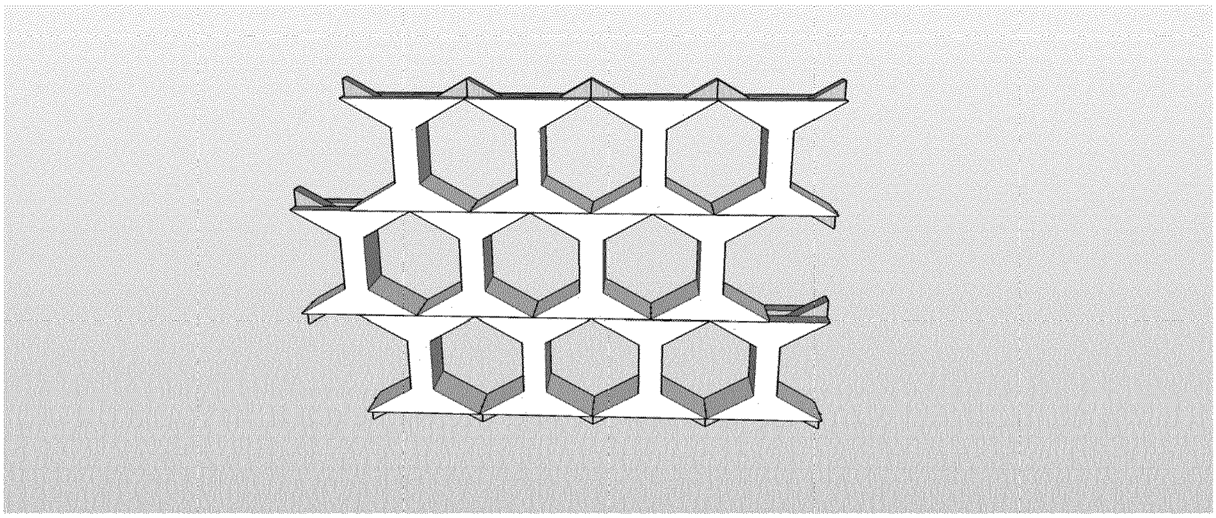

Fig. 8

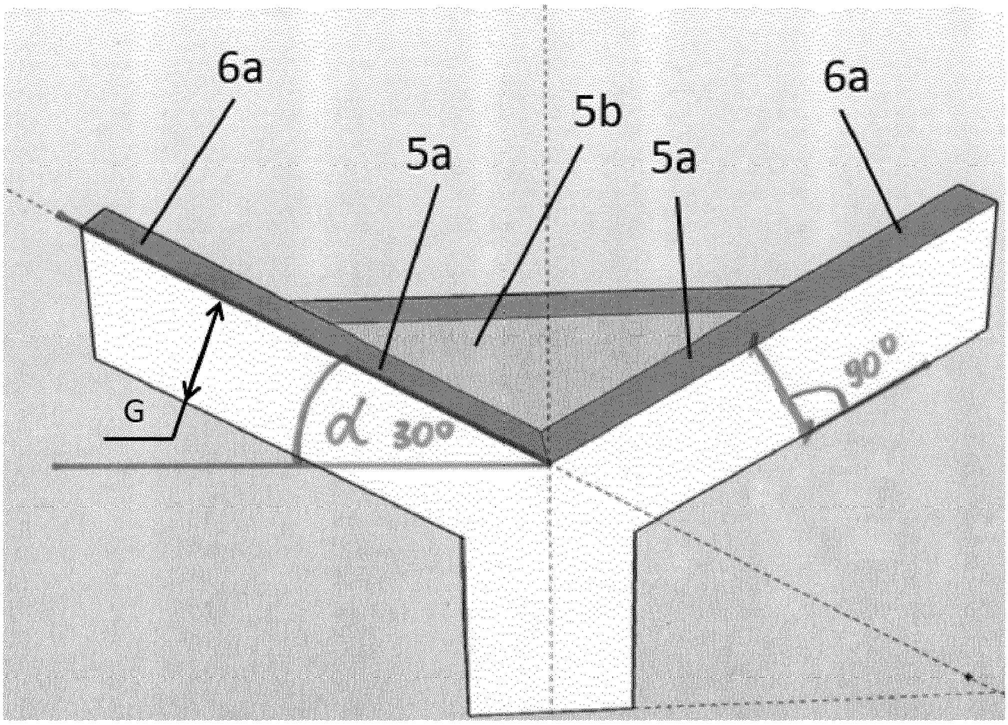

Fig. 9

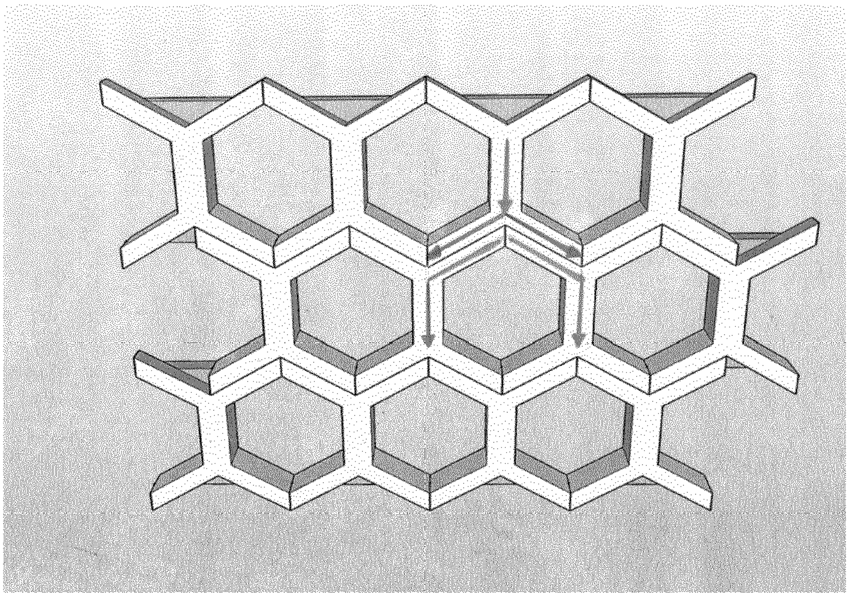

Fig. 10

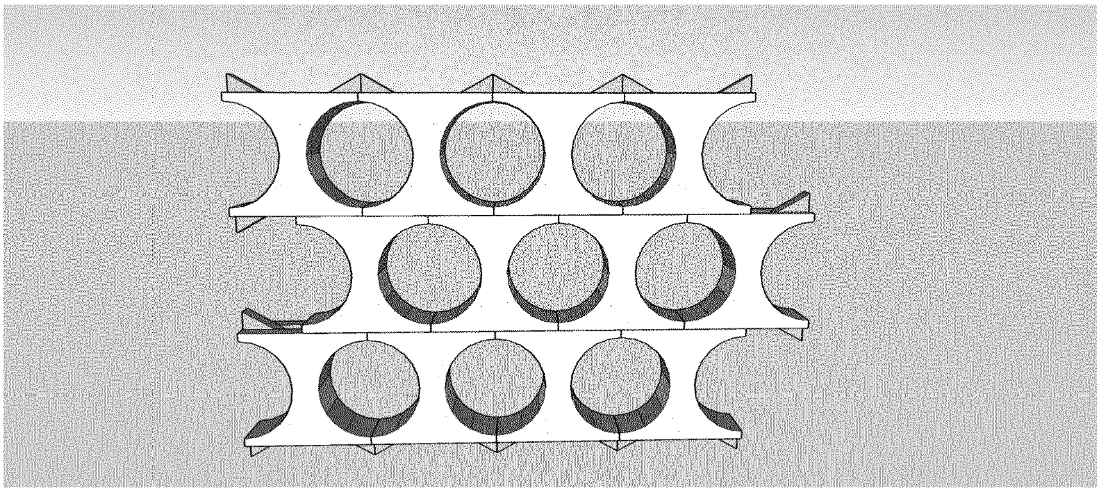

Fig. 11

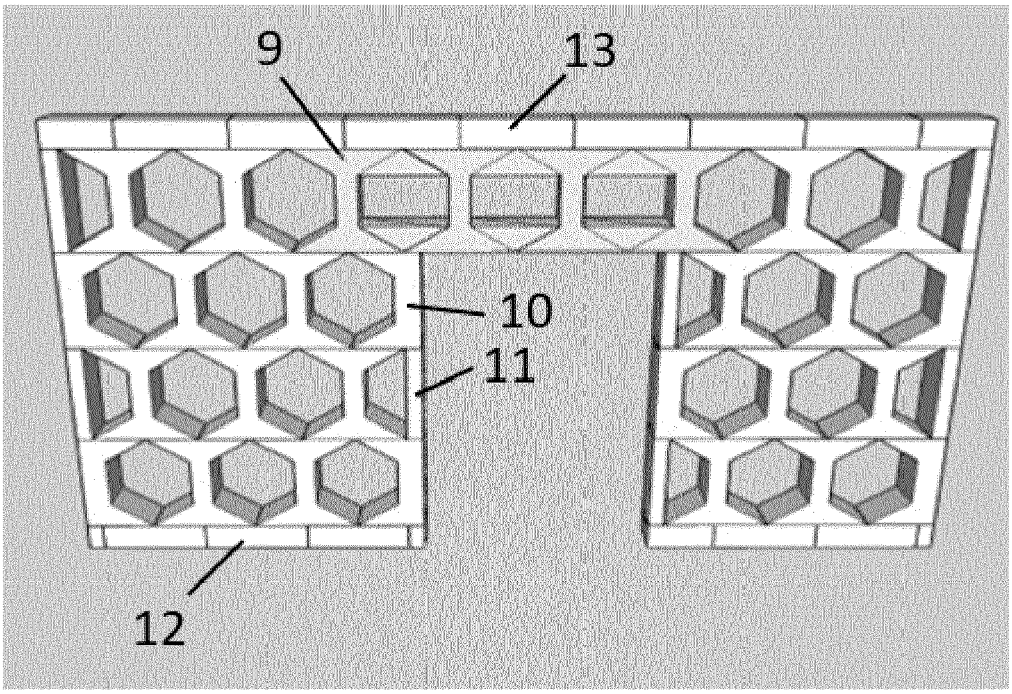

Fig. 12

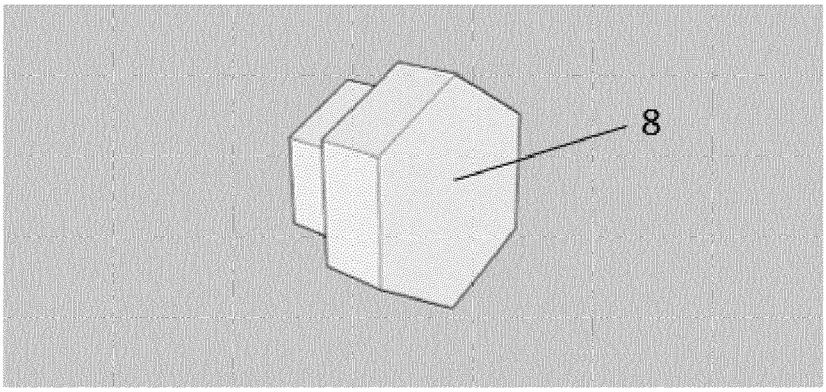

Fig. 13

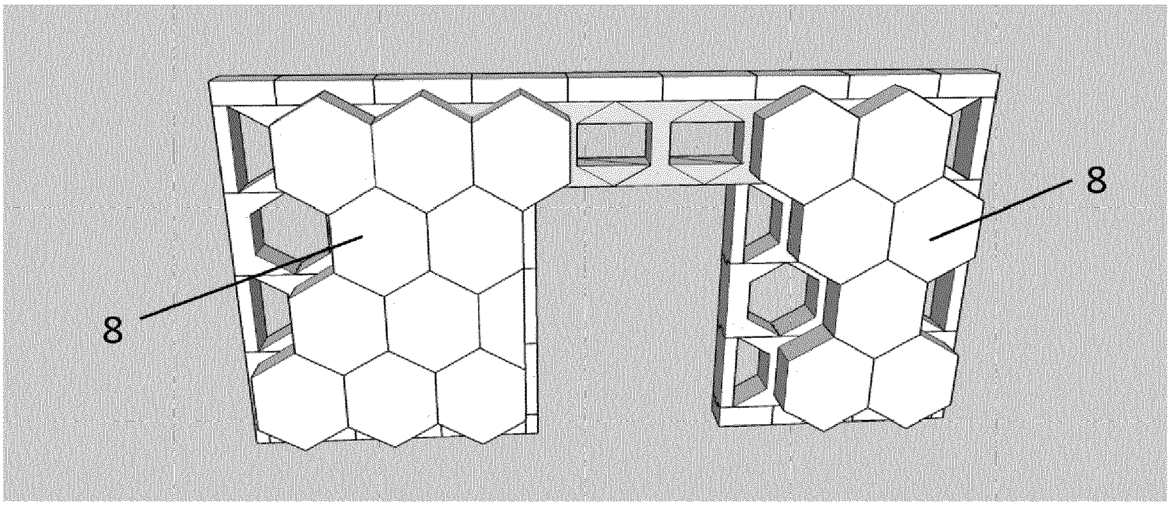

Fig. 14

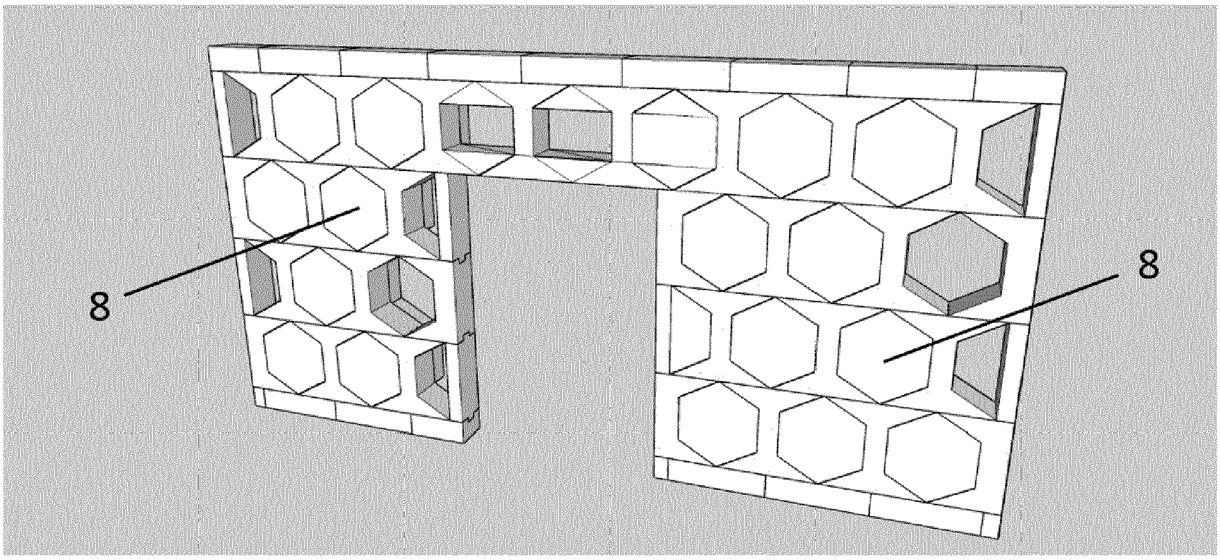

Fig. 15

A	B	C	D	E	B / C
Angle of the arm (tongues) to the horizontal	Contact surface (without vertical surfaces)	Front surface of element 1	Volume of element 1 (total including tongues)	Weight of element 1 (all including tongues)	Contact surface B / Front surface C
steps	cm 2	cm^2	cm^3	kg	
45	624	328	4 875	11,2	1,90
30	**631**	296	4 437	**10,2**	**2,13**
0	600	308	4 620	10,6	1,95

Fig. 16

	A	B	C	D	B / C
Description	Dimensions (width; height; depth)	Contact surface (without vertical surfaces)	Front surface	Estimated weight	Contact surface B / Front surface C
	cm	cm 2	in cm2	kg	
silicate brick	25/22/12	600	550	15,2	1,09
ceramic block	28,8/22/18,8	1 083	634	10,5	1,71
regular brick	25/6,4/12	600	160	3,8	3,75
2x element 1	40/37/15	1 262	592	20	2,13

Fig. 17

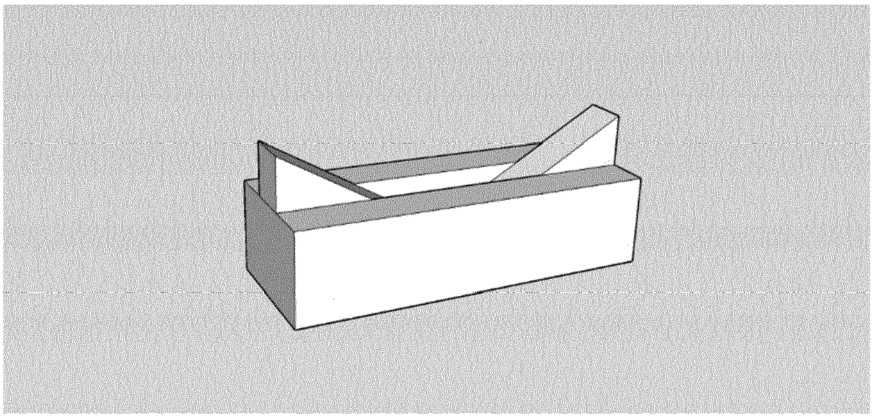

Fig. 18

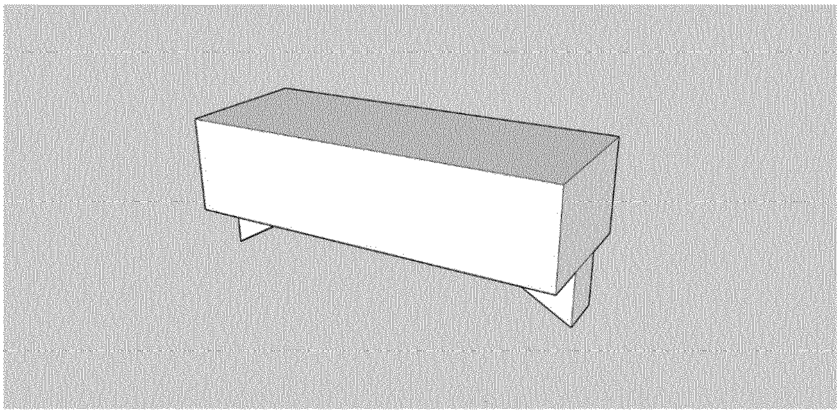

Fig. 19

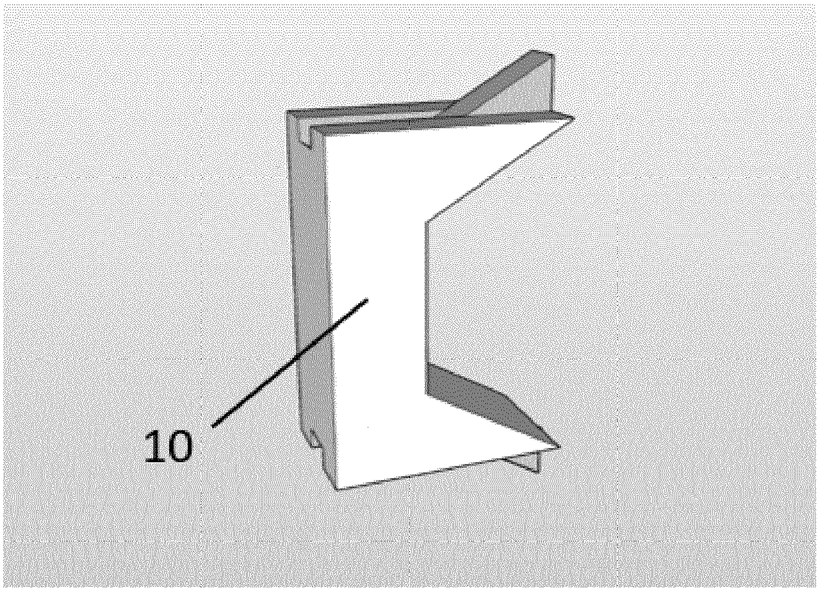

Fig. 20

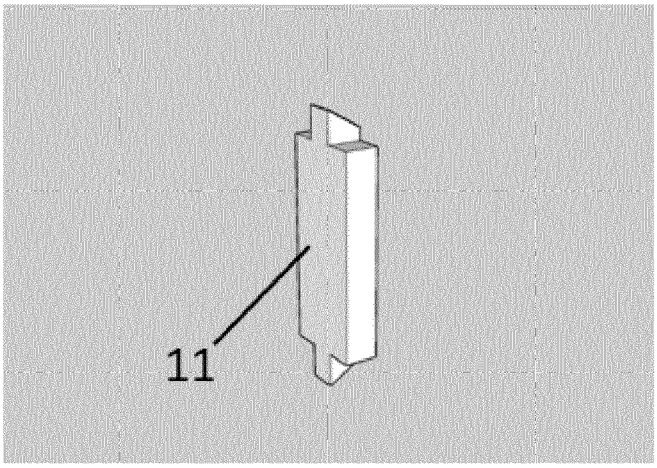

Fig. 21

Europäisches Patentamt
European Patent Office
Office européen des brevets

EUROPEAN SEARCH REPORT

Application Number
EP 23 46 1552

DOCUMENTS CONSIDERED TO BE RELEVANT

Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (IPC)
A	FR 961 163 A (DETOURNAY) 6 May 1950 (1950-05-06) * the whole document *	1-15	INV. E04B2/50 E04C3/34 E04B2/64 E04C2/04 E04B2/56 ADD. E04C2/00
A	GB 557 353 A (ARMAND WILMSHURST SODEN) 17 November 1943 (1943-11-17) * pages 2-3; figure 3 *	1-15	
A	CN 115 419 215 A (CHINA RAILWAY 11TH BUREAU GROUP CO LTD ET AL.) 2 December 2022 (2022-12-02) * figures 1,2 *	1-15	
A	CN 110 145 023 A (UNIV ANHUI JIANZHU) 20 August 2019 (2019-08-20) * figure 1 *	1-15	
			TECHNICAL FIELDS SEARCHED (IPC)
			E04B E04C

The present search report has been drawn up for all claims

1

Place of search	Date of completion of the search	Examiner
Munich	5 September 2023	Saretta, Guido

CATEGORY OF CITED DOCUMENTS

X : particularly relevant if taken alone
Y : particularly relevant if combined with another document of the same category
A : technological background
O : non-written disclosure
P : intermediate document

T : theory or principle underlying the invention
E : earlier patent document, but published on, or after the filing date
D : document cited in the application
L : document cited for other reasons

& : member of the same patent family, corresponding document

ANNEX TO THE EUROPEAN SEARCH REPORT ON EUROPEAN PATENT APPLICATION NO.

EP 23 46 1552

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report. The members are as contained in the European Patent Office EDP file on
The European Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

05-09-2023

Patent document cited in search report		Publication date	Patent family member(s)	Publication date
FR 961163	A	06-05-1950	NONE	
GB 557353	A	17-11-1943	NONE	
CN 115419215	A	02-12-2022	NONE	
CN 110145023	A	20-08-2019	NONE	

EPO FORM P0459

For more details about this annex : see Official Journal of the European Patent Office, No. 12/82