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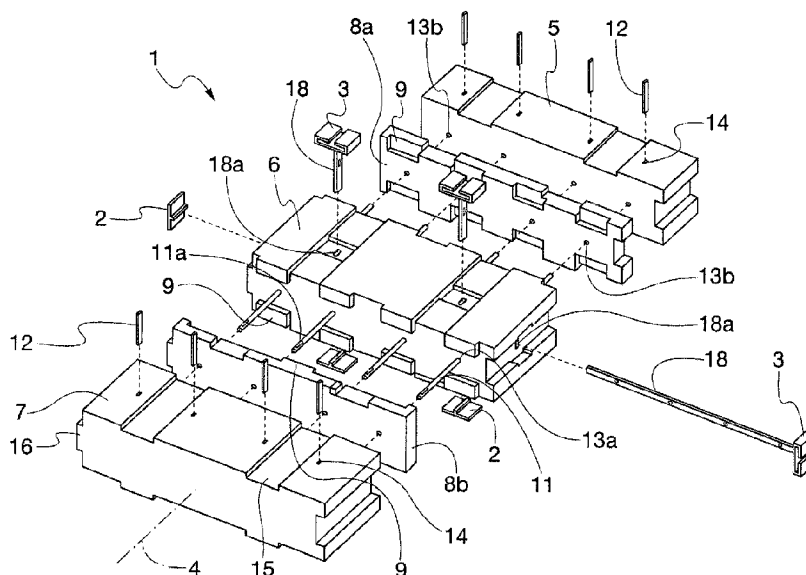
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A modular, self-supporting structural element (1, 10) for house building construction is described, which is provided with mechanical constraining means (2, 3) for the dry mutual connection with at least one second modular structural element (1, 10). The modular structural element has a variable density along at least one reference direction (4). A building structure (17) comprising a plurality of structural elements (1, 10) which are constrained to each other by said constraining means (2, 3) and a process for the construction of the building structure (17) are also described.

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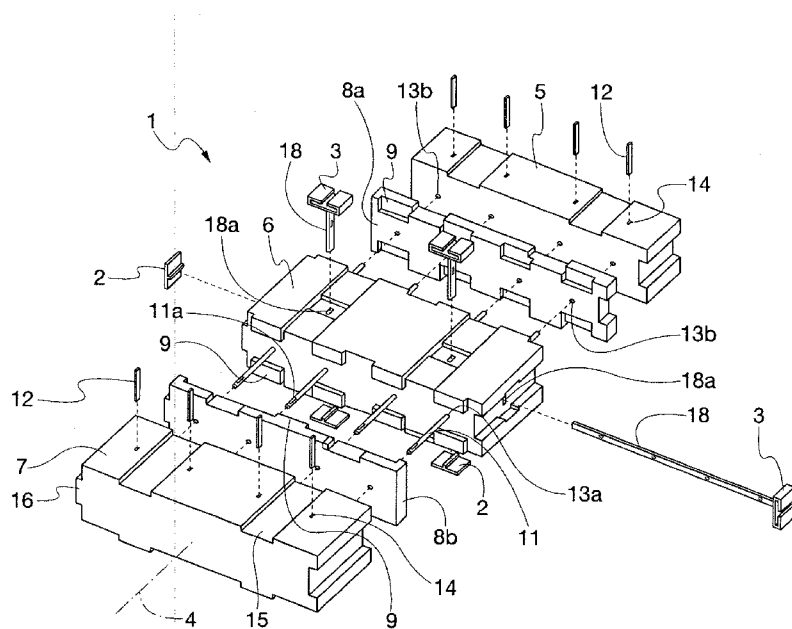


Fig. 1

(57) Abstract: A modular, self-supporting structural element (1, 10) for house building construction is described, which is provided with mechanical constraining means (2, 3) for the dry mutual connection with at least one second modular structural element (1, 10). The modular structural element has a variable density along at least one reference direction (4). A building structure (17) comprising a plurality of structural elements (1, 10) which are constrained to each other by said constraining means (2, 3) and a process for the construction of the building structure (17) are also described.

MODULAR STRUCTURAL ELEMENT HAVING SELF-SUPPORTING AND SUSTAINABLE CHARACTERISTICS

FIELD OF THE INVENTION

5 The present invention relates to the field of building construction, and particularly to the field of house building construction.

BACKGROUND OF THE INVENTION

10 It is well known that, in the contemporary building construction technique, it is possible to form a wall system or similar building structure by assembling blocks made of masonry material (tuff or stone), brick material (solid bricks or hollow bricks) or cement, or by assembling one or more preformed panels made of metal and plastic whose load-resisting (load-bearing) or structural part is formed by a metal frame. Similarly, the use of infilling building components, such as multi-layer panels secured to the load-bearing structure of the building by means of mechanical couplings, is particularly widespread.

15 In many cases, the coupling systems used to secure the various components of the structure to each other are, for example, mechanical clamping systems using rigid, load-resisting elements (typically made of steel such as bolts, threaded members or plates). In other cases, the shape itself of the building block is provided with appropriate profiles which are prearranged to enable the implementation of chemical sealing systems or bonding systems of the traditional type.

20 Alternatively, a wall can be formed with the use of self-supporting structural systems, i.e. structural frames to which the bricks are mounted. The self-supporting system can be formed in various ways, for example with the use of panels or bars assembled to each other and designed to support the bricks. Generally, the self-supporting panel systems are entirely prefabricated, and they are assembled and mounted in the building site and then made integral
25 by an in-situ casting according to dimensions and shapes of the structure to be built.

These methodologies involve the use of a wide variety of materials which introduce various discontinuities into the structure, resulting in evident disadvantages related to the response of the structure to mechanical and thermal stresses. Furthermore, the types of the above described constraint are very labor-intensive and complex, and they require both a great deal of time and

the use of specialized personnel, resulting in a considerable economic effort. Moreover, in the above described structures, when the life cycle of the building thus constructed has come to the end, the starting structural elements such as, for example, the bricks, are very difficult if not impossible to be recycled. In addition, if a single structural element comes to be damaged, its replacement is complex, so that the useful life of the entire building structure is shortened.

Moreover, since the various structural elements used for the construction are difficult to be separated, the recycling of the raw materials used during the construction of the structure is hard to be performed.

An aim of the present invention is to solve the problems of the known art and, particularly, to provide a modular structural element which allows a building structure having enhanced structural and seismic resistance characteristics to be built easily and quickly, the structural element being able to be detached from the building structure without undue difficulties and being provided with environmental compatibility characteristics.

Another aim of the present invention is to provide a structural element having good mechanical, sound-absorbing and thermal-insulating characteristics while maintaining the above advantages.

Another aim of the present invention is to provide a self-supporting structural element.

A further aim of the present invention is to provide a structural element which has a reduced impact on the environment and on the building construction costs.

SUMMARY OF THE INVENTION

These and other aims are achieved by the present invention through the provision of a modular structural element having self-supporting and sustainable characteristics. Preferred aspects of the structural element are set forth in the dependent claims.

The structural element according to the present invention is modular and self-supporting, and it is preferably made of at least one material which imparts structural

load-bearing characteristics to the entire structural element. Among these materials, it is possible to mention brick materials, clays, cements, stone-based materials, etc. The structural element is further provided with mechanical constraining means which allow the structural element to be mutually connected with at least one second
5 structural element in such a way that the connection can be carried out in a "dry" condition, i.e. without the application of a further material acting as a structural binder (epoxy glues, cementitious material, ...).

Therefore, the constraining means allow the structural elements to be secured to each other for the formation of a building structure.

10 In addition, the modular structural element has a variable density along at least one direction, which will be also hereinafter referred to as a reference direction.

It should be noted that the phrase "variable density" is intended to mean that the structural element of the present invention has at least two density values which are significantly different from each other along at least one direction and wherein,
15 according to a possible embodiment as will be described hereinafter, the gradient across these density values is continuous. The term "significantly" is intended to mean that the difference between the density values is large enough to not be within the usual natural tolerance of densities of a material about its average value, due to random lacks of homogeneity in the material itself.

20 Furthermore, the term "at least one direction" is intended to mean that, as said above, the modular structural element has at least two density values which are significantly different from each other substantially along at least one direction taken as a reference, and preferably along a direction of extension of the structural element.

Furthermore, according to one aspect of the present invention, the direction along
25 which the structural element has a variable density is a generic axis connecting two opposite faces of the structural element along the direction of axis itself. The axis thus established does not need to be the axis along which the density variation occurs, but it only needs to be a generic axis along which such a variation can be measured.

30 Furthermore, according to one aspect of the present invention, the direction along which the structural element has a variable density is oriented substantially in one of

the three main directions of extension which can be identified in the structural element.

In fact, a solid figure is generally defined by three main directions referred to as the thickness, the height and the width of the figure. Based on this reference system, the structural element of the present invention may have different density values along at least one of the three main directions, i.e. along at least one of height, width and thickness. Preferably, the structural element according to the present invention has a shape which can be approximated to a parallelepiped and, therefore, the three main directions defining the height, the width and the thickness can be preferably identified as three orthogonal axes.

Preferably, the density gradient (density variation) occurs along at least one direction substantially corresponding to at least one direction which, in the finished building structure and particularly in a wall comprising multiple structural elements constrained to each other, is oriented from the inside to the outside of the wall (or other building structure). Preferably, the density gradient occurs along the thickness of the structural element and, as will be better seen hereinbelow, the structural elements are constrained to each other in such a way as to form a building structure in which the direction of the density gradient corresponds to at least one direction of the building structure and, in the specific case of a wall, to at least the direction connecting the two opposite faces of the building structure and, therefore, of the wall.

It should also be noted that the density variation can equally be either continuous or discontinuous, i.e. “stepped”, or a combination thereof.

These characteristics allow to provide a building structure, which is simple to be produced and provided with good mechanical and insulating characteristics which can be obtained only due to the presence of the structural elements constituting it.

It should be noted that, advantageously, the structural element according to the present invention can be used for the construction of various building structures such as, for example, foundation footings, basement floors, wall-floor joints, wall-window/ door joints, vaults, walls, etc.

Hereinafter, particular reference will be made to the construction of building structures, especially walls, by connecting a plurality of modular structural elements according to the invention to each other, however, it is understood that the use of the structural element is not limited to the construction of such building structures.

- 5 Advantageously, due to the presence of the mechanical constraining means, a structure can be formed easily by juxtaposing and connecting a plurality of modular structural elements according to the present invention to each other.

Since the structural elements have a variable density, it is possible to achieve a good weight trade-off which allows the structural elements to be easily handled by the
10 workers while ensuring that the structure is self-bearing.

According to one aspect, since the structural element is entirely produced and assembled in the factory, therefore the entire structural element, and not only individual parts thereof, is easy to be handled and light in weight in order to facilitate the set-up processes in the building site.

- 15 On the contrary, elements having a constant density would result in a building structure which would be insufficient in providing the technical and physical properties required by current standards in matter of energy, structural and seismic audits for buildings. A structure made of particularly light-weight (low-density) structural elements may have good self-supporting and thermal-insulating properties,
20 however, it may be shown to be structurally unstable or unable to simultaneously ensure an appropriate acoustic insulation, thereby requiring additional operations which increase the technical complexity and, therefore, to the ultimate cost.

On the other hand, a structure made of particularly heavy (high-density) structural elements may provide a good structural stability and acoustic insulation, however, it
25 may not ensure a good thermal insulation and good performance against seismic stresses, and moreover, it would not be able to sustain its own weight, thereby suppressing the self-supporting and in-situ easy-to-handle properties of its constituent elements. Additionally, a high-density structural system, i.e. an assembly of interconnected high-density structural elements, would be difficult to be processed
30 when in use. For example, it is important to ensure the processability of an inner wall in order to allow for the passage of cables and tubes therethrough, as well as to allow

the end user to perform simple operations such as the insertion of nails, anchor bolts, etc. while preventing the wall from breaking or cracking due to its surface brittleness. On the contrary, a structural element having a variable density allows for the production of structural systems (structural buildings) characterized by the presence
5 of higher-density areas which provide an increased structural and acoustic response, and lower-density areas which provide an increased thermal response as well as a reduced weight and enhanced in-situ processability for the finished building structure.

Since these advantages are provided by the individual structural element according to
10 the present invention, and since these characteristics are reflected in the finished building structure (structural system), the latter exhibits a considerable processing uniformity and, therefore, an enhanced response to mechanical, thermal and acoustic stresses.

According to a first possible embodiment, the density gradient (variation) is obtained
15 by forming the structural element with multiple layers having densities different from each other and, preferably, with an insulating material interposed between the layers. In this way, it is possible to establish a density gradient of the structural element substantially in the direction along which the various layers are coupled and preferably constrained to each other, as will be seen below. According to a first case,
20 the structural element comprises at least two and preferably three layers.

In the case of a two-layer construction, the structural element comprises a first layer preferably made of lightweight cement and a second layer preferably made of a brick mixture.

In the preferred case of a three-layer construction, the structural element comprises a
25 first layer made of brick mixtures, a second layer made of a lightweight cement, and either a third layer made of the same material as the first layer or a layer comprising a stone-based material; according to a preferred aspect, the second layer is interposed between the first and third layers.

The layer made of brick materials, typically having a high concentration of mixed
30 recomposed - i.e. recycled - lightweight materials, provides a good acoustic isolation to the finished structure and ensures that it can be processed as indicated above.

Additionally, the layer thus formed can be easily treated with paints or other surface finishes. These properties make the afore said layer particularly suitable to form the face of the wall facing towards the internal environment of a building.

5 The layer of cement performs the load-bearing structural function of the modular structural element. This layer is typically made of a lightweight cement derived from screening and recycling processes; preferably, the mixture contains plastic components (or derivatives of rubber or other naturally occurring materials) adapted to provide both good elastic/ bending characteristics to the finished structure and environmentally-friendly recycling capabilities for the material.

10 The layer comprising the stone-based material is intended to form the external envelope of the building structure, and it is preferably made of recomposed calcareous stone.

Alternatively, the structural element according to the present invention can be formed with a body having a preferably continuous variable density. Such a "body"
15 can be made of either a single material or a mixture of several materials. The term "variable density" is intended to mean that such a single material or mixture of several materials has at least two different density values as measured along a reference direction.

As will be apparent below, in contrast to the embodiment involving multiple layers,
20 the structural element according to the present embodiment substantially comprises a single body having a variable density and made of either a material or a mixture of materials which are aggregated so as to form such a body.

As anticipated, the density gradient is preferably, but not necessarily, substantially continuous along the reference direction.

25 In other words, in this embodiment, the density gradient (variation) along at least one direction of the structural element is determined by the density variation occurring within the body constituting the structural element. Such a structural element can be obtained, for example, by employing a three-dimensional sand-printer, i.e. a process in which materials having different densities are laid down by stratified deposition.

30 According to one aspect of the present invention, the structural element may comprise guide means for the connection with at least one second modular structural

element. These means allow the second structural element to slide with respect to the first structural element until the constraining means are engaged with each other.

According to a further aspect of the present invention, the mechanical constraining means for the dry-connection of two or more structural elements to each other include shape couplings,
5 such as male-female couplings.

The structural element may further comprise supporting means, preferably comprising elongated metal elements, which are at least partially arranged within the modular structural element.

If such supporting means are present, it is advantageous to connect them to the mechanical
10 constraining means which allow two or more structural elements to be dry-connected to each other.

The supporting means improve the mechanical behavior of the structure, especially against seismic stresses.

According to one aspect of the present invention, the mechanical constraining means are
15 different from each other. In other words, one structural element can have multiple types of constraining elements.

According to a further aspect of the present invention, the structural element comprises damping means adapted to absorb any load applied to the more brittle or less tough layers (or areas) of the structural element. Such damping means are preferably incorporated in the guide
20 means, however, it is not excluded that damping means can also be formed as independent elements.

According to another aspect of the present invention, there is provided a modular, self-supporting structural element for house building construction, provided with mechanical
25 constraining means for a mutual dry connection with at least one second modular structural element, said modular structural element having a variable density along at least one reference direction, wherein the structural element is provided with supporting means passing through said structural element, the supporting means comprising elongated elements arranged within relevant channels formed in the structural element, wherein said supporting means are connected to the constraining means.

The present invention also relates to a process for the manufacture of a building structure.

BRIEF DESCRIPTION OF THE FIGURES

Further characteristics and advantages of the present invention will be more evident in the following description, for illustrative and not limitative purposes referring to the attached
5 figures, wherein:

- Figure 1 is an exploded axonometric view of a first embodiment of a structural element according to the present invention;
- Figure 2 is an axonometric view of the device of Figure 1;
- Figure 3 is an axonometric view of a structure formed by combining the elements of
10 Figure 1;
- Figure 4 is an axonometric view of a second embodiment of a structural element according to the present invention.

DETAILED DESCRIPTION

With reference to the Figures, a modular structural building element 1, 10 having self-
15 supporting characteristics is provided with mechanical constraining means 2, 3 for the dry connection with at least one second modular structural element similar in shape. As anticipated, the structural element 1, 10 has a variable density along at least one reference direction.

As already said, the reference direction along which the structural element has a variable
20 density preferably coincides with a direction of extension of the structural element, and particularly, the reference direction can be oriented according to a main direction of the structural element. In the embodiments described herein, the direction along which the structural element has a variable density is oriented according to the main direction which identifies the thickness; such a direction is indicated by a straight line 4 in the axonometric
25 views of Figures 1 and 4.

The approach used to achieve such a density gradient is the aspect differentiating the two embodiments shown in Figures 1 - 3 and Figure 4, respectively.

In the embodiment of Figures 1 - 3, the structural element is formed by coupling at least two layers, and particularly three layers 5, 6, 7, made of materials having different densities. Of course, the number and shape of the layers can be varied according to the needs.

As will be better seen below, the layers constituting the structural element define parts of the
5 element having different densities along a certain direction. Preferably, such a direction of variable density coincides with the direction along which the various layers are coupled to each other. In the embodiment illustrated in the Figures, such a direction coincides with the thickness of the structural element, as identified by the straight line 4. Along this direction, as
10 can be seen from the accompanying Figures, the layers 5, 6, 7 constituting the structural element are placed sequentially.

In the embodiment of Figure 4, the structural element 10 comprises a body having a variable density, preferably along the thickness of the structural element 10 itself.

As anticipated, such a density variation results from the body being made of either one material having a variable density or a mixture or aggregate of materials having a variable density.

With reference to Figures 1 - 3, the first layer 5 is shaped in such a way as to allow an easy assembling, such as a shape approximated to a parallelepiped, as shown in Figures. As shown, such a configuration is also repeated in the successive layers.

As anticipated above, such a layer is preferably made of brick materials. In the shown embodiment, the first layer 5 is made of mixed recomposed lightweight brick materials.

This layer coincides with the portion of the finished structure 17 facing towards the interior of the building. The composition of the first layer 5 allows both the weight of the structural element 1 to be reduced and the finished structure 17 to be well thermally-insulated.

Furthermore, the low density of the layer 5 allows the structural element to accommodate tubing and wiring of typical installations of a building (water installations, sewage installations, electrical installations, etc.) through the provision of suitable grooves and wireways. Moreover, the composition of the layer 5 allows it to be able to be surface-treated, for example with paints.

The first layer 5 is followed by a second layer 6 of increased density and strength which performs the structural functions of the element 1. Preferably, as in the embodiment shown herein, the layer 6 is made of a lightweight cement derived from screening and recycling processes. As mentioned above, such a mixture preferably comprises plastic components (or rubber derivatives) which can impart good mechanical characteristics, and particularly good elastic/ bending characteristics, to the finished structure.

Preferably, an insulating material 8a is interposed between the first layer 5 and the second layer 6. Preferably, the insulating material 8a is characterized by a minimal elastic property which allows the structural element 1 to be subjected to a compressive force along the mutually contacting faces of the modular structural

element 1 in order to allow reversible fastening means 11 and 12 of the different layers of the modular structural element 1 to be tightened up. The first layer 5 and the insulating material 8a may be provided with complementary coupling teeth 9 in order to enhance a mutual friction therebetween.

5 The third layer 7 can be made in different ways according to the characteristics of the building structure 17 in which the structural element 1 is to be used. For example, if the building structure 17 is an internal wall structure, i.e. if both the faces of the building structure are facing towards the interior of the building comprising the building structure, the composition of the layer 7 will be similar to that of the first
10 layer 5. On the contrary, if the third layer 7 is facing towards the outside of the building, the layer 7 will be made of a stone-based material. In the embodiment shown herein, the third layer 7 is made of recomposed calcareous stone and acts both as a thermally and acoustically insulating material and as an aesthetic finishing and protective element for the external envelope of the building.

15 Also in this case, an insulating material 8b is interposed between the second layer 6 and the third layer 7, and there are also provided respective teeth 9 similar to those previously described. In the embodiments involving the use of multiple layers, such as the embodiment shown herein, these layers are preferably assembled with the use of reversible fastening means.

20 Preferably, such reversible fastening means comprise elongated elements 11, 12 which can be inserted into suitable seats 13a, 13b formed within the layers themselves.

In the embodiment shown herein, metal rods 11 are constrained within channels 13a formed within the second layer 6 so as to protrude therefrom. When the layers 5, 6, 7
25 are to be assembled, the metal rods 11 are inserted into suitable seats 13b formed within the other layers 6, 7 and within the insulating materials 8a and 8b, if any.

The layers 5, 6, 7 are then secured to each other by inserting metal plates 12 through openings 14 into seats 11a formed in the rods 11.

The embodiment of the reversible fastening means 11, 12 as shown herein has been
30 found to be particularly effective, although the use of different mechanical means adapted to assemble the layers 5, 6, 7 is not excluded.

Since the layers 5, 6, and 7 are reversibly assembled to each other, for example by the fastening means of the above described type, they can be separated from each other in a relatively simple manner even when the structural element 1 has been assembled.

- 5 In virtue of this feature, for example, it is possible to replace one of the individual layers within a structural element 1, or it is possible to separately recover the materials constituting the layers 5, 6 and 7 at the end of the life cycle of the structural element 1.

This aspect, along with the fact that the layers 5, 6 and 7 comprise a high proportion
10 of recycled materials, allows the environmental impact of the structural element 1 to be significantly reduced.

In Figure 4 there is shown a different embodiment in which the structural element 10 comprises a body made of one or more aggregate materials and having a variable density along its thickness, i.e. along the direction defined by the straight line 4. As
15 anticipated above, this embodiment can be obtained, for example, with the use of a three-dimensional sand-printer. Therefore, the structural element thus obtained is homogeneous in composition while maintaining areas of different densities from each other. In the embodiment shown herein, for example, there are three areas 5a, 6a and 7a which can perform functions similar to those of the layers 5, 6 and 7 in the
20 embodiment of Figures 1 - 3.

It is clear that, since the density of the material of the structural element 10 may vary continuously along the direction defined by the straight line 4, the boundaries between the various areas 5a, 6a and 7a of the body of the structural element 10, as indicated by dotted lines in Figure 4, are only indicative as they cannot be actually
25 well defined. It is understood that the density gradient profile of the structural element 10 can be formed in different ways according to the needs.

In the two embodiments described above, the structural element 1, 10 has a density variation only along one reference direction, and particularly along the thickness thereof, whereas the density gradient along the two other dimensions, i.e. the height
30 and the width, is substantially zero. However, embodiments involving density

gradients at least along another direction, such as the height and/or width of the structural element, for example, are not excluded.

Furthermore, an embodiment of a structural element comprising layers each made of a material (or a mixture of multiple materials) having a variable density is also possible.

Unless otherwise indicated, the aspects disclosed hereinbelow are common for the two embodiments disclosed herein, and generally for the various embodiments of the present invention.

Generally, the structural element 1, 10 has a shape which allows the various modular structural elements 1, 10 to be connected in a simple manner. In the embodiments shown herein, the structural elements 1, 10 have a shape which can be substantially approximated to a parallelepiped.

Obviously, the shape and dimensional features of the structural element according to the present invention can be varied based on the needs, and particularly based on the part of the building structure to be built by constraining multiple structural elements to each other.

According to a possible embodiment, the structural elements 1, 10 have the following dimensions: about 50 cm in thickness, about 40 cm in width, and about 15 cm in height. However, it should be noted that the dimensions of the structural element according to the present invention can be suitably selected and changed - even considerably - compared to those indicated above based on the construction requirements.

As already said, according to one aspect of the present invention, the structural element 1, 10 is provided with constraining means 2, 3 which allow multiple structural elements 1 to be dry-connected to each other, as shown in Figure 3.

Generally, the constraining means 2, 3 comprise mechanical shape couplings, preferably male-female couplings such as those in the embodiment of Figures 1 - 3. Particularly, (male) plates 2, typically metal plates, are adapted to be inserted into (female) plates 3 complementary in shape and also generally made of metal.

Preferably, guide means 15, 16 facilitate the connection of two structural elements 1, 10 with each other. In the embodiments shown herein, the guide means 15, 16

comprise grooves 15 and protrusions 16 having mutually complementary shapes and adapted to slide, i.e. the latter within the former.

According to a particular embodiment, the guide means 16a can at least partially act as damping means, i.e. elements able to absorb any load that may be applied to the
5 more brittle or less resistant layers in the modular structural element 1, 10.

However, alternative embodiments involving the use of damping means which are formed separately from the guide means are also possible. Generally, such damping means are plastic elements.

The constraining means 2, 3, and possibly the corresponding guide means 15, 16, are
10 preferably arranged on all the faces of the structural element which can establish a connection with another structural element; in the embodiments shown herein, there are three female plates 3 and three male plates 2. Similarly, there are three grooves 15 and three protrusions 16.

In the embodiments illustrated in the accompanying Figures, the guide means 15, 16
15 as well as the constraining means 2, 3, which are arranged in pairs along the parallel faces of the structural element 1, 10, respectively, are shown as elements which are substantially identical to each other. However, such elements can also be significantly different from each other, for example due to the different stresses to be adsorbed by the individual components of the modular structural element within the
20 finished building system, as well as the manner in which the structural elements are interconnected to each other.

Generally, the constraining means may vary in number, arrangement and shape depending on the construction requirements.

A structural element 1, 10 according to the present invention can also be provided
25 with supporting means passing through the element itself.

Such supporting means may comprise elongated elements 18, typically metal rods, which are arranged within respective channels 18a formed in the structural element 1, 10, preferably orthogonally to each other.

Preferably, the channels 18a are formed in the portion of the element 1, 10 which
30 performs the load-bearing structural function.

Particularly, in the embodiment of Figures 1 - 3, two metal rods 18 are arranged along two main directions (length and height) of the structural element 1.

If the embodiment of the structural element 1, 10 involves the presence of different layers and the presence of elongated elements 11, the supporting means 18 are also
5 preferably arranged orthogonally to such elongated elements 11.

In the embodiment of Figure 4, supporting means, although not shown, are arranged within the area 6a of the structural element 10 according to a shape and arrangement similar to those of the previous embodiment. According to an advantageous aspect of the present invention, the supporting means 18 may be connected to the constraining
10 means 2, 3. For example, in the embodiments shown herein, the elongated elements 18 have the constraining means 2, 3 at the ends thereof and, therefore, they can be used to couple the constraining means to the structural element 1, 10.

The supporting means 18 allow to form a metal cage in the finished structure 17 which enables the structure 17 to better react to seismic stresses.

15 During the assembling process, in order to build a structure 17 consisting of structural elements 1, 10, an operator assembles several structural elements 1, 10 by engaging the constraining means 2, 3 with each other. Particularly, the operator initially moves two structural elements 1, 10 closer to each other by sliding one structural element over the other while coupling a protrusion 16 to a corresponding
20 groove 15. Once the protrusion 16 has stopped to slide along the groove 15, the male plate 2 is fitted into and locked within the female plate 3.

By repeating this operation with different structural elements 1, 10, it is possible to build a structure 17 having high structural performance and, particularly, exhibiting a steady behavior against seismic stresses.

25 Preferably, the structural elements 1, 10 are connected to each other in the same orientation, in such a way that the finished building structure has a density gradient along at least one direction connecting two opposite faces of the structure, typically the two side faces, preferably in the direction of the thickness.

Particularly, if the structural elements according to the present invention are used for
30 the construction of a wall or a similar building structure, the structural elements are oriented in such a way that the direction along which the structural element exhibits a

density variation substantially corresponds to at least one direction connecting two opposite faces, or two side surfaces, of the wall or building structure.

As anticipated, the connection of the various structural elements 1, 10 is performed in a dry condition. The nature of the structural element allows the structure to be self-
5 bearing even from the early stages of construction, thereby not requiring timbering works, struts, scaffolds or the like.

As a person skilled in the art can readily understand, the system used to interconnect the structural elements 1, 10 is very simple and allows the assembling and in-situ works to be performed very quickly, resulting in a significant reduction of the
10 building site set-up time.

Moreover, the presence of the constraining means 2, 3 and guide means 15, 16 makes the structural elements asymmetrical and therefore not interchangeable, thereby avoiding potential mistakes during the assembling process.

Furthermore, in virtue of these aspects, it is also possible to employ a workforce
15 which is not particularly specialized.

CLAIMS

1. A modular, self-supporting structural element for house building construction, provided with mechanical constraining means for a mutual dry connection with at least one second modular structural element, said modular structural element having a variable density along at least one reference direction, wherein the structural element is provided with supporting means passing through said structural element, the supporting means comprising elongated elements arranged within relevant channels formed in the structural element, wherein said supporting means are connected to the constraining means.
2. The structural element according to claim 1, wherein said reference direction is oriented substantially as the height or the width or the thickness of said structural element.
3. The structural element according to claim 1 or 2, comprising at least two layers having different densities from each other, preferably comprising three layers having different densities from each other.
4. The structural element according to claim 3, wherein at least one insulating material is interposed between said layers.
5. The structural element according to claim 3 or 4, wherein a first layer is made of brick materials, a second layer is made of cement, a third layer is made similarly to the first layer or comprises a stone-based material.
6. The structural element according to any one of claims 3 to 5, wherein said layers can be assembled with the use of reversible fastening means.
7. The structural element according to claim 6, wherein said reversible fastening means comprise elongated supporting elements which can be inserted into respective seats formed in said layers.

8. The structural element according to claim 1, comprising a body having a variable density, said body comprising either a material having a variable density or a mixture having a variable density of two or more materials.
9. The structural element according to any one of claims 1 to 8, wherein said constraining means for the mutual dry connection with at least one second modular structural element comprise shape couplings.
10. The structural element according to any one of claims 1 to 8, wherein said constraining means for the mutual dry connection with at least one second modular structural element comprise male-female couplings.
11. The structural element according to any one of claims 1 to 10, wherein said elongated elements are metal rods.
12. A building structure comprising a plurality of structural elements according to any one of claims 1 to 11 dry-constrained to each other by mechanical constraining means.
13. The building structure according to claim 12, having a variable density along at least one direction connecting two opposite faces of said structure.
14. A process for the construction of a building structure, comprising the step of dry-constraining a plurality of structural elements according to any one of claims 1 to 11 by means of said mechanical constraining means.
15. The process according to claim 14, wherein said structural elements are constrained in the same orientation with each other.

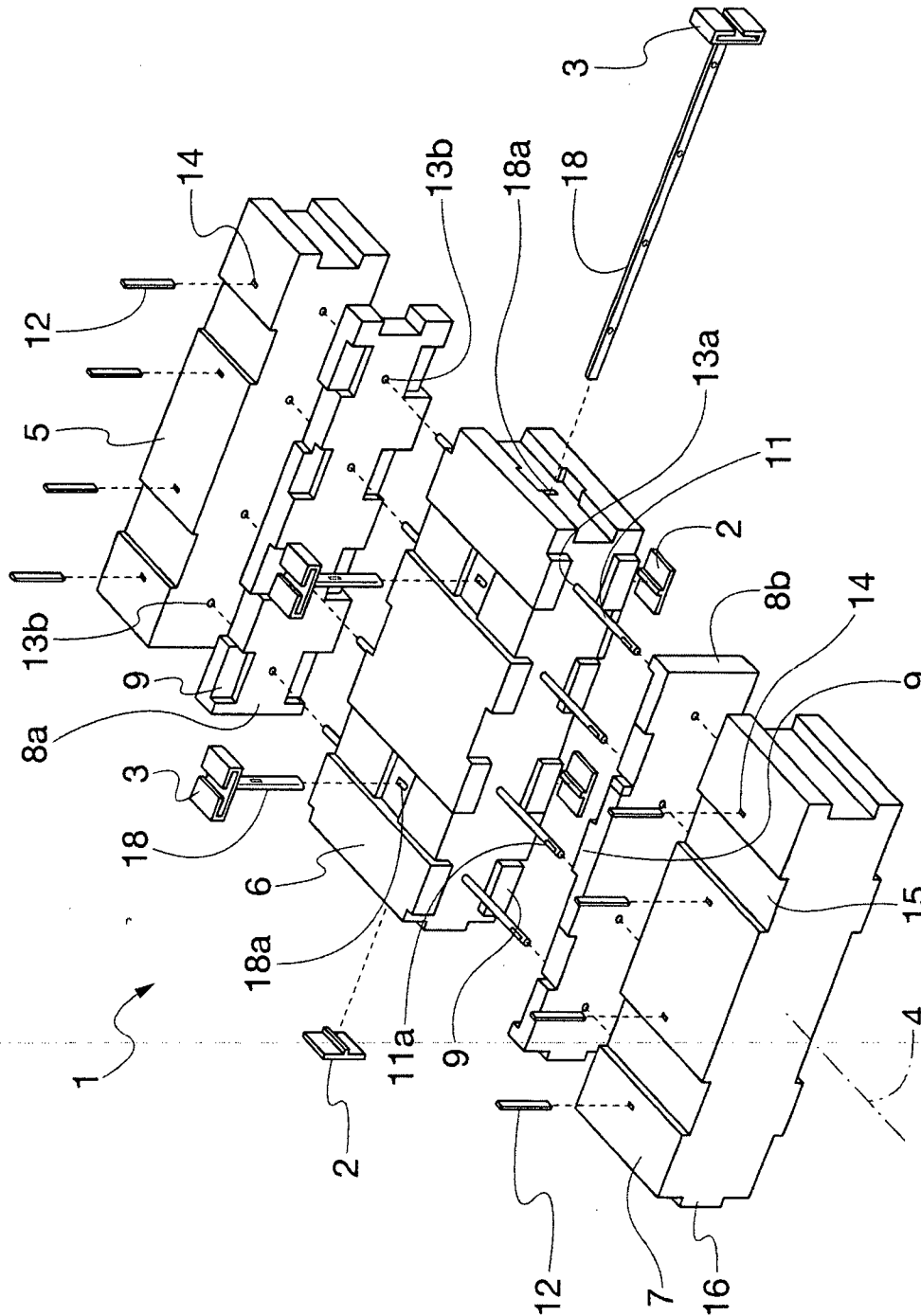


Fig. 1

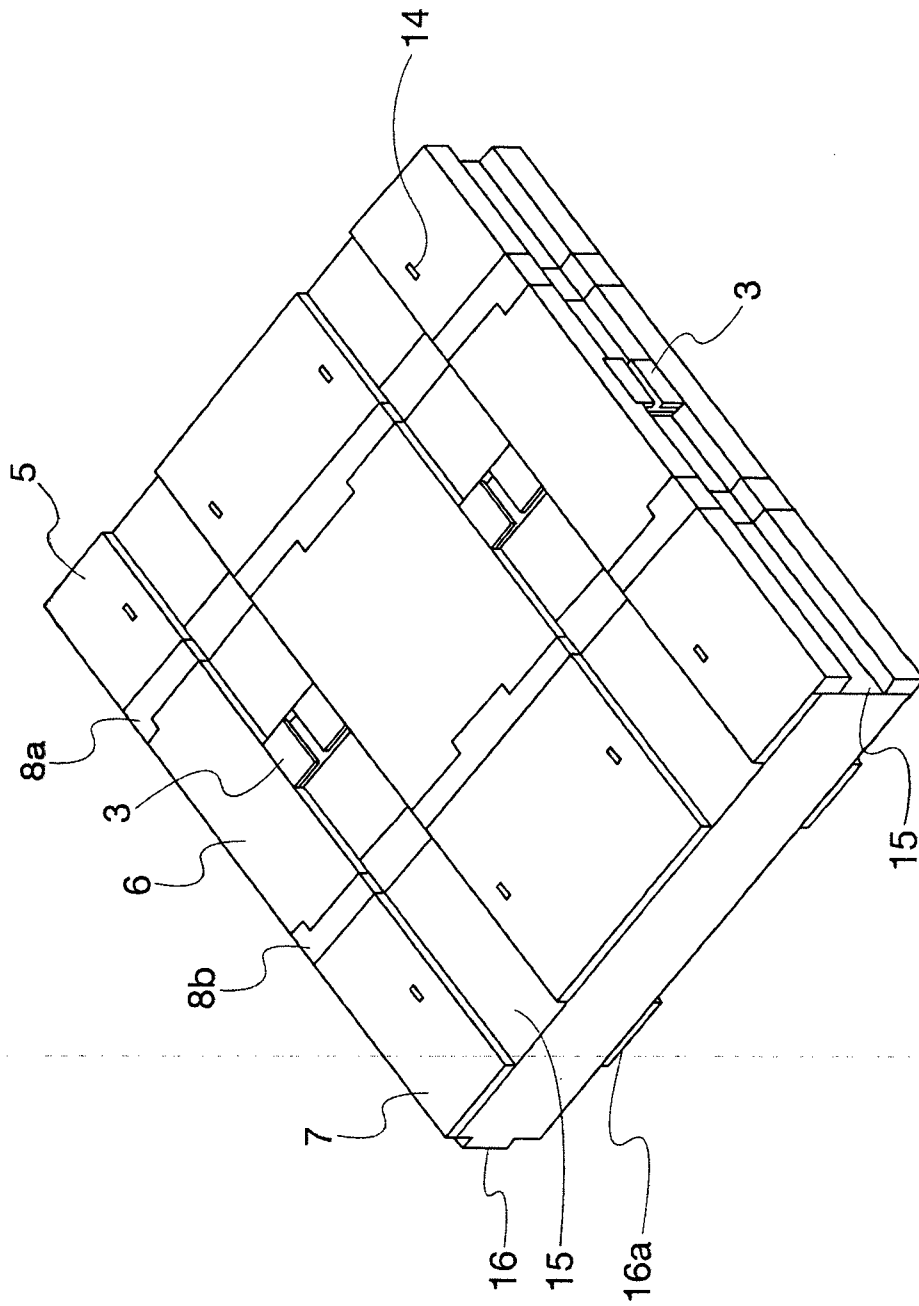


Fig. 2

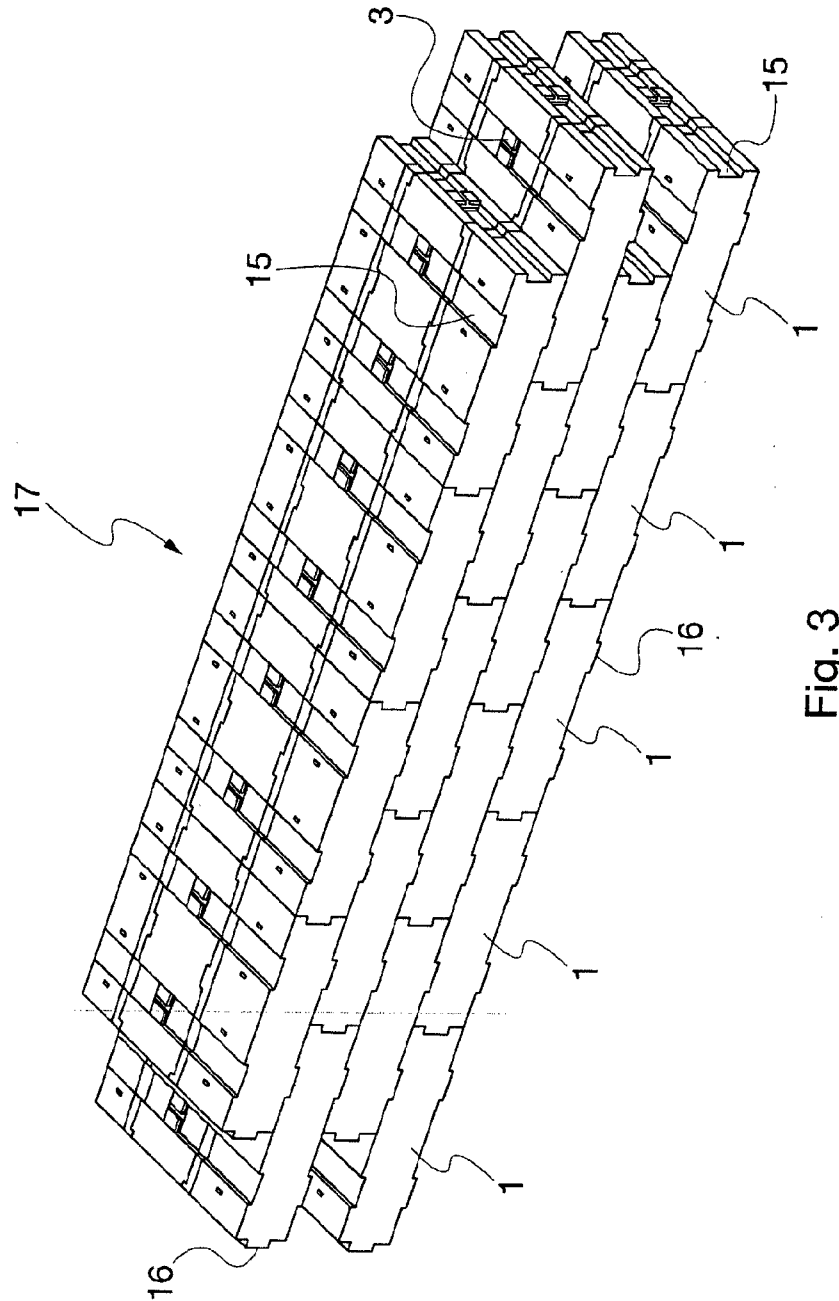


Fig. 3

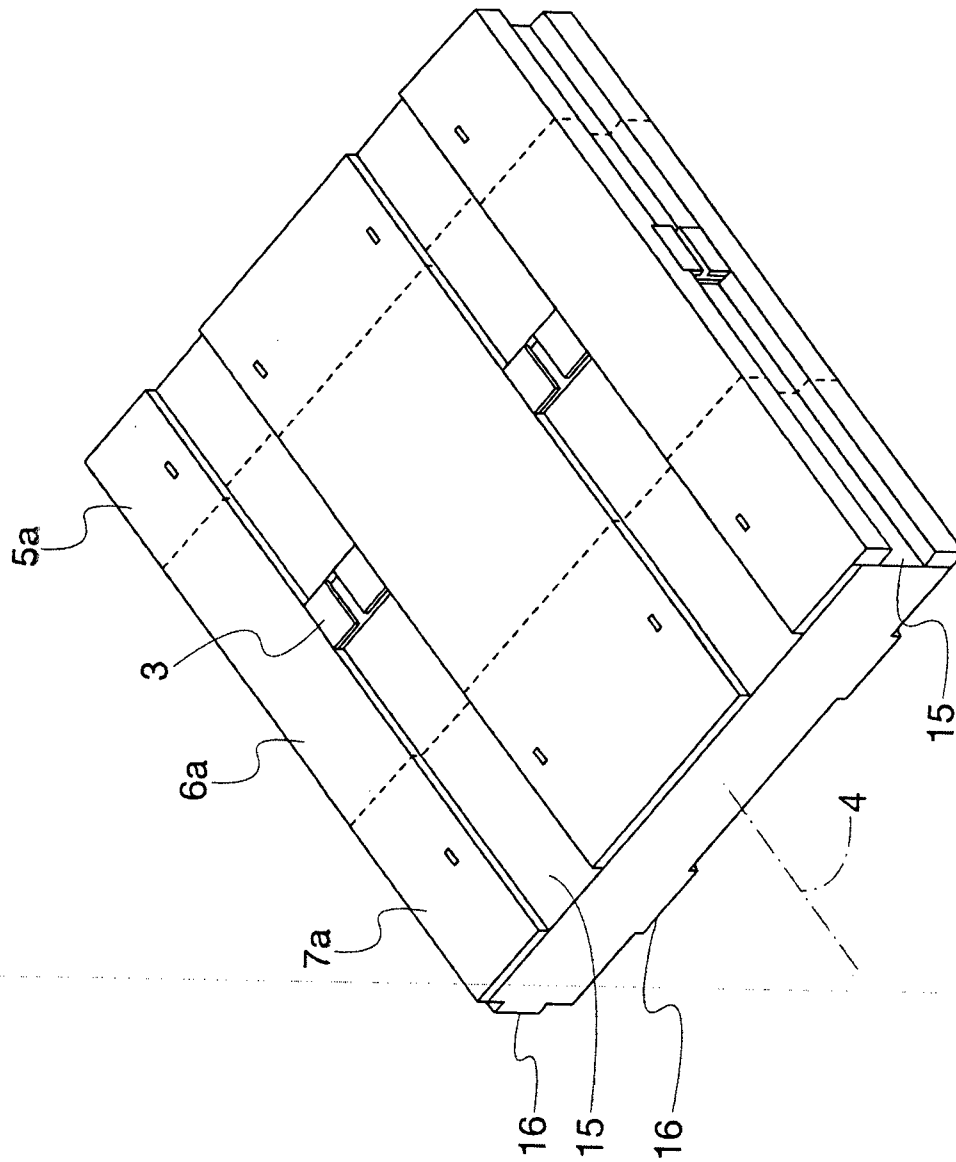


Fig. 4

