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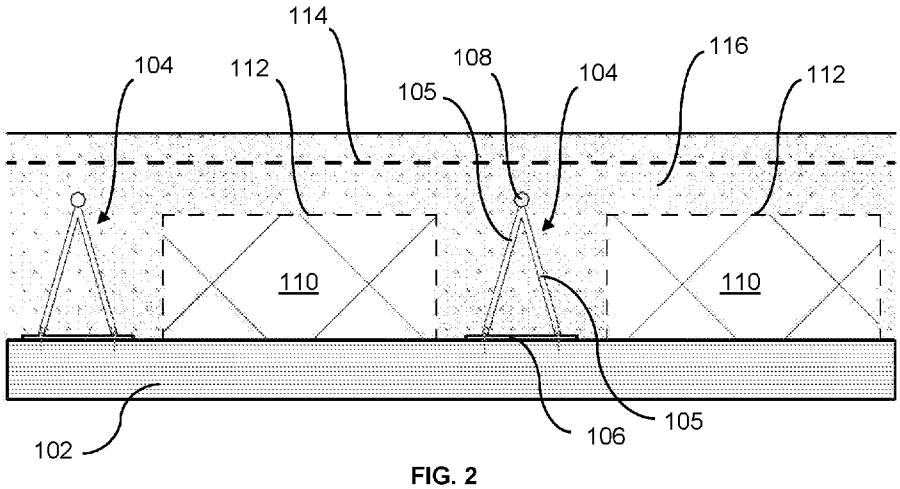


FIG. 2

(57) **Abstract:** In a first aspect there is disclosed building panel (100) for forming a load-bearing structure. The building panel (10) comprises a backing member (102) and a strengthening element (104) mountable to the backing member (102). The building panel (100) further includes a void former (110) mountable to the backing member (102) and disposed adjacent to the strengthening element (104) for forming a void (112) in the structure wherein the backing member (102), the strengthening element (104) and the void former (110) are configured to receive a mixture curable to form the structure.

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# BUILDING PANEL

## Field

[0001] The present invention relates to a building panel for forming a load-bearing structure, and especially for forming a suspended composite floor slab.

[0002] Thus, the invention is particularly designed for use in industrial applications, and it will be convenient to describe the invention herein in this exemplary context. It will be appreciated, however, that the invention is not limited to this particular application but may also be employed in commercial or domestic applications.

## Background

[0003] Suspended floor slabs are typically constructed of concrete, which is poured into shuttering or formwork spanning between temporary or permanent floor supports, such as walls, band beams or columns, to form a concrete floor. This method has the disadvantages, however, that the process of erecting and stripping the shuttering or formwork is time-consuming, labor intensive, high risk from a safety perspective and costly. Furthermore, the span of the concrete floor between the support columns is often limited by the weight of the concrete floor.

## Object

[0004] It is an object of the present invention to substantially overcome, or at least ameliorate, one or more of the above disadvantages.

## Summary

[0005] In a first aspect, the present invention provides a building panel for forming a load-bearing structure, the building panel comprising:

a backing member;

a strengthening element mountable to the backing member; and

a void former mountable to the backing member and disposed adjacent to the strengthening element for forming a void in the structure;

wherein the backing member, the strengthening element, and the void former are configured to receive a mixture curable to form the structure.

[0006] In a preferred form, the mixture is a concrete mixture.

[0007] In a preferred form, the building panel further comprises a reinforcing mesh spaced apart from the strengthening element to provide tensile strength to the structure.

[0008] In a preferred form, the backing member is comprised of a fire-resistant material to substantially protect the structure from fire damage.

[0009] In a preferred form, the backing member is in the form of a timber board having a predetermined thickness, wherein the timber board is configured to char when exposed to a fire hazard thereby substantially protecting the structure from fire damage.

[0010] In a preferred form, the timber board has a predetermined length and width, wherein the void former extends substantially along the entire predetermined length of the timber board and at least along a majority of the predetermined width of the timber board.

[0011] In a preferred form, the strengthening element is in the form of a steel beam having a uniform transverse cross-sectional profile and extending substantially along the entire predetermined length of the timber board.

[0012] In an alternative embodiment, the strengthening element comprises a number of truss elements arranged in a repeating manner along the entire predetermined length of the timber board.

[0013] In a preferred form, the void former is comprised of polystyerene, polyisocyanurate (PIR) foam, rock wool or plastics, or combinations thereof.

[0014] In a second aspect, the present invention provides a building panel for forming a load-bearing structure, the building panel comprising:

a backing member; and

a strengthening element mountable to the backing member such that the strengthening element and the backing member enclose a volume therebetween, wherein the volume defines a void;

wherein the backing member and the strengthening element are configured to receive a mixture curable to form the structure.

[0015] In a preferred form, the mixture is a concrete mixture.

[0016] In a preferred form, the building panel further comprises a reinforcing mesh spaced apart from the strengthening element to provide tensile strength to the structure.

[0017] In an alternative embodiment, the building panel further comprises a reinforcing mesh fixed to or laid on top of the strengthening element to provide tensile strength to the structure.

[0018] In a preferred form, the backing member is comprised of a fire-resistant material to substantially protect the structure from fire damage.

[0019] In a preferred form, the backing member is in the form of a timber board having a predetermined thickness, wherein the timber board is configured to char when exposed to a fire hazard.

[0020] In a preferred form, the timber board has a predetermined length and width, wherein the strengthening element extends substantially along the entire predetermined length of the timber board and at least along a majority of the predetermined width of the timber board.

[0021] In a preferred form, the strengthening element is in the form of a folded steel sheet having a uniform transverse cross-sectional profile and extending substantially along the entire predetermined length of the timber board.

[0022] In a preferred form, the cross-sectional profile of the folded steel sheet is substantially trapezoidal.

[0023] In a third aspect, the present invention provides a composite floor slab comprising:

at least one of the building panels according to any one of the aspects or embodiments of the invention described above; and

a concrete mixture cured over the at least one building panel.

[0024] In a fourth aspect, the present invention provides a method of constructing a suspended composite floor slab comprising:

arranging at least one of the building panels according to either the first or second aspects of the invention described above across floor supports;

pouring a concrete mixture over the at least one building panel; and

curing the concrete mixture to form a concrete structure.

## Brief Description of Drawings

[0025] For a more complete understanding of the present invention, exemplary embodiments of the invention are explained in more detail in the following description with reference to the accompanying drawing figures, in which like reference signs designate like parts and in which:

[0026] FIG. 1 is a perspective view of a building panel according to a first embodiment of the present invention;

[0027] FIG. 2 is a sectional view of the building panel of FIG. 1;

[0028] FIG. 3 is a perspective view of a building panel according to a second embodiment of the present invention;

[0029] FIG. 4 is a sectional view of the building panel of FIG. 3;

[0030] FIG. 5 is a perspective view of a building panel according to a third embodiment of the present invention;

[0031] FIG. 6 is a sectional view of the building panel of FIG. 5;

[0032] FIG. 7 is a perspective view of a building panel according to a fourth embodiment of the present invention;

[0033] FIG. 8 is a sectional view of the building panel of FIG. 7;

[0034] FIG. 9 is a perspective view of a building panel according to a fifth embodiment of the present invention;

[0035] FIG. 10 is a sectional view of the building panel of FIG. 9;

[0036] FIG. 11 is a perspective view of a building panel according to a sixth embodiment of the present invention;

[0037] FIG. 12 is a sectional view of the building panel of FIG. 11;

[0038] FIG. 13 is a perspective view of a building panel according to a seventh embodiment of the present invention; and

[0039] FIG. 14 is a sectional view of the building panel of FIG. 13.

[0040] The accompanying drawings are included to provide a further understanding of the present invention and are incorporated in and constitute a part of this specification. The drawings illustrate particular embodiments of the invention and together with the description serve to explain the principles of the invention. Other embodiments of the invention and many of the attendant advantages of the invention will be readily appreciated as they become better understood with reference to the following detailed description.

[0041] It will be appreciated that common and/or well understood elements that may be useful or necessary in a commercially feasible embodiment are not necessarily depicted in order to facilitate a more abstracted view of the embodiments. The elements of the drawings are not necessarily illustrated to scale relative to each other. It will also be understood that certain actions and/or steps in an embodiment of a method may be described or depicted in a particular order of occurrences while those skilled in the art will understand that such specificity with respect to sequence is not actually required.

## Description of Embodiments

[0042] FIGS. 1 and 2 show a building panel 100 according to a first embodiment. The building panel 100 is suitable for use in forming a load-bearing structure such as a suspended composite floor slab (not shown).

[0043] With particular reference to FIG. 1, the building panel 100 includes a backing member in the form of a timber board 102 having a predetermined thickness preferably in the range of about 60 mm to 100 mm, more preferably about 80 mm. In this way, the timber board 102 is designed to a thickness so that, in the event of a fire hazard, the timber board 102 is allowed to char when exposed to the fire hazard thereby substantially protecting the rest of the structure from fire damage. It can also be envisaged that the timber board 102 is treated or coated with a fire-resistant material or compound for added fire protection. The timber board 102 may be engineered as cross laminated timber (CLT), laminated veneer lumber (LVL), nail-laminated timber (NLT) or glue laminated timber (GLT), although other suitable engineered wood products may be used. The timber board 102 has a predetermined length preferably in the range of about 4m to 12m, more preferably about 9m, and a predetermined width preferably in the range of about 1m to 2.5m, more preferably about 1.2m and 2.4m. It will be appreciated that the length and width of the timber board 102 is determined based on certain design criteria for a particular application.

[0044] The building panel 100 further includes a strengthening element in the form of repeating steel truss elements 104 (only one of the truss elements 104 is labelled in FIG. 1 for clarity) arranged along the entire predetermined length of the timber board 102. Each of the truss elements 104 include a number of web chord elements 105 (shown in FIG. 2) which define a substantially pyramidal arrangement in which the proximal ends of each of the web chord elements 105 which are located at the corners of the pyramidal arrangement are welded to a steel plate 106. The distal ends of each of the web chord elements 105 are welded together to define an apex 107 of the substantially pyramidal arrangement which in turn is welded to a steel bridging chord 108 extending along the entire predetermined length of the timber board 102 parallel with the timber board 102. The steel plate 106 is mounted to the timber board 102 via a composite connection such as with nail fixings (not shown), screw fixings (not shown) or an adhesive. In this way, the truss elements 104 are designed to limit deflection of the timber board 102 and hence the structure when under axial load.

[0045] The building panel 100 further includes a void former 110 mounted to the timber board 102 and disposed adjacent to the truss elements 104 for forming a void 112 (shown in FIG. 2) in the structure. The void former 110 is preferably a block of lightweight material such as polystyrene, polyisocyanurate (PIR) foam, rock wool or plastics, or combinations thereof. The void former 110 is preferably mounted to the timber board 102 via an adhesive or other suitable fixing means. The void former 110 extends substantially along the entire predetermined length of the timber board 102 and at least along a majority of the predetermined width of the timber board 102, that is, the void former 110 occupies more of the width of the timber board 102 than the truss elements 104.

[0046] With particular reference to FIG. 2, the building panel 100 further includes a reinforcing mesh 114, preferably steel or fibreglass mesh, shown spaced apart from the steel bridging chord 108 of the truss elements 104 to provide tensile strength to the structure. Although, it is preferred for the reinforcing mesh 114 to be fixed to or laid on top of the steel bridging chord 108.

[0047] As shown in FIG. 2, the timber board 102, the truss elements 104, the void former 110 and the reinforcing mesh 114 are configured to receive a concrete mixture 116 which is cured to form a concrete structure of the composite floor slab. In this way, the void 112 formed by the void former 110 defines a volume impenetrable by the concrete mixture 116 thereby reducing the volume of concrete mixture required to form the composite floor slab (and hence reducing the total dead weight) whilst still maintaining overall strength of the composite floor slab. The concrete mixture 116 preferably covers the reinforcing mesh 114 to a depth of at least about 65 mm. The thickness of the concrete mixture 116 between the reinforcing mesh 114 and the bridging chord 108 is preferably in the range of about 30 mm to 35 mm. Although it will be appreciated that the depth of the concrete mixture 116 above the reinforcing mesh 114 and the thickness of the concrete mixture 116 between the reinforcing mesh 114 and the bridging chord 108 can be tailored to meet particular design standards for a given application.

[0048] It will be appreciated that more than one arrangement of repeating truss elements 104 and more than one void former 110 may be mounted in an alternating manner on the one timber board 102 per building panel 100 as depicted in FIGS. 1 and 2.

[0049] It will also be appreciated that one or more of the building panels 100 may be entirely pre-fabricated off-site and delivered ready to use on-site.

[0050] FIG. 3 shows a building panel 200 according to a second embodiment. The building panel 200 is similar to that of the building panel 100, but does not include the truss elements 104. Rather, the truss elements 104 are replaced with a steel beam 204. Accordingly, features of the building panel 200 that are identical to those of the building panel 100 are provided with an identical reference numeral. For features that are identical between the building panel 100 and the building panel 200, it will be appreciated that the above description of those features in relation to the building panel 100 is also applicable to the corresponding identical features found in the building panel 200.

[0051] With reference to FIGS. 3 and 4, the steel beam 204 extends substantially along the entire predetermined length of the timber board 102. The steel beam 204 is preferably comprised of cold-formed "C" sections 205 (shown in FIG. 4) which are welded together along their longitudinal length back-to-back to form a uniform transverse cross-sectional profile along the length of the steel beam 204. The steel beam 204 is mounted to the timber board 102 via a composite connection such as with nail fixings (not shown), screw fixings (not shown) or an adhesive between a bottommost surface of the steel beam 204 and the timber board 102. In this way, the steel beam 204 is designed to limit deflection of the timber board 102 and hence the structure when under axial load. The reinforcing mesh 114 is shown spaced apart from the top most surface of the steel beam 204. Although, it is preferred for the reinforcing mesh 114 to be fixed to or laid on top of the top most surface of the steel beam 204.

[0052] As shown in FIG. 4, the timber board 102, the cold-formed "C" sections 205 of the steel beam 204, the void former 110 and the reinforcing mesh 114 are configured to receive the concrete mixture 116 which is cured to form the concrete structure of the composite floor slab. The concrete mixture 116 preferably covers the reinforcing mesh 114 to a depth of at least about 65 mm. The thickness of the concrete mixture 116 between the reinforcing mesh 114 and the top most surface of the steel beam 204 is preferably in the range of about 30 mm to 35 mm. Although it will be appreciated that the depth of the concrete mixture 116 above the reinforcing mesh 114 and the thickness of the concrete mixture 116 between the reinforcing mesh 114 and the top most surface of the steel beam 204 can be tailored to meet particular design standards for a given application.

[0053] It will be appreciated that more than one arrangement of the steel beam 204 and more than one void former 110 may be mounted in an alternating manner on the one timber board 102 per building panel 200.

[0054] It will also be appreciated that one or more of the building panels 200 may be entirely pre-fabricated off-site and delivered ready to use on-site.

[0055] FIGS. 5 and 7 show a building panel 300 and a building panel 400 according to a third and fourth embodiment, respectively. Both the building panel 300 and the building panel 400 are similar to that of the building panel 200, but the steel beam 304 of the building panel 300 and the steel beam 404 of the building panel 400 each have a different transverse cross-sectional profile to that of the steel beam 204 of the building panel 200. In particular, the steel beam 304 of the building panel 300 is comprised of cold-formed "Z" sections 305 which are welded together along their bottommost edges to form a generally "U" shaped uniform transverse cross-sectional profile along the length of the steel beam 304. The steel beam 404 of the building panel 400 is comprised of a cold-formed box section 405 forming a generally box shaped uniform transverse cross-sectional profile along the length of the steel beam 404. Accordingly, features of the building panel 300 and the building panel 400 that are identical to those of the building panel 200 are provided with an identical reference numeral, whereas equivalent features are provided with the same reference numeral to that of the second embodiment, increased by 100 and 200 respectively. For features that are identical/equivalent between the building panel 200 and the building panels 300, 400, it will be appreciated that the above description of those features in relation to the building panel 200 is also applicable to the corresponding identical/equivalent features found in the building panels 300, 400. It will also be appreciated that by virtue of the shape and configuration of the steel beam 404, less volume of the concrete mixture 116 is required to form the concrete structure of the composite floor slab of the building panel 400 compared to the volume of the concrete mixture 116 required for the building panels 100, 200, 300.

[0056] It will also be appreciated that more than one arrangement of the steel beams 304, 404 and more than one void former 110 may be mounted in an alternating manner on the one timber board 102 per building panel 300, 400.

[0057] It will also be appreciated that one or more of the building panels 300, 400 may be entirely pre-fabricated off-site and delivered ready to use on-site.

[0058] FIG. 9 shows a building panel 500 according to a fifth embodiment. The building panel 500 is similar to that of the building panel 100, but does not include the truss elements 104, nor the void former 110. Rather, the building panel 500 includes a strengthening element in the form of a folded steel sheet 504. Accordingly, features of the building panel 500 that are identical to those of the building panel 100 are provided with an identical reference numeral. For features that are identical between the building panel 100 and the building panel 500, it will be appreciated that the above description of those features in relation to the building panel 100 is also applicable to the corresponding identical features found in the building panel 500.

[0059] With reference to FIGS. 9 and 10, the folded steel sheet 504 is mountable to the timber board 102 such that the folded steel sheet 504 and the timber board 102 enclose a volume therebetween so that the volume defines a void 112. The folded steel sheet 504 is comprised of a cold-formed top hat section 505 which is mounted at its bottommost flanges to the timber board 102 via composite connections such as those described above. The folded steel sheet 504 preferably defines a uniform transverse cross-sectional trapezoidal profile and extends substantially along the entire predetermined length of the timber board 102. In this way, the folded steel sheet 504 is designed to limit deflection of the timber board 102 and hence the structure when under axial load whilst simultaneously forming the void 112. The reinforcing mesh 114 is shown spaced apart from the top most surface of the folded steel sheet 504. Although, it is preferred for the reinforcing mesh 114 to be fixed to or laid on top of the top most surface of the steel sheet 504.

[0060] The timber board 102 and the folded steel sheet 504 are configured to receive a concrete mixture 116 which is cured to form a concrete structure of the composite floor slab. In this way, the void 112 formed by the folded steel sheet 504 and the timber board 102 defines a volume impenetrable by the concrete mixture 116 thereby reducing the volume of concrete mixture required to form the composite floor slab (and hence reducing the total dead weight) whilst still maintaining overall strength of the composite floor slab. The concrete mixture 116 preferably covers the reinforcing mesh 114 to a depth of at least about 65 mm. The thickness of the concrete mixture 116 between the reinforcing mesh 114 and the top most surface of the steel sheet 504 is preferably in the range of about 30 mm to 35 mm. Although it will be appreciated

that the depth of the concrete mixture 116 above the reinforcing mesh 114 and the thickness of the concrete mixture 116 between the reinforcing mesh 114 and the top most surface of the steel sheet 504 can be tailored to meet particular design standards for a given application. By this arrangement, the building panel 500 is more cost efficient to fabricate compared to the building panel 100.

[0061] It will be appreciated that more than one arrangement of the folded steel sheet 504 may be mounted in a repeating manner on the one timber board 102 per building panel 500.

[0062] It will also be appreciated that one or more of the building panels 500 may be entirely pre-fabricated off-site and delivered ready to use on-site.

[0063] FIGS. 11 and 12 show a building panel 600 according to a sixth embodiment. The building panel 600 is similar to that of the building panel 500, but the folded steel sheet 604 of the building panel 600 has a different transverse cross-sectional profile. Accordingly, features of the building panel 600 that are identical to those of the building panel 500 are provided with an identical reference numeral. For features that are identical between the building panel 500 and the building panel 600, it will be appreciated that the above description of those features in relation to the building panel 500 is also applicable to the corresponding identical features found in the building panel 600.

[0064] Like the folded steel sheet 504, the folded steel sheet 604 is comprised of a cold-formed top hat section 605 which is mounted at its bottommost flanges to the timber board 102 via composite connections such as screws 601 (shown in FIG. 12) or those described above. These connections / fixings may extend into the concrete mixture to act as shear studs, connecting the concrete mixture 116 to the timber board 102. Differently, however, the top hat section 605 includes a trough portion 606 extending along the length of the folded steel sheet 604 which is configured to receive the concrete mixture 116. A further point of difference is that the reinforcing mesh 114 rests on the uppermost surface of the folded steel sheet 604 as shown in FIG. 12. By this arrangement, the trough portion 606 is configured to receive a portion of the concrete mixture 116 so that the thickness of the concrete mixture 116 between the reinforcing mesh 114 and the bottommost surface of the trough portion 606 is preferably in the range of about 30 mm to 35 mm, although it will be appreciated that this thickness of the concrete mixture 116 can be tailored to meet particular design standards for a given application.

[0065] It will be appreciated that more than one arrangement of the folded steel sheet 604 may be mounted in a repeating manner on the one timber board 102 per building panel 600.

[0066] It will also be appreciated that one or more of the building panels 600 may be entirely pre-fabricated off-site and delivered ready to use on-site.

[0067] FIGS. 13 and 14 show a building panel 700 according to a seventh embodiment. The building panel 700 is suitable for use in forming a load-bearing structure such as a suspended composite floor slab (not shown). The building panel 700 includes a laminated backing member 702 having a plurality of treated or untreated timber lamellas 703 that are adhered to each other. The lamellas 703 can also be dowelled or nailed together.

[0068] The building panel 700 further includes a plurality of strengthening elements in the form of N20 reinforcing bars 704 arranged along the entire predetermined length of the laminated blacking member 702. The N20 reinforcing bars 704 are designed to limit deflection of the backing member 702 and hence the structure when under axial load.

[0069] The building panel 700 further includes a void former 710. The void former is formed by providing that a number of lamellas 706 have a longer width than the other lamellas 703. A cross-member 708 in the form of an 18mm formply panel is secured to two longer lamellas 706 as shown to form a void 712. The void former 710 extends substantially along the entire predetermined length of the backing member 702.

[0070] With particular reference to FIG. 14, the building panel 700 further includes a reinforcing mesh 714, preferably steel or fibreglass mesh, shown spaced apart from the cross-members 708 to provide tensile strength to the structure.

[0071] The backing member 702, strengthening elements 104, void formers 110 and the reinforcing mesh 714 are configured to receive a concrete mixture 716 which is cured to form a concrete structure of the composite floor slab. In this way, the void 712 formed by the void former 710 defines a volume impenetrable by the concrete mixture 716 to reduce the volume of concrete mixture required to form the composite floor slab. To secure the backing member 702 in position a number of dowels 718 spaced along the length of the backing member 702. The

concrete mixture 716 is connected to the backing member 702 by non-illustrated shear studs or steel rods located between the wider lamellas.

[0072] It will be appreciated that more than one arrangement of repeating truss elements 104 and more than one void former 110 may be mounted in an alternating manner on the one timber board 102 per building panel 100 as depicted in FIGS. 1 and 2.

[0073] It will also be appreciated that one or more of the building panels 100 may be entirely pre-fabricated off-site and delivered ready to use on-site.

[0074] A preferred method of constructing a suspended composite floor slab will now be described. The method comprises the initial step of arranging at least one of the building panels 100, 200, 300, 400, 500, 600, 700 to span across temporary or permanent floor supports such as columns, band beams or wall. The building panel 100, 200, 300, 400, 500, 600, 700 may be arranged adjacent to many of the same or different building panels 100, 200, 300, 400, 500, 600, 700 to span a desired area. A concrete mixture is then poured over the one or more building panels 100, 200, 300, 400, 500, 600, 700 and allowed to cure using typical techniques to form a concrete structure.

[0075] Although specific embodiments of the invention are illustrated and described herein, it will be appreciated by those of ordinary skill in the art that a variety of alternative and/or equivalent implementations exist. It should be appreciated that the exemplary embodiment or exemplary embodiments are examples only and are not intended to limit the scope, applicability, or configuration in any way. Rather, the foregoing summary and detailed description will provide those skilled in the art with a convenient road map for implementing at least one exemplary embodiment, it being understood that various changes may be made in the function and arrangement of elements described in an exemplary embodiment without departing from the scope as set forth in the appended claims and their legal equivalents. Generally, this application is intended to cover any adaptations or variations of the specific embodiments discussed herein.

[0076] It will also be appreciated that in this document the terms "comprise", "comprising", "include", "including", "contain", "containing", "have", "having", and any variations thereof, are intended to be understood in an inclusive (i.e. non-exclusive) sense, such that the process, method, device, apparatus or system described herein is not limited to those features or parts or

elements or steps recited but may include other elements, features, parts or steps not expressly listed or inherent to such process, method, article, or apparatus. Furthermore, the terms "a" and "an" used herein are intended to be understood as meaning one or more unless explicitly stated otherwise. Moreover, the terms "first", "second", etc. are used merely as labels, and are not intended to impose numerical requirements on or to establish a certain ranking of importance of their objects.

## Claims

1. A building panel for forming a load-bearing structure, the building panel comprising:

a backing member;

a strengthening element mountable to the backing member; and

a void former mountable to the backing member and disposed adjacent to the strengthening element for forming a void in the structure;

wherein the backing member, the strengthening element, and the void former are configured to receive a mixture curable to form the structure.

2. A building panel according to claim 1, wherein the mixture is a concrete mixture.

3. A building panel according to claim 1, comprising a reinforcing mesh spaced apart from the strengthening element to provide tensile strength to the structure.

4. A building panel according to claim 1, wherein the backing member is comprised of a fire-resistant material to substantially protect the structure from fire damage.

5. A building panel according to claim 4, wherein the backing member is in the form of a timber board having a predetermined thickness, wherein the timber board is configured to char when exposed to a fire hazard thereby substantially protecting the structure from fire damage.

6. A building panel according to claim 5, wherein the timber board has a predetermined length and width, wherein the void former extends substantially along the entire predetermined length of the timber board and at least along a majority of the predetermined width of the timber board.

7. A building panel according to claim 1, wherein the strengthening element is in the form of a steel beam having a uniform transverse cross-sectional profile and extending substantially along the entire predetermined length of the timber board.

8. A building panel according to claim 1, wherein the strengthening element comprises a number of truss elements arranged in a repeating manner along the entire predetermined length of the timber board.

9. A building panel according to claim 1, wherein the void former is comprised of polystyerene, polyisocyanurate (PIR) foam, rock wool or plastics, or combinations thereof.

10. A building panel for forming a load-bearing structure, the building panel comprising:

a backing member; and

a strengthening element mountable to the backing member such that the strengthening element and the backing member enclose a volume therebetween, wherein the volume defines a void;

wherein the backing member and the strengthening element are configured to receive a mixture curable to form the structure.

11. A building panel according to claim 10, wherein the strengthening element is in the form of a folded steel sheet having a uniform transverse cross-sectional profile and extending substantially along the entire predetermined length of the timber board.

12. A building panel according to claim 11, wherein the cross-sectional profile of the folded steel sheet is substantially trapezoidal.

13. A composite floor slab comprising:

at least one building panel according to any one of claims 1 to claim 12; and

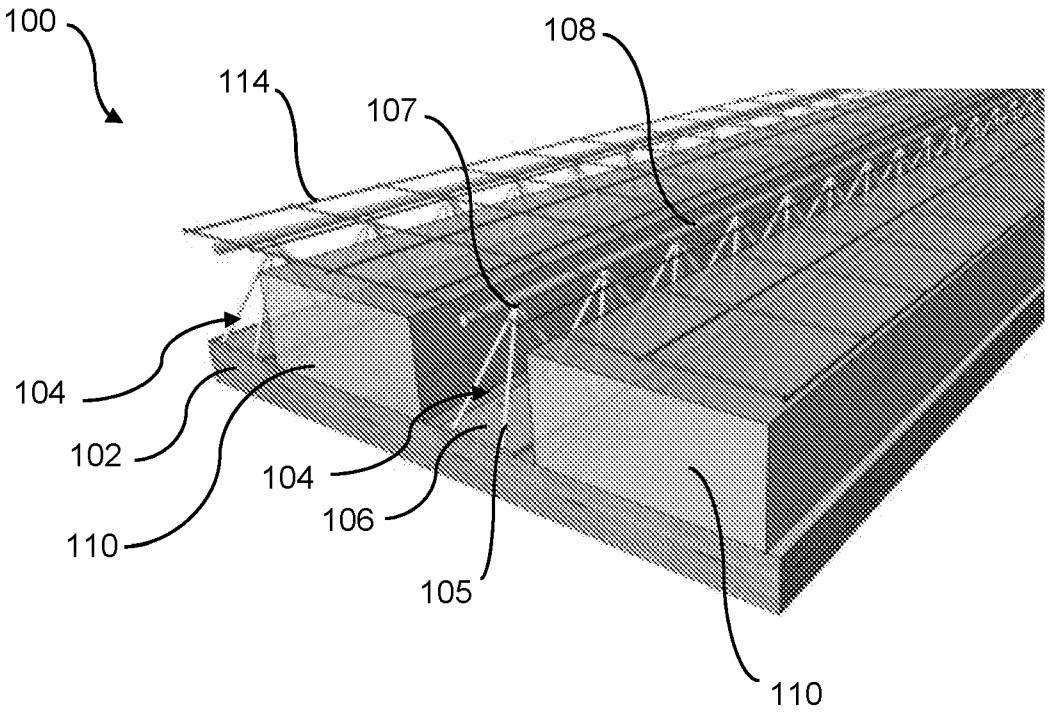
a concrete mixture cured over the at least one building panel.

14. A method of constructing a suspended composite floor slab comprising:

arranging at least one building panel according to any of claims 1 to 12 across floor supports;

pouring a concrete mixture over the at least one building panel; and

curing the concrete mixture to form a concrete structure.


100
114
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110

FIG. 1

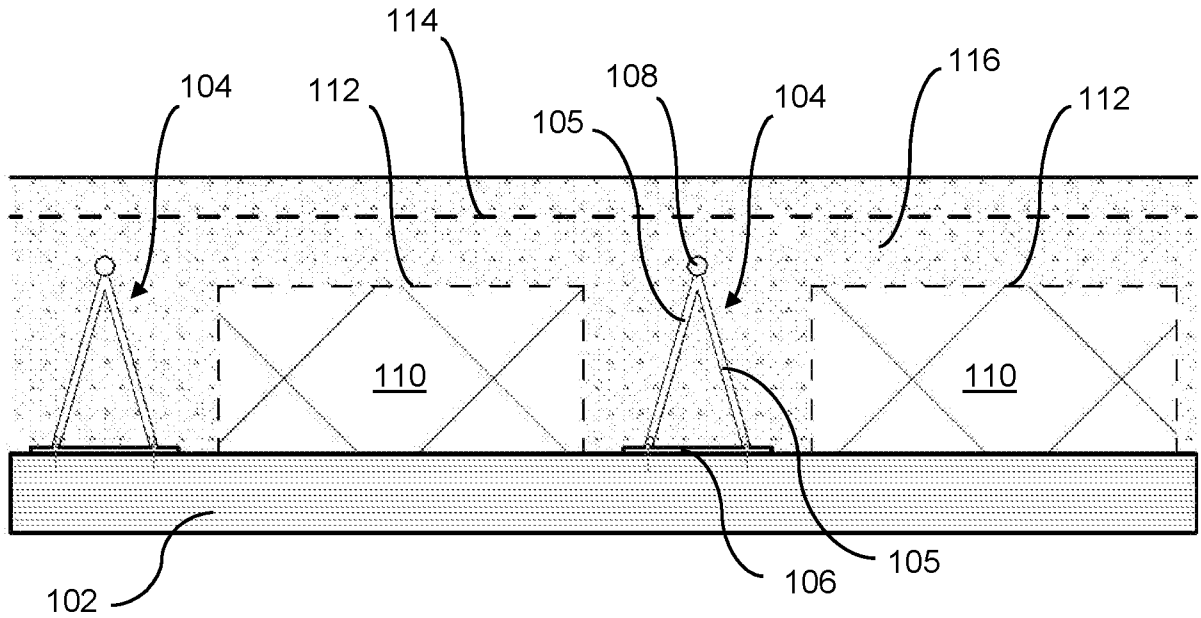
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FIG. 2

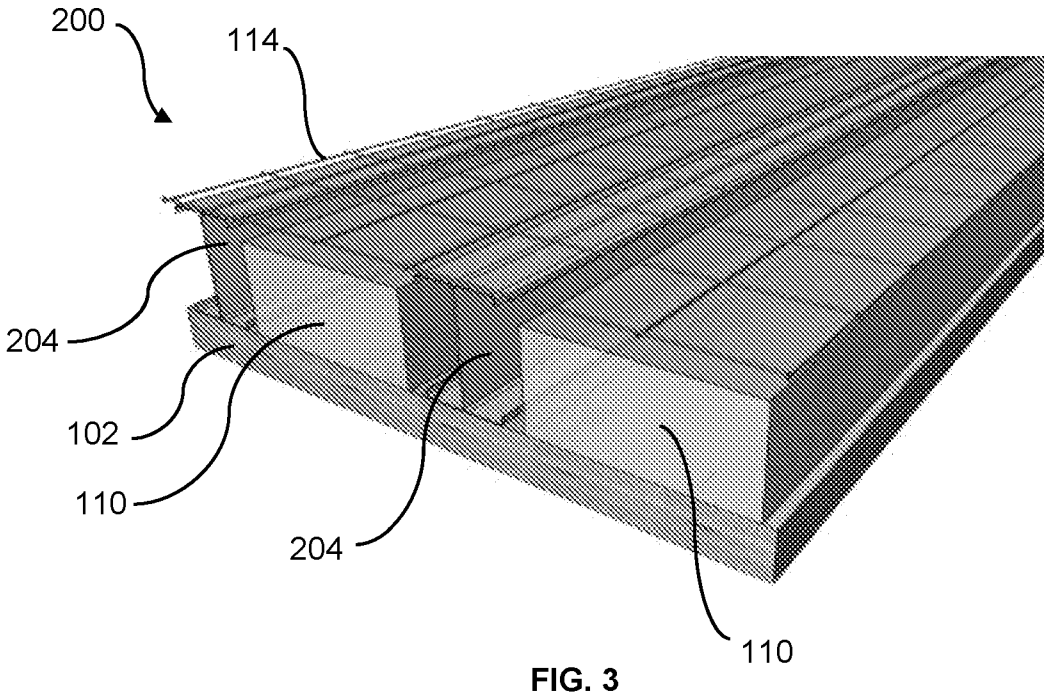
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FIG. 3

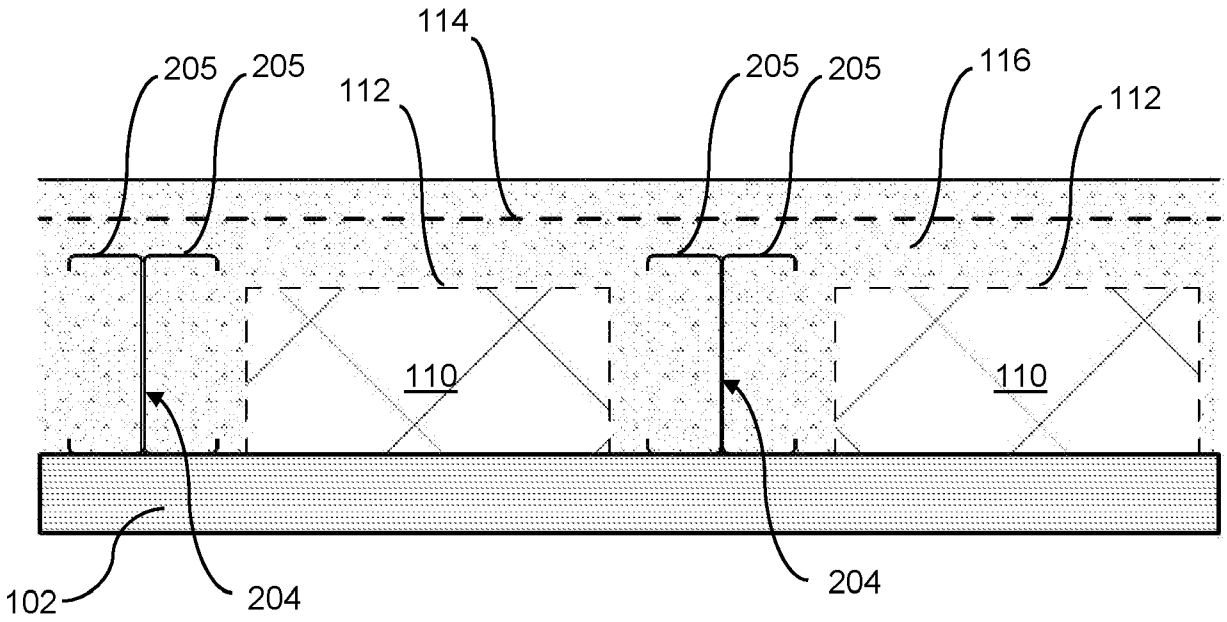
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FIG. 4

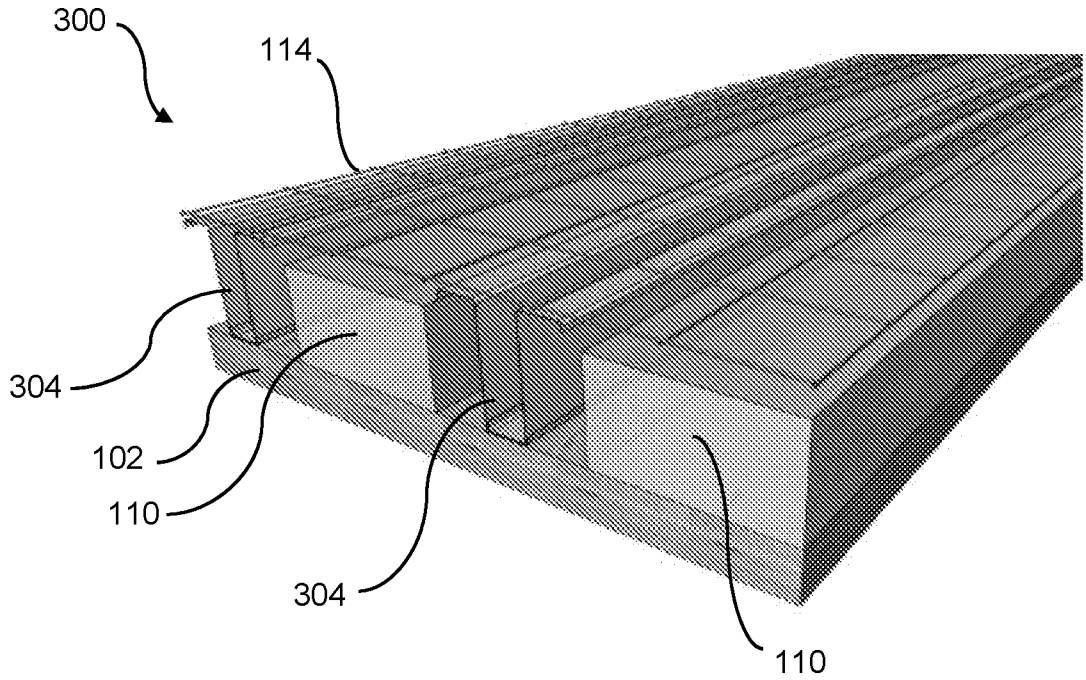
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FIG. 5

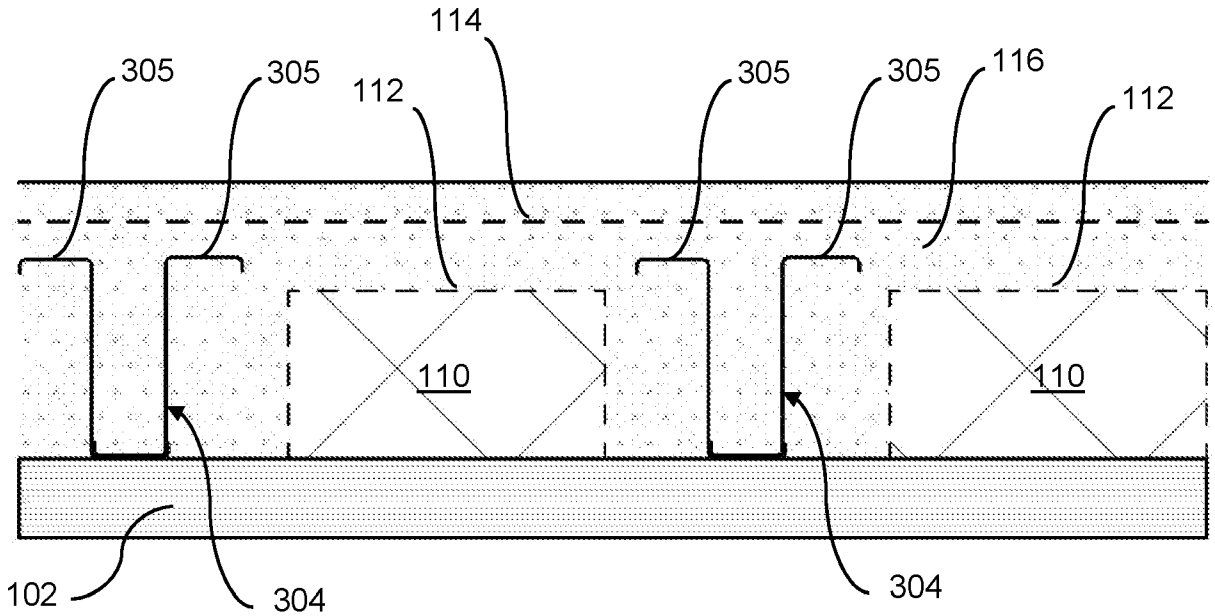
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FIG. 6

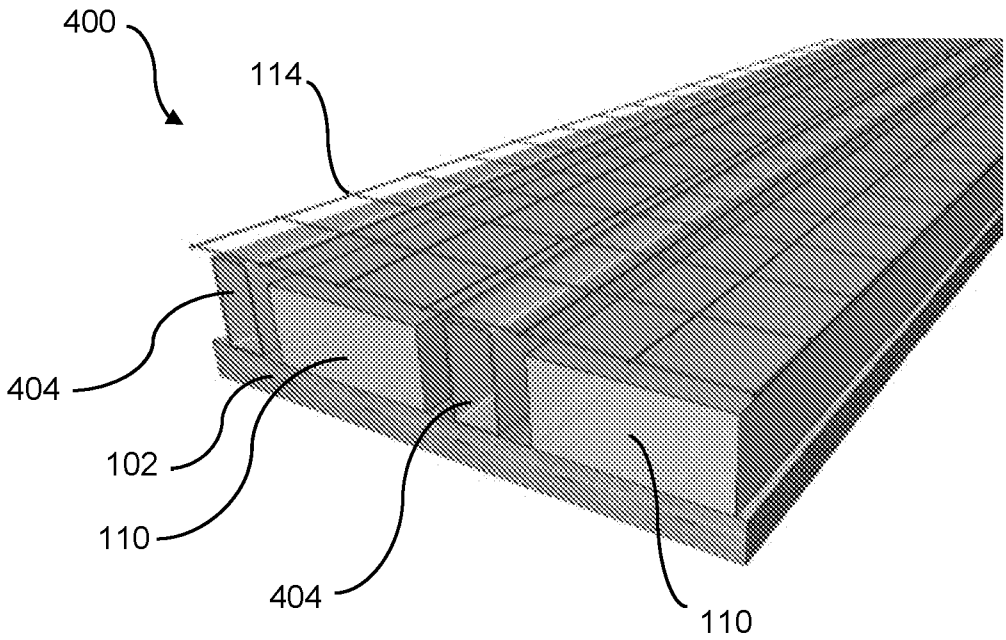
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FIG. 7

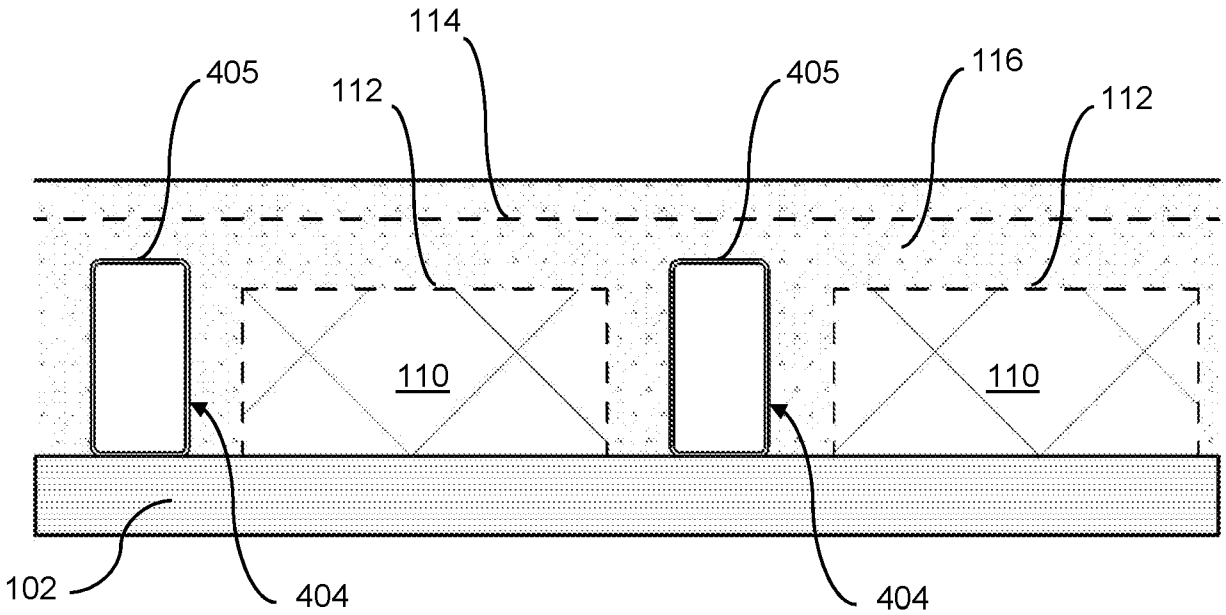
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FIG. 8

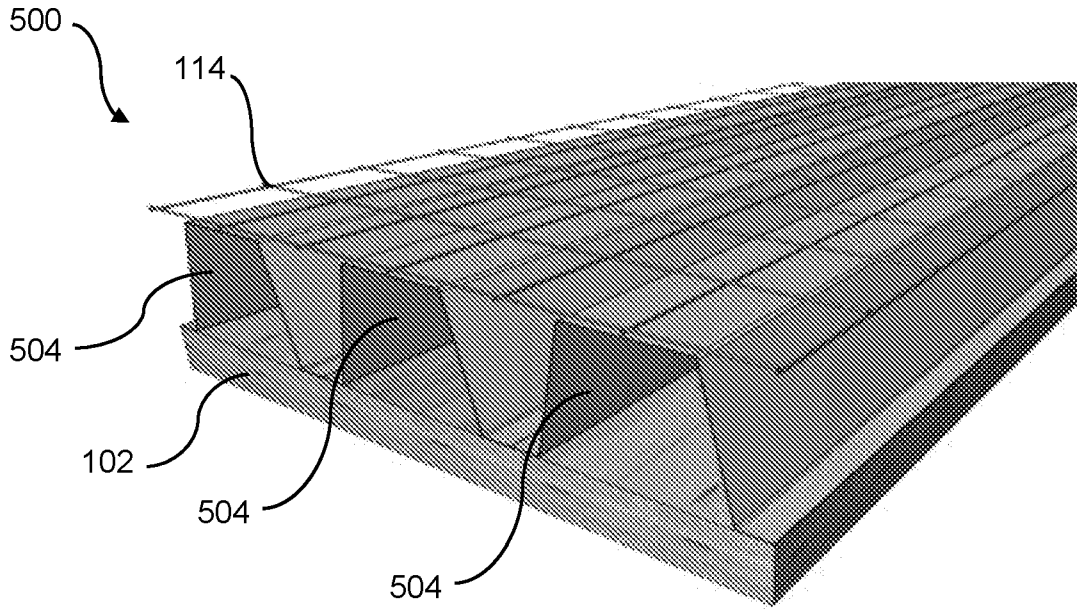
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FIG. 9

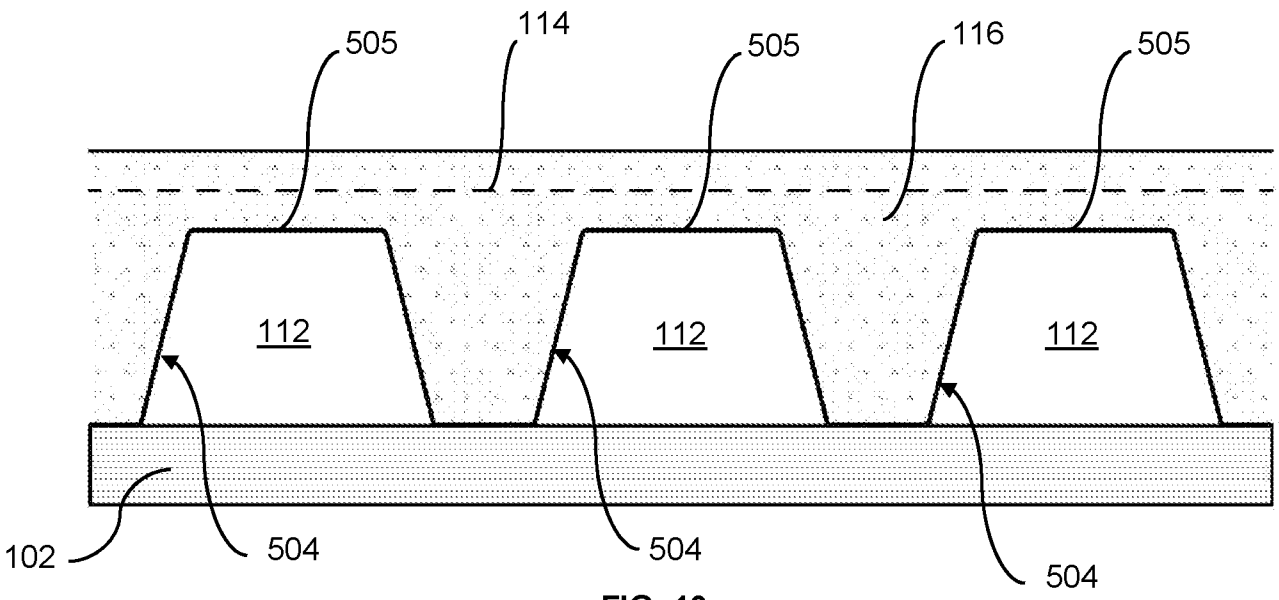
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FIG. 10

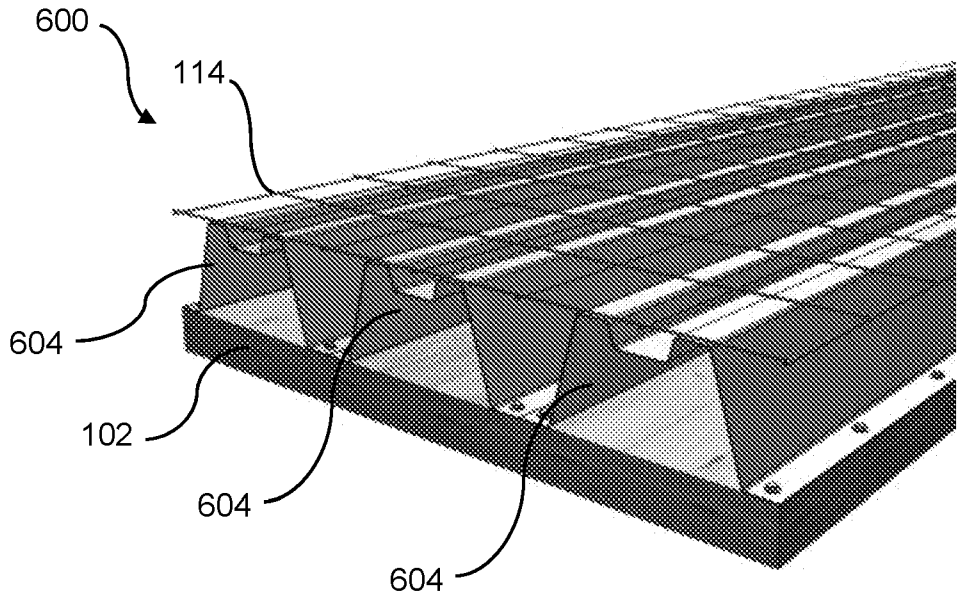
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FIG. 11

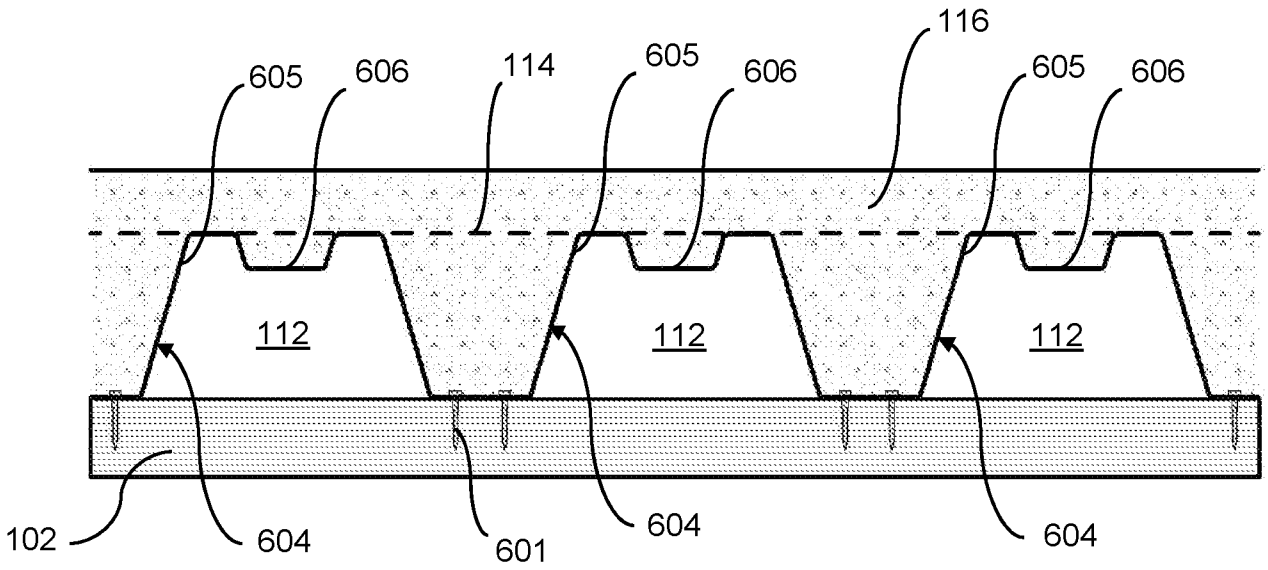
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FIG. 12

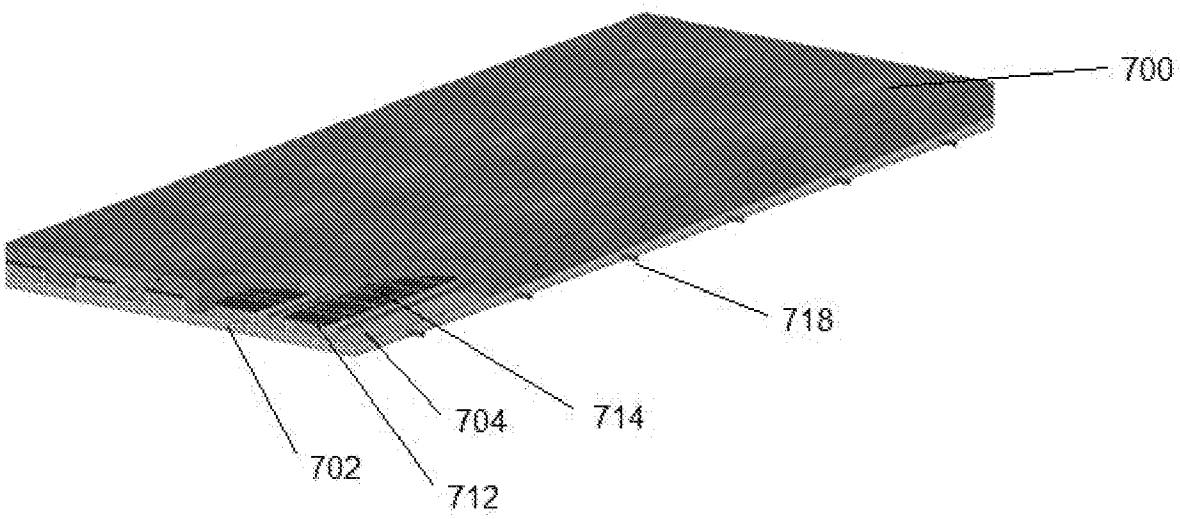
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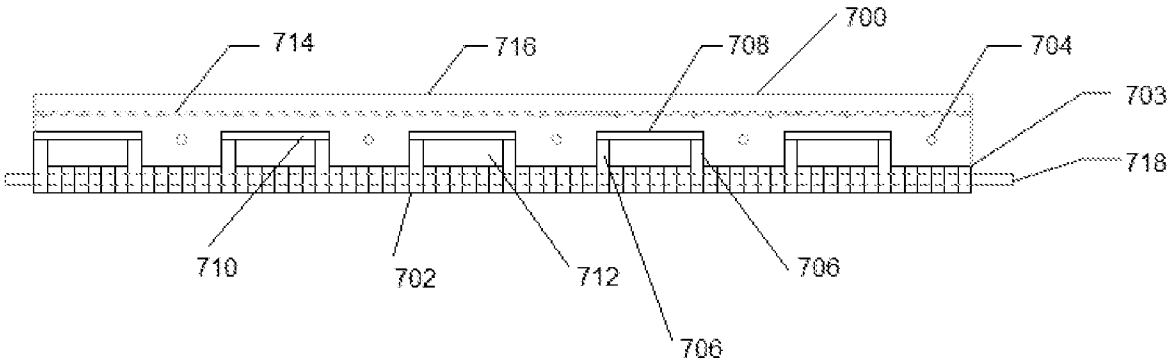
FIG. 13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706

FIG. 14

**INTERNATIONAL SEARCH REPORT**

International application No.
**PCT/AU2019/050969**

A. CLASSIFICATION OF SUBJECT MATTER

***E04B 5/36 (2006.01) E04B 5/40 (2006.01) E04B 1/94 (2006.01)***

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

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

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

PATENW database cluster - CPC: E04B5/36/LOW, E04B5/38/LOW, E04B5/326/LOW, E04B5/043, E04B5/10; IPC, CPC, FI: E04B5/04/LOW, E04B5/06, E04B5/36/LOW; IPC E04B5/48, E04B5/38/LOW; FI: E04B5/38A, E04B5/32B, E04B5/43A. Keywords; void, hollow, cavity, reinforce, rebar, timber, wood, backing, base and similar terms in various combinations.

AUSPAT full text search - IPC: E04B5/38, E04B5/36, E04B5/32, E04B5/48 and keywords hollow or void in various combinations

AUSPAT, espacenet worldwide, IP Australia internal databases; applicant and inventor search

C. DOCUMENTS CONSIDERED TO BE RELEVANT

| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
|---|---|---|
| | Documents are listed in the continuation of Box C | |

[X] Further documents are listed in the continuation of Box C [X] See patent family annex

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"D" document cited by the applicant in the international application

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

| Date of the actual completion of the international search | Date of mailing of the international search report |
|---|---|
| 21 November 2019 | 21 November 2019 |

| **Name and mailing address of the ISA/AU** | **Authorised officer** |
|---|---|
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| INTERNATIONAL SEARCH REPORT<br>C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT | | International application No.<br>PCT/AU2019/050969 |
|---|---|---|
| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
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| X | EP 0617180 A2 (ONDAPLAST S.p.A) 28 September 1994<br>Figures 3 and 4, column 2 line 36 to column 3 line 17 | 1-4, 9, 13, 14 |
| X<br>Y | JP H11-141036 A (ISHII KK) 25 May 1999<br>Figures 3 and 4, paragraphs 0010-0015<br>Figures 3 and 4, paragraphs 0010-0015 | 1-9, 13, 14<br>5-8 |
| X | JP 2000-204706 A (NIPPON KAISER KK et al.) 25 July 2000<br>Figure 1, paragraphs 0021-0023 | 1-4, 9, 13, 14 |
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| Y | GB 884553 A (RHEIN G.M.B.H.) 13 December 1961<br>figure 5, column 3 lines 15 to 37 | 7, 11-12 |
| | WO 2006/097962 A1 (CENCI) 21 September 2006 | |

| INTERNATIONAL SEARCH REPORT<br>C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT | | International application No.<br>**PCT/AU2019/050969** |
|---|---|---|
| Category* | Citation of document, with indication, where appropriate, of the relevant passages | Relevant to claim No. |
| Y | Page 4 lines 11-14, page 18 lines 24-25, abstract | 5-8, 11-12 |
| Y | AU 229875 B (NEUWIRTH) 15 August 1960<br>Figure 2 | 7 |

| INTERNATIONAL SEARCH REPORT<br>Information on patent family members | International application No.<br>**PCT/AU2019/050969** |
|---|---|

This Annex lists known patent family members relating to the patent documents cited in the above-mentioned international search report. The Australian Patent Office is in no way liable for these particulars which are merely given for the purpose of information.

| **Patent Document/s Cited in Search Report** | | **Patent Family Member/s** | |
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Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.

| INTERNATIONAL SEARCH REPORT<br>Information on patent family members | International application No.<br>**PCT/AU2019/050969** |
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| **Patent Document/s Cited in Search Report** | | **Patent Family Member/s** | |
|---|---|---|---|
| **Publication Number** | **Publication Date** | **Publication Number** | **Publication Date** |
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| | | EP 1859109 A1 | 28 Nov 2007 |
| | | IT CO20050010 A1 | 15 Sep 2006 |
| AU 229875 B | 15 August 1960 | None | |

**End of Annex**

Due to data integration issues this family listing may not include 10 digit Australian applications filed since May 2001.