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(54) **BUILDING PANELS**

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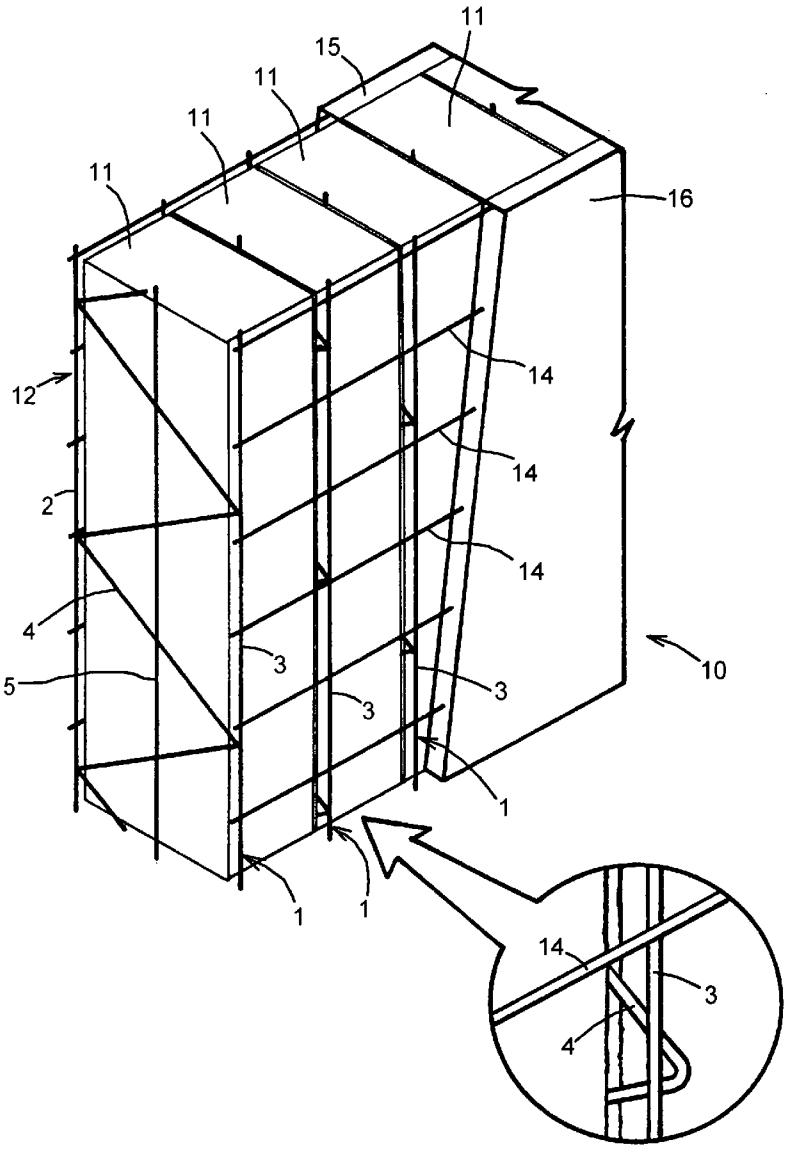
(57) **ABSTRACT**

A building panel incorporates blocks (**11**) of a low density material contained within a surrounding wire support cage (**12**). The cage is formed from a plurality of wire trusses (**1**) which are spaced apart such that each truss separates adjacent low density blocks, and the trusses are held together by strapping wires (**14**) which are encased within layers of render (**15**, **16**) in use. The truss has opposing longitudinally extending reinforcing wires (**2**, **3**) to which the strapping wires (**14**) are connected, and intermediate wires (**4**) which are preferably formed in a zig-zag. Each truss includes at least one additional wire (**5**) which extends longitudinally of the truss.



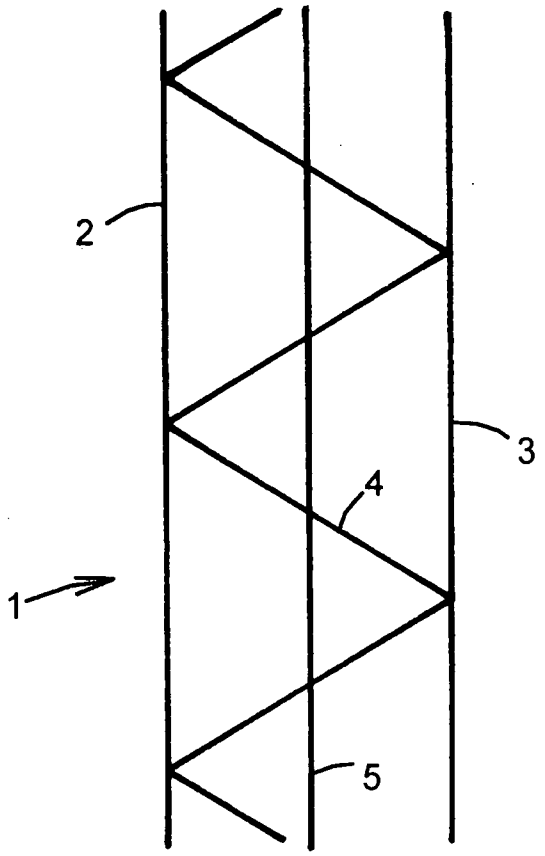


Fig. 1

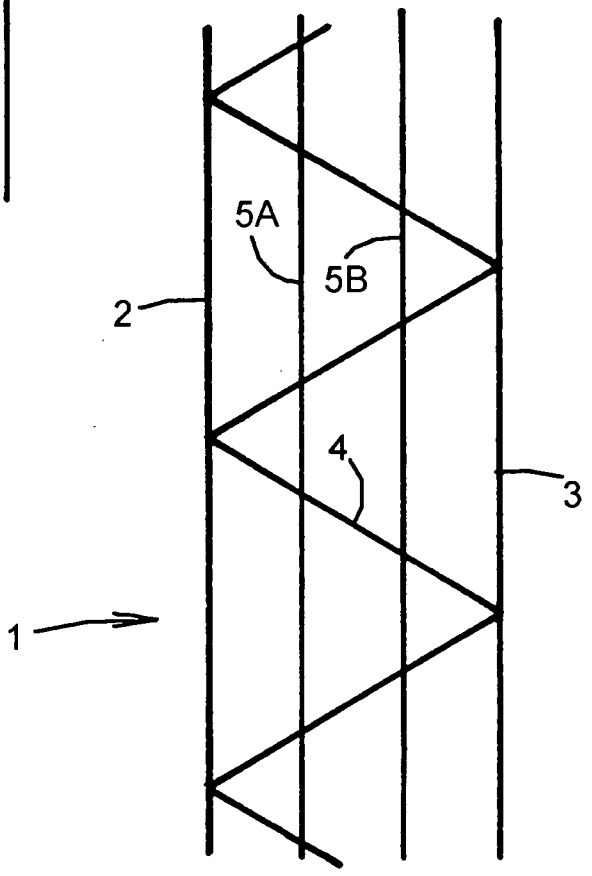


Fig. 3

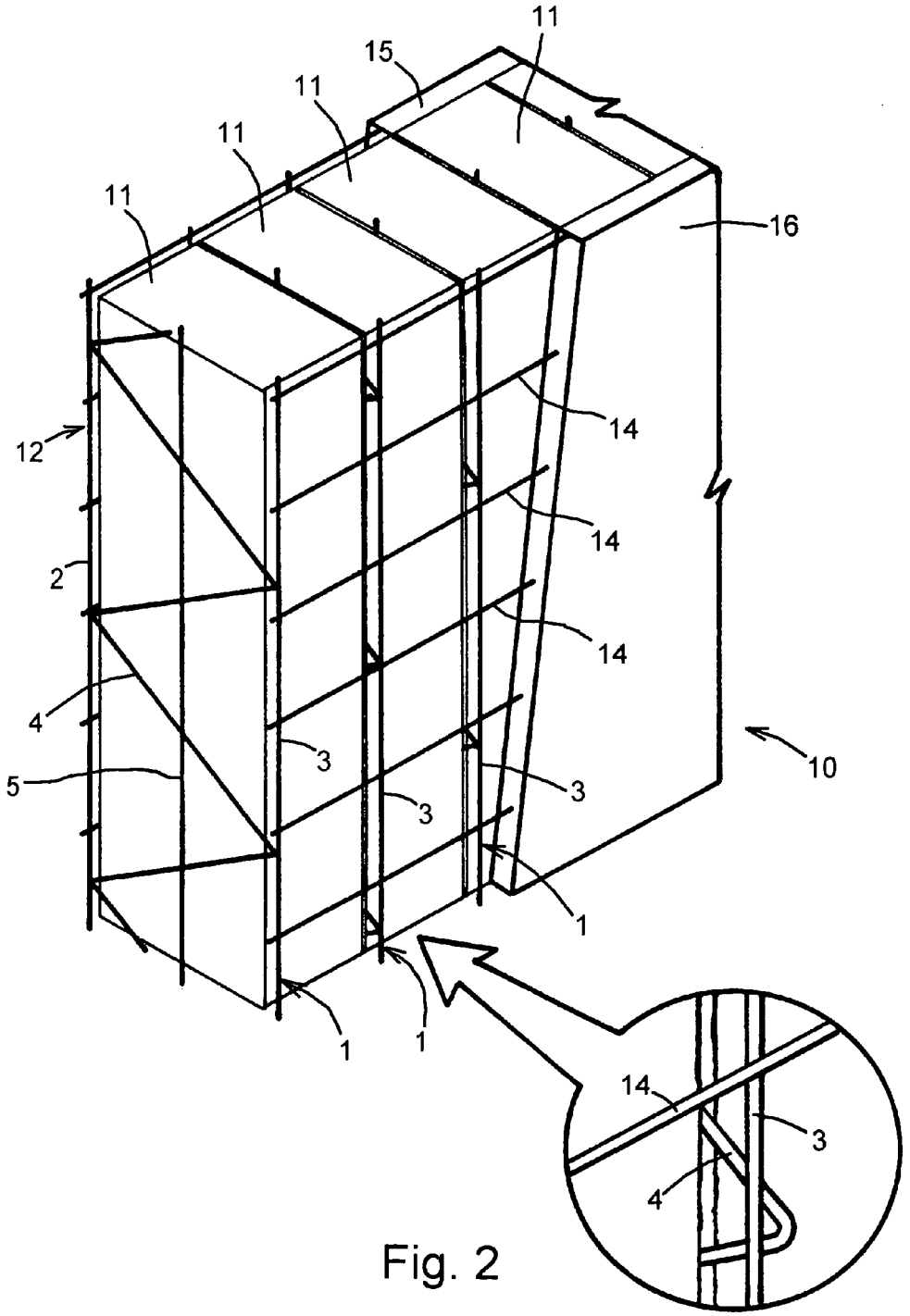


Fig. 2

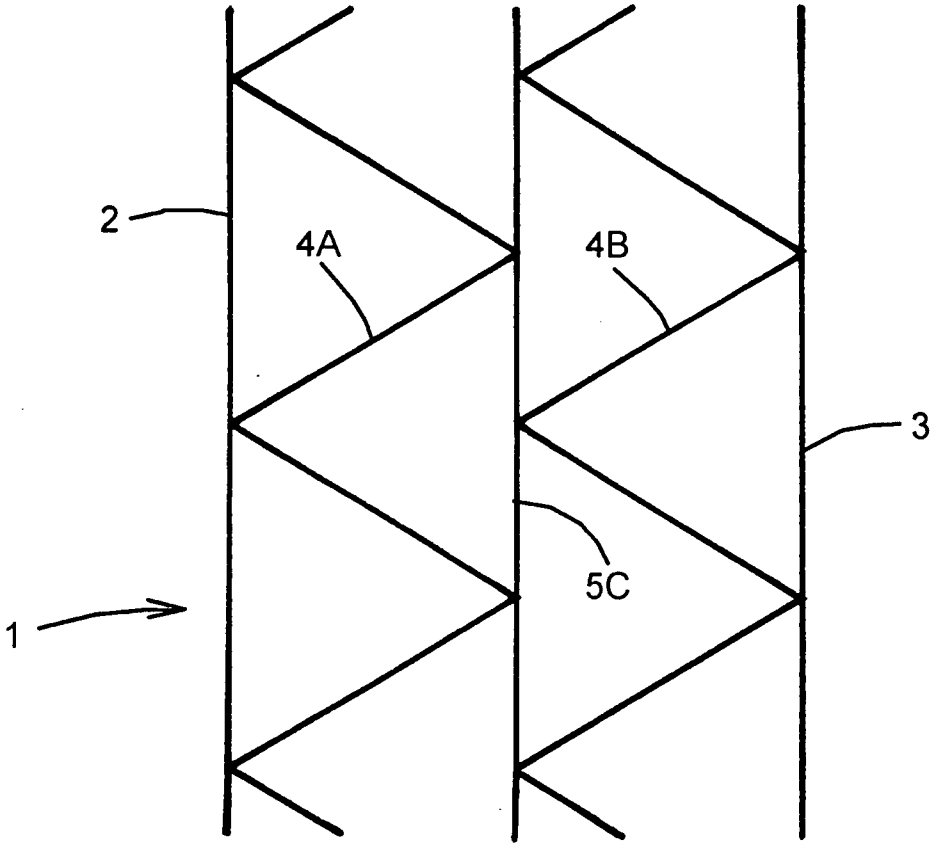


Fig. 4

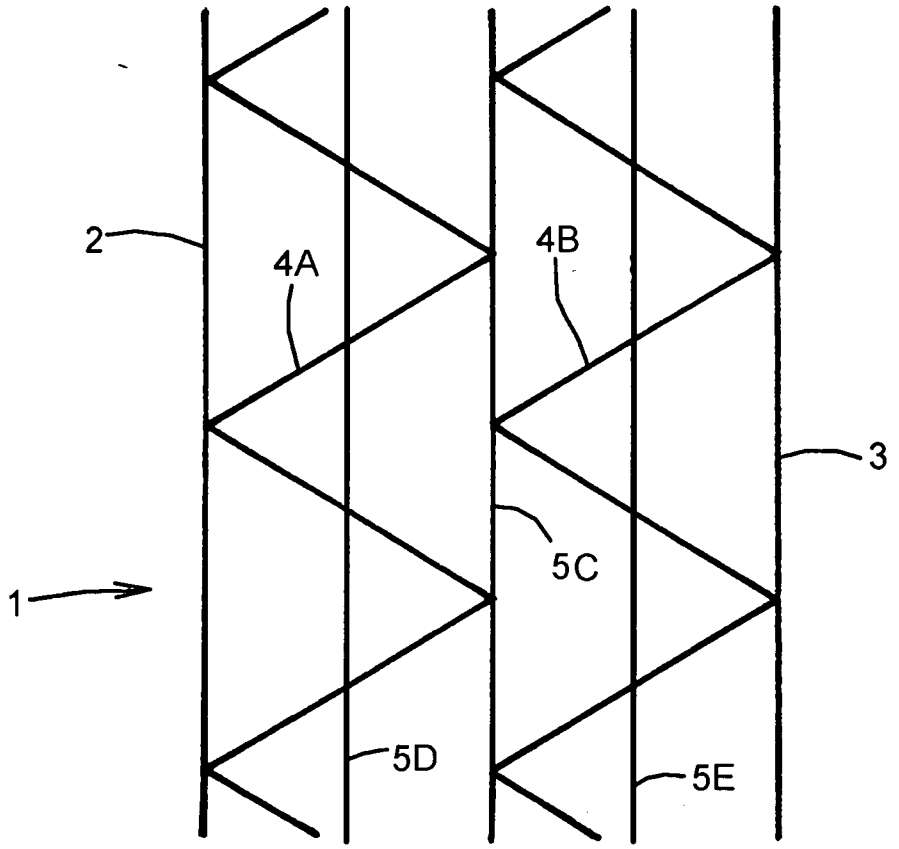


Fig. 5

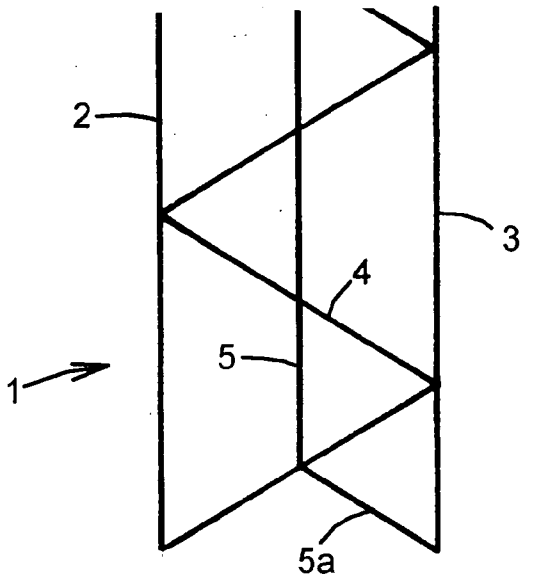


Fig. 6

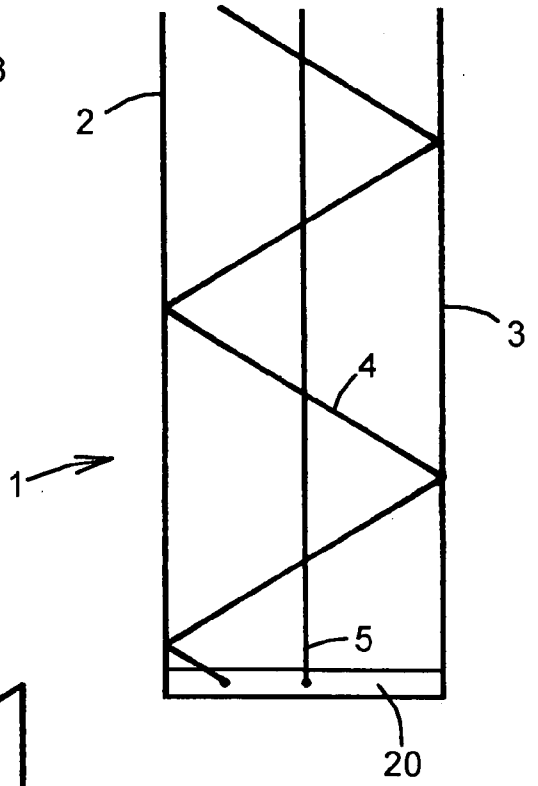


Fig. 7

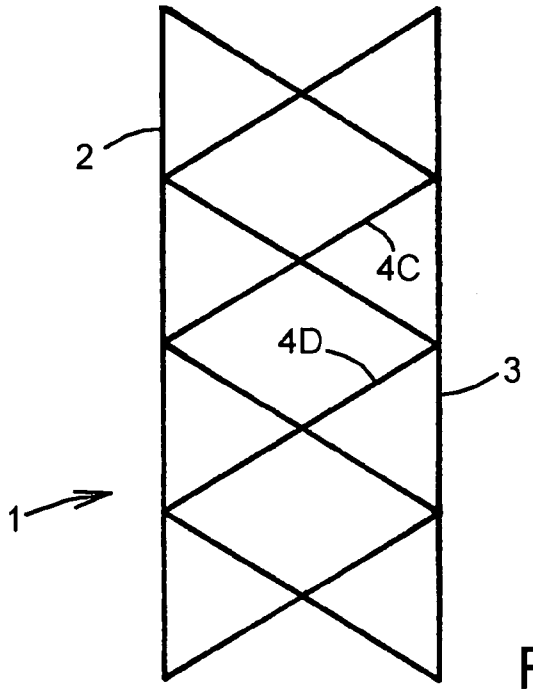


Fig. 8

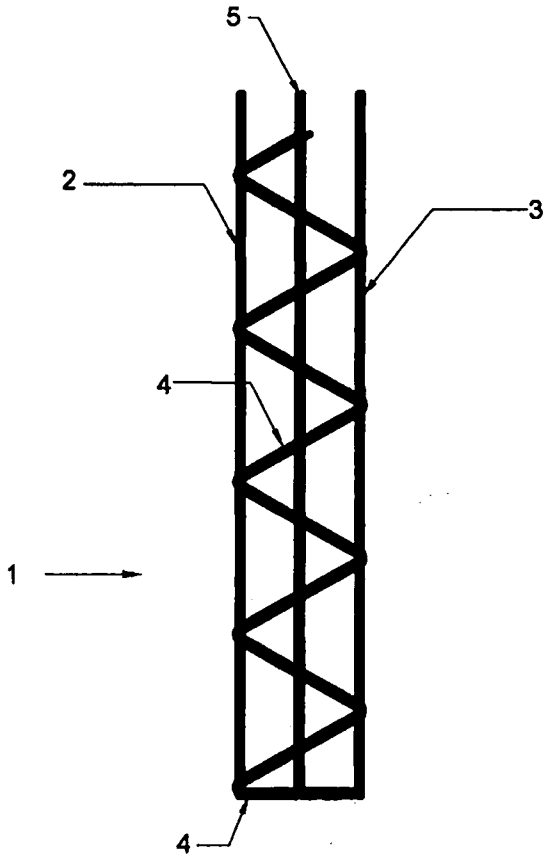


Fig. 9

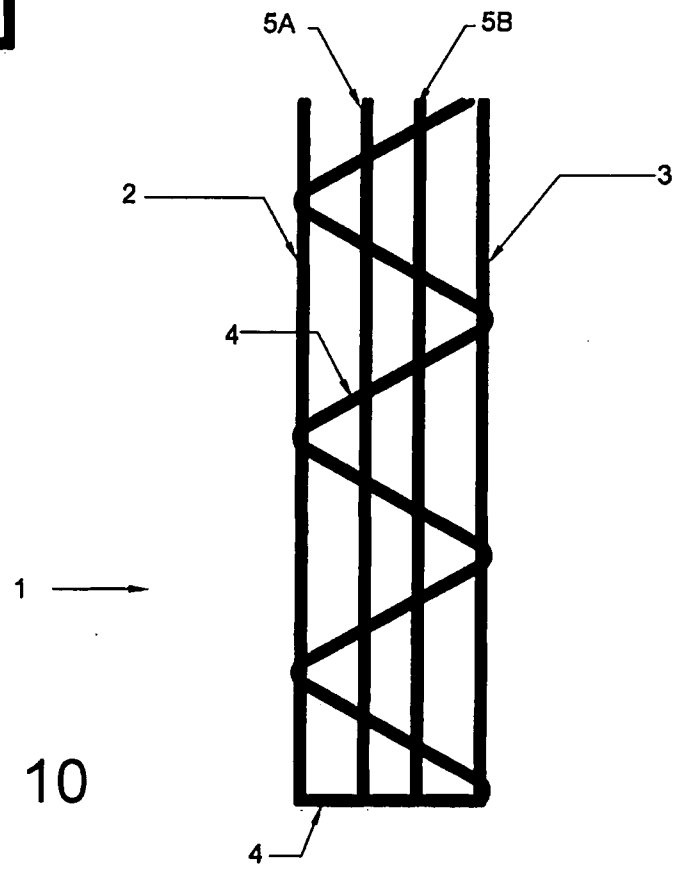


Fig. 10

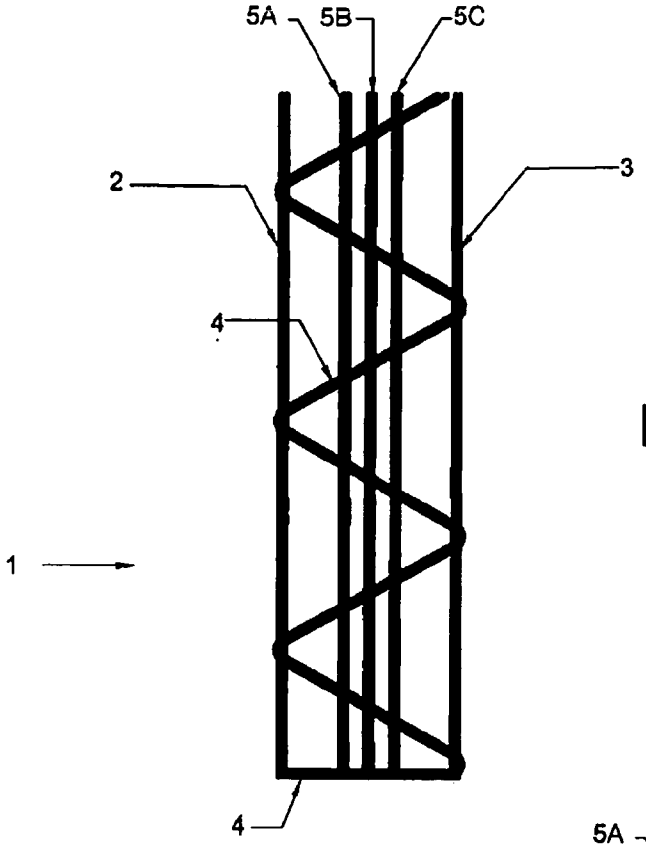


Fig. 11

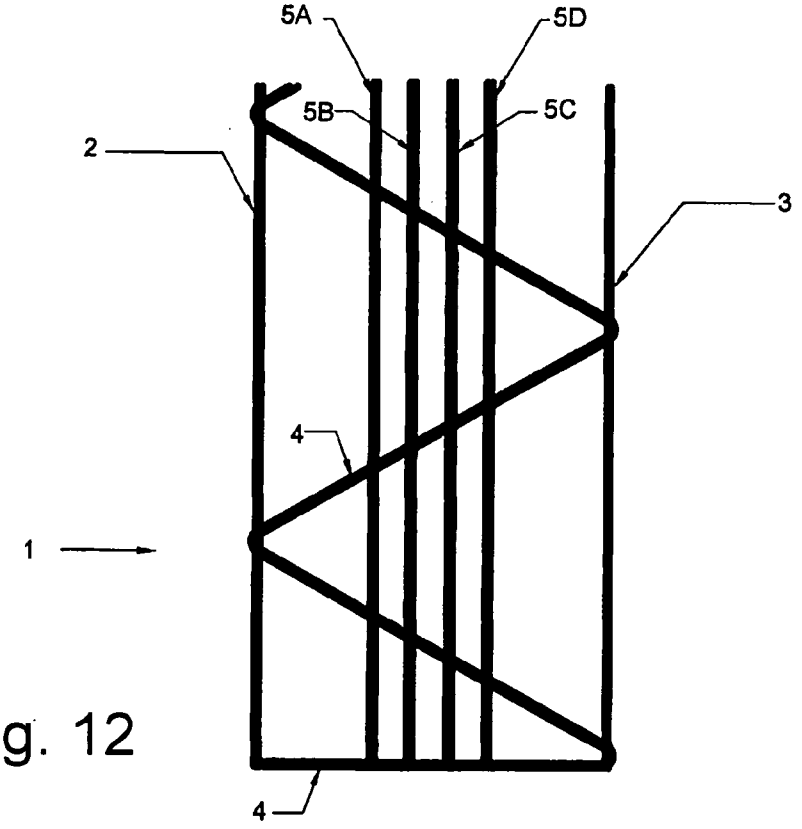


Fig. 12

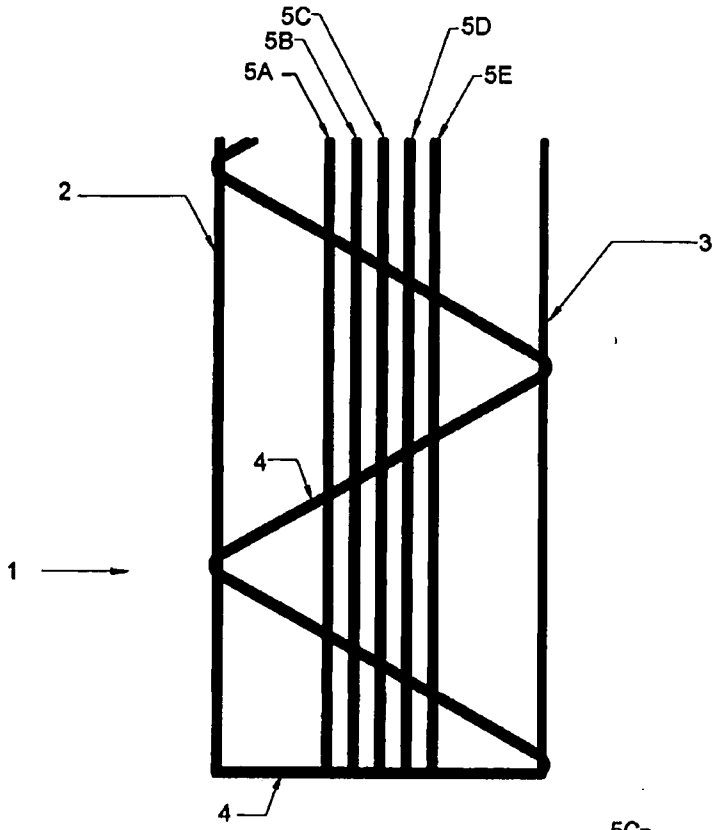


Fig. 13

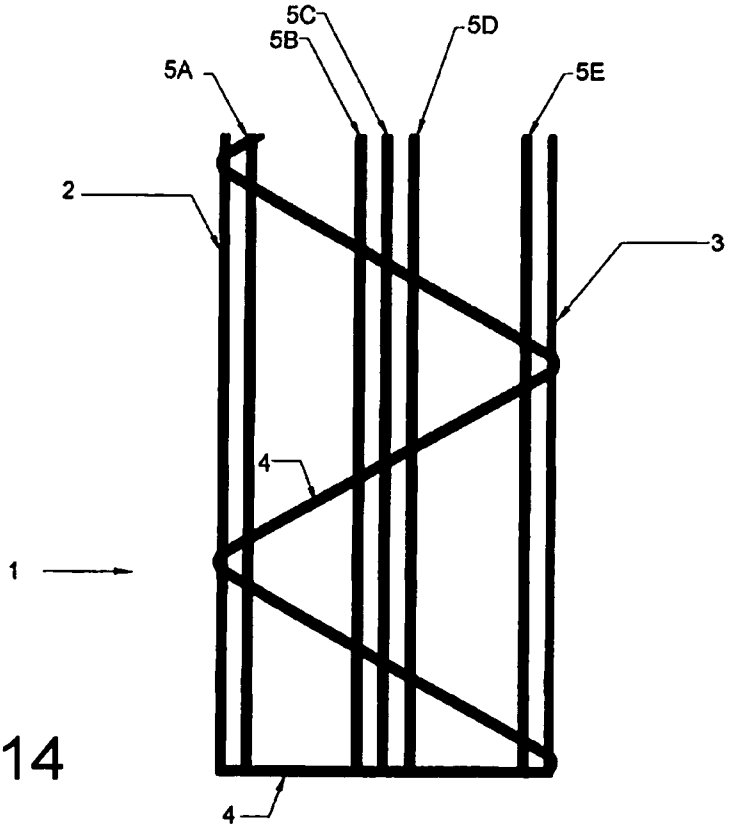


Fig. 14

BUILDING PANELS

TECHNICAL FIELD OF THE INVENTION

[0001] This invention relates to building panels of the kind which comprise a wire reinforcing cage enclosing a low density core.

BACKGROUND

[0002] Buildings are sometimes constructed from off-site construction building panels (also known as prefabricated building panels) which have a low core of low density material held in a wire reinforcing cage. For example, GB 2 323 404 A describes building panels which are fabricated from welded wire trusses sandwiched between blocks of foamed plastics material, e.g. phenolic foam. In this instance zig-zag warren trusses are used which are held together by horizontal strapping wires to form the cage around the blocks. The width of the cage is typically about 75 mm whereas the width of the foam core is typically around 50 mm so that the cage extends approximately 10 mm or so on either side of the core. A layer of cement or plaster, produced on site, is applied to each side of the core. The finished thickness of the wall, including the cement/plaster layers, is typically around 95 to 100 mm. Such panels, which are typically of the order of 1.2 m high and 2.4 m wide, are relatively light and easily handled and may be cut to any desired shape if necessary. The panels may be used to construct internal and external walls as well as roofs and multi-storey floors.

[0003] Buildings are constructed by arranging the building panels adjacent to one another on a foundation to which the panels are anchored. Adjacent panels may be tied to one another by securing each panel to a strip of reinforcing mesh. Once wall and roof panels have been erected, internal and external surfaces of the panels are rendered to provide a finished surface. For instance, the external render may typically comprise a weatherproofing mix of Portland cement and sand. Alternatives, such as gypsum plaster, might typically be used for rendering internal surfaces. The layer of cement or plaster encases the wire mesh cage on both sides of the foam core producing a strong and rigid structure when dry. If desired, various waterproofing, anti-fungal and fibre reinforcing agents may be applied to the rendering mixture or the dried surface.

[0004] Whilst such building panels are not difficult to manufacture and are generally convenient to handle and erect, they are not sufficiently load bearing to enable construction of multi-storey buildings without additional supporting structure. GB 2 323 404 A proposes constructing multi-storey buildings by including vertical "I" section columns erected at spaced apart locations around the building perimeter which support horizontal "U" section steel members which span adjacent columns, and which may be supported intermediate adjacent columns by vertical props. This structure provides additional support for second and subsequent stories which are erected in the same manner by securing further vertical columns to the ground floor columns, and adding additional horizontal channel members and props if necessary.

[0005] A further important requirement in buildings formed from lightweight building panels is that the structure should have high resistance to forces such as high winds and earthquakes.

[0006] In a move towards increasing the insulation value of buildings, it has become desirable to increase the insulation thickness from around 50 mm to as much as 300 mm or more. However, in walls having a single panel thickness such significant increases in dimensions require a substantial increase in wire diameter in order to retain sufficient structural rigidity. This not only significantly increases the costs, but also produces a considerable increase in weight, making the panels much more difficult to handle.

[0007] Ladder trusses are also known, although they are generally not as strong on a weight-for-weight basis as zig-zag warren trusses.

[0008] It is an object of the present invention to provide a building panel of improved load bearing capabilities whilst also meeting the requirements for improved heat insulation properties, low cost and low weight.

SUMMARY OF THE INVENTION

[0009] The present invention proposes a building panel comprising blocks of a low density material contained within a surrounding support cage, in which the cage comprises a plurality of wire trusses extending along a length of the panel, the trusses being spaced apart such that each truss separates adjacent low density blocks, in which each truss comprises a pair of substantially parallel longitudinally extending reinforcing wires located on opposite sides of the low density blocks, and the trusses are held together by strapping wires joined to the reinforcing wires on opposite sides of the panel,

[0010] wherein each truss includes a plurality of intermediate wires which travel along the length of the truss between the low density blocks.

[0011] The intermediate wires preferably comprise at least one transverse wire which meanders between the reinforcing wires as it travels along the length of the truss. In a preferred form of truss the or each transverse wire preferably travels in a zig-zag path along the length of the truss.

[0012] The intermediate wires preferably include at least one tie wire which extends longitudinally of the truss, spaced from the reinforcing wires. The or each tie wire is preferably joined to a transverse wire.

[0013] The cut ends of the intermediate wires may be joined to the reinforcing wires, or they may be joined to a cross element which bridges the reinforcing wires.

BRIEF DESCRIPTION OF THE DRAWINGS

[0014] The following description and the accompanying drawings referred to therein are included by way of non-limiting example in order to illustrate how the invention may be put into practice. In the drawings:

[0015] FIG. **1** is a side view of a short length of a first form of truss for use in a building panel;

[0016] FIG. **2** is a general schematic representation of a building panel constructed from the trusses, in accordance with the invention;

[0017] FIG. **3** is a side view of a second form of truss which can be used in a building panel in accordance with the invention; and

[0018] FIG. **4** is a side view of a third form of truss which can be used in a building panel in accordance with the invention;

[0019] FIG. **5** is a side view of a fourth form of truss which can be used in a building panel in accordance with the invention;

[0020] FIG. **6** is a side view of the first form of truss, showing a method of end termination;

[0021] FIG. **7** is a side view of the first form of truss showing an alternative method of end termination;

[0022] FIG. **8** is a side view of a fifth form of truss which can be used in a building panel in accordance with the invention;

[0023] FIG. **9** is a side view of the first form of truss showing yet another method of end termination; and

[0024] FIGS. **10** to **14** are side views showing different variations of the second form of truss.

DETAILED DESCRIPTION OF THE DRAWINGS

[0025] Referring firstly to FIG. **1**, the truss **1** is formed of a pair of substantially parallel longitudinal reinforcing wires **2** and **3** and two intermediate wires **4** and **5**, including a single transverse wire **4** which travels along the length of the truss in a zig-zag manner. The angular bends of the zig-zag wire **4** are welded to alternate wires **2** and **3**, forming a series of rigid triangles. In accordance with the invention the truss includes a further intermediate wire in the form of a tie wire **5** which extends longitudinally substantially mid-way between the wires **2** and **3**, welded to the zig-zag wire **4** at the points where the tie wire crosses the zig-zag wire.

[0026] FIG. **2** shows an off-site construction building panel using trusses of the kind just described. The panel **10** includes a core of low density blocks **11**, e.g. of expanded polystyrene, held within a wire cage **12**. The panel is formed by stacking the blocks **11** and trusses **1**, with a truss **1** sandwiched between pairs of blocks **11**. The distance between the longitudinal reinforcing wires **2** and **3** is greater than the width of the blocks so that the reinforcing wires lie on opposite sides of the low density core. The wires **3** on one side of the core are joined together by parallel strapping wires **14** which are welded perpendicularly to the wires **3**. On the opposite side of the core the reinforcing wires **2** are similarly welded to a further set of strapping wires **14**. The trusses **1** and strapping wires **14** thus form a rigid cage which encloses and firmly holds the low density core of blocks **11**.

[0027] The longitudinal reinforcing wires **2** and **3** are preferably inset by approximately one wire thickness from the bends in the zig-zag wire **4**, as shown in the enlarged inset detail of FIG. **2**. This enables a stronger joint to be formed since the longitudinal wire **2**, **3** can be welded at two points instead of one.

[0028] Once the caged core is in situ a cementitious and or plaster render **15**, **16** is sprayed or otherwise applied to the opposite side faces of the core. The reinforcing wires **2**, **3** and the strapping wires **14** are encased within the render, acting as reinforcement for the rendering layers. It is, however, important to note that in the building panels according to the invention the cage structure has sufficient strength and rigidity in its own right so that the render is not necessary to add strength to the panels, and the render layers can therefore be relatively thin.

[0029] By way of example, the wires forming the cage may be 2, 3 or 4 mm in diameter. The core blocks **11** may be at least 150 mm wide, and could be up to 300 mm or more in width, with a typical thickness (truss spacing) of 50 mm. The longitudinal reinforcing wires **2** and **3** preferably project between 5 and 10 mm on both sides of the core, encased within a render about 20 mm thick. The strapping wires **14** are typically spaced at 50 mm intervals. It will be appreciated however that the panels could be made to other dimensions as required in any particular application.

[0030] The trusses are simple to manufacture by means of a machine that forms one strand of wire into a zig-zag configuration, and draws and straightens three further strands into contact with the zig-zag wire. The wires are welded together at the points of contact, and the trusses are cut to the required length.

[0031] The blocks and trusses are assembled, pressed together, and the strapping wires are welded to the trusses in known manner.

[0032] For any given set of panel dimensions the trusses are considerably stronger than known trusses of comparable dimensions, which means that the wire diameter and weight can be reduced without compromising the strength of the truss. The building panels have significantly greater structural rigidity and load bearing capability compared with known building panels of similar construction. Zig-zag warren trusses have been criticised because the welded trusses are sometimes under a certain amount of internal tension, and the ends of the zig-zag wire might spring out when the trusses are cut. Although this is not usually a problem, this tendency is reduced in the present trusses since cut lengths of wire spanning more than half the width of the truss are held by the tie wire. Cut lengths less spanning less than half the width of the truss do not normally move enough to be significant.

[0033] Where a still greater increase in strength (or truss width) is required more than one longitudinally-extending tie wire can be used. For example, the truss shown in FIG. **3** has two tie wires **5**A and **5**B extending parallel to the reinforcing wires **2** and **3**, again both welded to the zig-zag wire **4**. Such additional tie wires allow further reduction in the wire diameter and/or increase in the thickness of the building panel. The risk of springing movement of cut ends of the zig-zag wire is reduced still further.

[0034] An alternative way of increasing the strength of the trusses is illustrated in FIG. **4**. Such an arrangement may be preferable in trusses up to around 300 mm wide, although it can also be used for wider or relatively narrow trusses. This form of the truss **1** again has a pair of substantially parallel longitudinal reinforcing wires **2** and **3** with a tie wire **5**C extending longitudinally substantially mid-way between the wires **2** and **3**. The wires **2** and **5** are joined by a first zig-zag wire **4**A which has its angular bends welded to both wires, while the wires **5** and **3** are joined by a second zig-zag wire **4**B which also has its angular bends welded to the alternate wires. The truss thus forms a series of relatively small rigid triangles and is thus much stronger and lighter than a known truss of the same width. The truss just described could be modified to enable the width to be increased still further with a relatively small increase in weight. For example, further zig-zag wires and longitudinal wires can be added to extend the width, typically up to 450 mm or more. Also, as shown in FIG. **5**, additional longitudinally extending tie wires such as **5**D and **5**E can be fixed along the intermediate portions of the zig-zag wires **4**A and **4**B.

[0035] In each form of truss it would be possible for the intermediate tie wires of adjacent trusses to be connected together during fabrication of the building panels by additional strapping wires which are welded transversely to the tie wires, passing between two adjacent low density blocks. Thus, the lightweight core is more than one block wide.

[0036] If the free cut ends of the tie wires is perceived to be a problem this can be eliminated by the method shown in FIG. **6**. The free end **5***a* of the tie wire **5** is bent angularly at its junction with the transverse wire **4** and then welded or other-

wise joined to the adjacent reinforcing wire **3**. This method is only suitable where the length of the free end **5***a* is sufficient to meet one of the reinforcing wires. An alternative arrangement is shown in FIG. **7**, where a bridging element **20** is welded between the reinforcing wires **2** and **3** at the end of the truss. The free cut ends of the transverse wires **4** and tie wires **5** can each be welded to the element **20**, as shown. The element **20** may for example comprise a flat metal strip, e.g. 2 mm×6 mm, a short length of wire, etc.

[0037] Although it has been found that a straight tie wire provides the greatest increase in strength for minimum increase in weight and cost, the additional longitudinal wires need not necessarily be straight. For example, as shown in FIG. **8**, the use of two transverse zig-zag wires **4**C and **4**D, preferably welded together at their crossing points, will also increase the strength of the truss without increasing wire thickness.

[0038] FIGS. **9** to **14** show another method of eliminating the free cut ends of the tie wires in which the free end of a zig-zag wire **4** is bent angularly at its junction with one of the reinforcing wires **2** to extend perpendicularly across the truss. This end portion of wire **4** is welded to the reinforcing wires **2** and **3** and the free cut ends of any tie wires **5**. These Figures also show that, for even greater strength, various numbers of longitudinally-extending tie wires **5**C to **5**E, with equal or unequal spacing, may be joined to the zig-zag wire **4**.

[0039] Whilst the above description places emphasis on the areas which are believed to be new and addresses specific problems which have been identified, it is intended that the features disclosed herein may be used in any combination which is capable of providing a new and useful advance in the art.

1. A building panel comprising blocks (**11**) of a low density material contained within a surrounding support cage (**12**), in which the cage comprises a plurality of wire trusses (**1**) extending along a length of the panel, the trusses being spaced apart such that each truss separates adjacent low density blocks, in which each truss comprises a pair of substantially parallel longitudinally extending reinforcing wires (**2**, **3**) located on opposite sides of the low density blocks, and the trusses are held together by strapping wires (**14**) joined to the reinforcing wires on opposite sides of the panel,

wherein each truss (**1**) includes a plurality of intermediate wires (**4**, **5**) which travel along the length of the truss between the low density blocks (**11**).

2. A building panel according to claim **1** in which the intermediate wires include at least one transverse wire (**4**) which meanders between the reinforcing wires (**2**, **3**) as it travels along the length of the truss.

3. A building panel according to claim **2** in which the or each transverse wire (**4**) travels in a zig-zag path along the length of the truss.

4. A building panel according to claim **2** in which the intermediate wires include at least one tie wire (**5**) which extends longitudinally of the truss, spaced from the reinforcing wires (**2**, **3**).

5. A building panel according to claim **4** in which the or each tie wire (**5**) is joined to a transverse wire (**4**).

6. A building panel according to claim **5** in which the or each tie wire (**5**) is joined to a zig-zag transverse wire (**4**) part-way between the zig-zag bends.

7. A building panel according to claim **5** in which the or each tie wire (**5**) is joined to two or more transverse wires (**4**).

8. A building panel according to claim **3** in which the longitudinally extending reinforcing wires (**2**, **3**) are inset from the bends in the zig-zag transverse wires (**4**).

9. A building panel according to claim **2** in which the cut ends of the transverse wires (**4**) are joined to the reinforcing wires (**2**, **3**).

10. A building panel according to claim **4** in which the cut ends of the tie wires (**5**) are joined to the transverse wires (**4**).

* * * * *