Nov. 3, 1970 C. H. LERCHENTHAL 3,537,223

REINFORCED BUILDING ELEMENTS

Filed Nov. 17, 1965 3 Sheets-Sheet 1

FIG. 1.

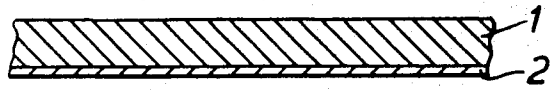


FIG. 2.

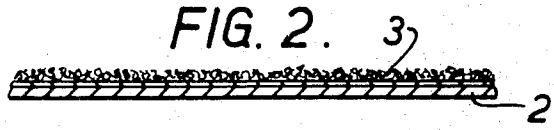


FIG. 3.

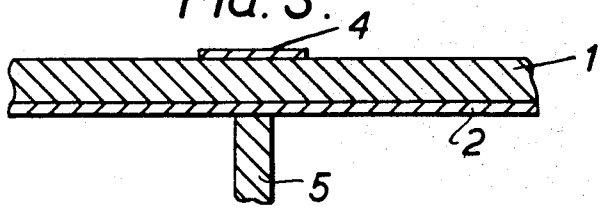


FIG. 4.

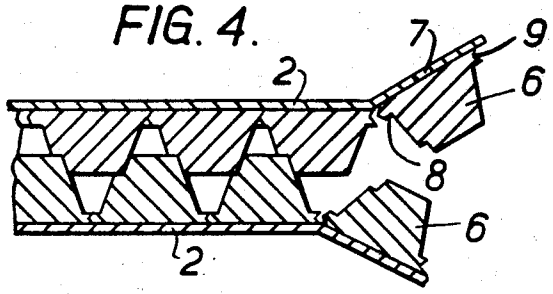


FIG. 5.

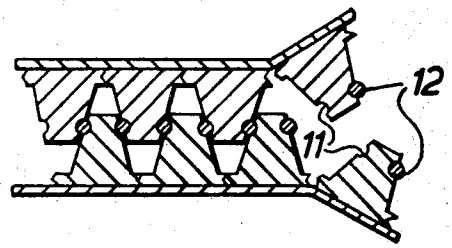
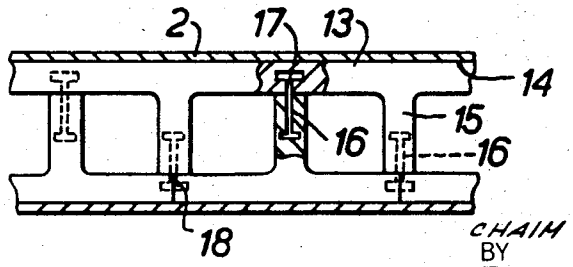


FIG. 6.



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REINFORCED BUILDING ELEMENTS

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FIG. 7.

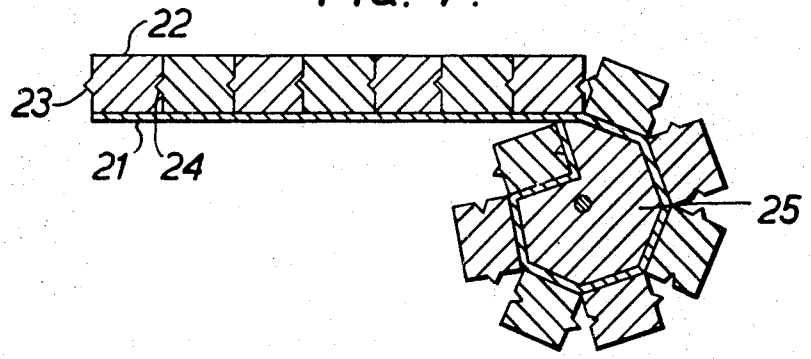
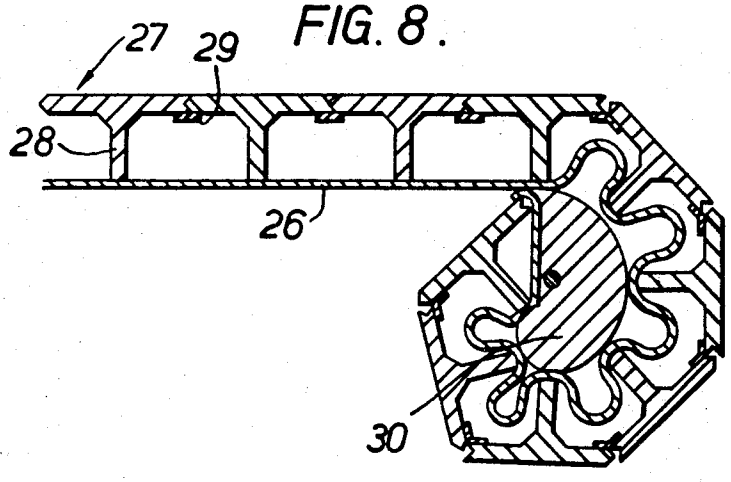


FIG. 8.



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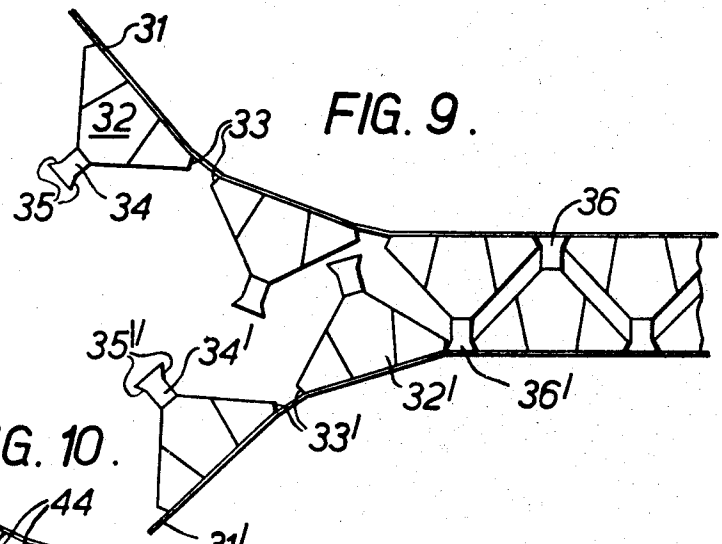


FIG. 9.

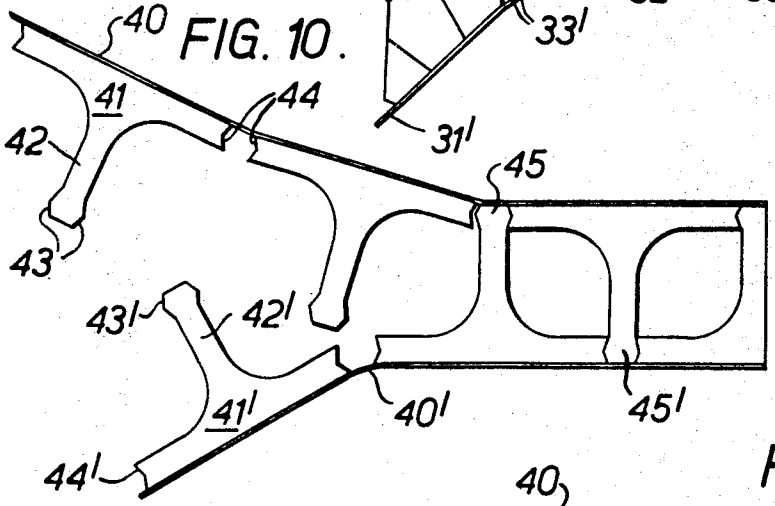


FIG. 10.

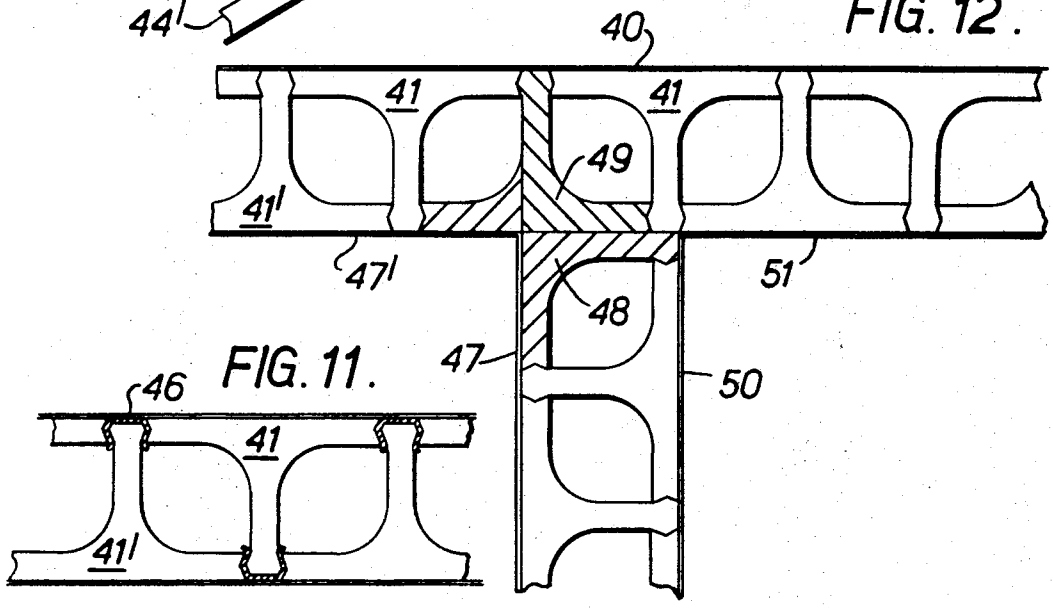


FIG. 12.

FIG. 11.

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REINFORCED BUILDING ELEMENTS

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Int. Cl. E04b 1/02
U.S. Cl. 52—571 9 Claims

ABSTRACT OF THE DISCLOSURE

This invention relates to reinforced building elements and in particular to reinforced concrete slabs, blocks, panels, walls and the like. According to the present invention there is provided a reinforced building element comprising a first component capable of withstanding compressional and/or shearing forces and a second component in sheet form bonded to the first component, the second component being capable of withstanding tensional forces acting in its plane in any direction.

Conventional methods for reinforcing concrete include the embedding in the concrete of steel rods or strips. It is known, however, that with these conventional methods, the concrete thus reinforced is strengthened against tensional forces only in the direction of the steel rods or strips. In order to enable the reinforced concrete to resist tensional forces or transverse bending moments acting in more than one direction, it has been known to embed, in the concrete, a network of steel rods or strips which cross each other substantially at right angles, each group of parallel rods or strips being designed to resist tension or bending moments only along its own direction. However, the use of such networks involves the provision of superimposed layers of rods or strips thereby increasing the effective height of the blocks thus reinforced.

It is an object of the present invention to provide a reinforced building element in which the above referred to disadvantages are substantially overcome.

Preferably, the first component consists of a concrete mass and the second component consists of sheet metal bonded to a surface of the concrete mass.

By virtue of using a reinforcement in sheet form, the power of the building element to resist tensional forces in more than one direction is very substantially increased for the same amount of reinforcing material over building elements which have been reinforced in the conventional manner.

The invention will now be described by way of example and with reference to the accompanying drawings in which:

FIG. 1 is a cross-sectional view of a first form of a reinforced building element in accordance with the invention;

FIG. 2 is a cross-sectional view of a reinforcing plate prior to being bonded to the concrete which it is to reinforce;

FIGS. 3, 4, 5, 6, 7 and 8 are respective cross-sectional views of six further forms of building elements in accordance with the invention; and

FIGS. 9, 10, 11, and 12 are respectively cross-sectional views showing several embodiments of folding partitions.

As seen in FIG. 1 of the drawings, the reinforced building element comprises a concrete block **1** to one exposed surface of which is adhesively bonded a metal sheet **2**. This metal sheet can be bonded to the hardened concrete block by means of a suitable adhesive or, alternatively, the sheet can be roughened by the bonding thereto of gravel and sand and the fresh concrete is then cast onto the roughened sheet and is bonded thereto during setting. In this latter method, the metal sheet effectively constitutes a part of the shuttering in which the concrete is cast.

Hardening of the adhesive and/or setting and hardening of the concrete can then take place at room temperature or, alternatively, in an elevated temperature of, say, 70° C.

Alternatively, the concrete can be cast on a fresh layer of a suitable adhesive covering the sheet, or the adhesion of the concrete may be increased by the addition of suitable polymers.

FIG. 2 shows the metal sheet **2** to which has been bonded fine gravel **3** prior to the casing of the concrete on the sheet.

While in the example shown in FIG. 1 the metal sheet **2** is bonded only to one surface of the concrete slab **1**, this being the surface most subject to tension, in the example shown in FIG. 3, a further metal sheet **4** is bonded to an opposite surface of the slab **1** in a position opposite to where the slab is supported by a column **5**, wall or the like, thus reinforcing a portion where stress is liable to occur on the face opposite to the sheet **2**.

FIGS. 3, 4, 5, 6, 7 and 8 show differing examples of the application of the main principles of the invention in the provision of building elements of adjustable lengths.

As seen in FIG. 4, each building element consists of a flexible metal sheet **2** to which is bonded a plurality of longitudinal concrete blocks **6** each of essentially prismatic cross-section. Each block **6** is shaped so as to be capable of interengaging with a preceding and a succeeding block. For this purpose, each block is provided with a base portion **7**, one edge **8** of which is shaped convexly while the other edge **9** is shaped concavely. As seen in FIGS. 4 and 5 of the drawings, when the sheet **2** is extended into a flat position the convex edge **8** of one block engages in the concave edge **9** of the preceding block thereby enabling the building element as a whole to retain its flat shape. Thus, a building element as shown in FIG. 4 or 5 of the drawings can be produced in differing lengths and, owing to the flexibility of the metal sheet **2**, these lengths can, during transport and storage, be rolled up and then be unrolled on the side. In addition, the length can be cut to size as required on the site.

As seen in FIGS. 4 and 5 of the drawings, two such building elements are caused to interlock so as to constitute a rigid reinforced wall. For this purpose, the prismatical units are so shaped that the prismatic units of one element are adapted to interengage and interlock with the prismatic units of the other element. In the example shown in FIG. 4, the edges **10** of each unit are partly inset so that either opposite edge of that unit interengages in the inset portion **10** of the preceding or succeeding unit of the opposite element.

In the arrangement shown in FIG. 5 of the drawings, the interlocking of the units of the two opposite elements is achieved by shaping the prismatic unit such that along one edge of each unit there are cavities **11** capable of accommodating dowels **12** stuck into similar cavities formed in the opposite edge of each unit. Thus, the dowel of one unit **12** engages in the cavity **11** of the preceding or succeeding unit in the opposite element. The dowels **12** are preferably made of a material which is capable of transferring shearing forces yet can effectively isolate elements against transmission of heat, moisture, sound or vibrations.

The embodiment shown in FIG. 6 of the drawings constitutes a variation of the embodiment shown in FIGS. 4 and 5. Thus, as seen in FIG. 6 each building element consists of the reinforcing sheet **2** and a plurality of T-shaped units **13**, each unit **13** being bonded at its base **14** to the sheet **2** and having secured in its vertical limb **15** an anchoring pin **16**. This anchoring pin **16** projects beyond the vertical limb **15** of the unit, the projecting end forming an enlarged head **17**. The opposite ends of each

horizontal limb are formed with concave recesses **18** such that when the element is stretched out, as shown in the drawings, two adjacent concave recesses **18** together define a longitudinal opening of oval cross-section. By arranging that the head **17** of each anchoring pin **16** is located in the thus formed oval cavity of two opposite adjacent units, the two elements can be arranged to interengage.

In addition, or as an alternative to the mechanical means for interlocking the two elements, these elements can be bonded to each other. By arranging that the elements have trapped between them air or other insulants, the walls formed by two interlocking elements can have excellent thermal or sound insulating properties.

While in the arrangments shown in FIGS. 4, 5 and 6 of the drawings pairs of building elements in accordance with the invention are arranged to interengage so as to form a rigid wall or the like, in the arrangements shown in FIGS. 7 and 8, each element, when stretched with its adjacent units, interengaging one with the other can constitute a wall, ceiling, roofing or the like. Thus, the element seen in FIG. 7 of the drawings comprises a reinforcing sheet **21** to which are adhesively bonded a succession of rectangular, longitudinal blocks **22**. Projecting from one side face of each block **22** is a rib-like protrusion **23**, while formed in the opposite side face of each block is a longitudinal groove **24**. When the element is stretched out flat, the rib-like protrusion **23** of one block engages in the longitudinal groove **24** of an adjacent block. For transport and storage the element is rolled around a specially shaped core **25** and when unrolled adopts the flat disposition shown in the drawings. If required, this mechanical interengagement of the blocks can be replaced or supplemented by adhesively bonding the blocks together. Such a building element as shown in FIG. 7 of the drawings can suitably be made to form the roof or ceiling of a building.

In an alternative embodiment shown in FIG. 8 of the drawings, the element comprises a reinforcing sheet **26** and a plurality of T-shaped units **27** which are respectively bonded at the base of their upright limbs **28** to the reinforcing sheet **26**. Opposite edges of the transverse limbs of the unit **27** are respectively convexly and concavely shaped so that when the element is stretched out flat as shown in FIG. 8, corresponding edges of adjacent elements interlock. These interlocking elements are additionally coupled together by means of flexible, strip-like joints **29**. As in the embodiment shown in FIG. 7 the building element is coiled around a suitably shaped core **30**.

As can be seen when the building element is coiled around the core, the reinforcing sheet **26** is bent inwardly towards the flexible joints **29**.

For the purpose of increasing the rigidity of the stretched-out building element, there can be subsequently inserted between the upright limbs **28** or bonded to the sheet **26** after the element has been flattened out, reinforcing rods, panels or the like which can suitably be formed of timber, light concrete or the like. Additionally, or alternatively, the space between the reinforcing sheet **26** and the joined limbs of such unit can be wholly or partially filled with a suitable rigidifying or insulating material such as plastic foam, concrete, gypsum or the like.

In various tests carried out with reinforced concrete slabs as shown in FIG. 1 of the drawing, it was found that the resistance of the reinforced concrete to biaxial transverse bending was up to double that of equivalent slabs reinforced with the same quantity of metal but wherein the reinforcing metal, instead of being in sheet form, was embedded in the concrete in the standard grid fashion.

As reinforcing sheet, differing metal sheets such as, for example, steel or aluminium can be employed as can

in fact non-metallic materials such as, for example, plastic sheeting or woven natural or synthetic materials.

In the form shown in FIG. 9, flexible band **31** has a plurality of spaced blocks **32** bonded thereon. The opposite edges **33** have reverse angles. Legs **34** are formed with angular extensions **35** adapted to fit into angles **33** as indicated at **36'**. A complementary element denoted by reference characters **31'**, **32'**, **33'**, **34'** and **35'** is adapted to interlock with extensions **35'** fitting into angles **36**.

Referring to FIG. 10, flexible sheet **40** has T-shaped blocks **41** bonded thereto in spaced relation. Legs **42** have sloping ends **43** complementary to notches **44** and adapted to fit into notches **44'** of the complementary element **40'**, **41'**, **42'**, **43'** and **44'**. Ends **43'** fit into notches **44**. In FIG. 11, there are interposed between the two elements sound absorbing or cushioning members **46** which are preferably elastic gaskets.

FIG. 12 illustrates the structure in which a lateral connection is provided. Sheet **47** of element **48** meets sheet **47'** of element **41**. Member **49** contacts element **48**. Sheet **50** meets sheet **51**. As shown, sheets **47** and **47'** are integral as are sheets **50** and **51**.

Reinforcing sheets can be bonded to the elements by any suitable adhesive such as, for example, epoxy resin or the like.

As an alternative to concrete, the rigid elements can be made of gypsum, chipwood, porous lime silicate, fibre reinforced plastic or any other rigid material. The elements can be solid or hollow and can themselves be composite in order to accommodate such features as roofing, flooring, ceiling or wall finishes, insulating material and the like.

What is claimed is:

1. A reinforced building element comprising a first component of rigid non-metallic material, which material withstands compressional and/or shearing forces, and a second component of flexible material in sheet form which withstands tensional forces acting in the plane of said sheet in any direction, a face of said first component being adhesively bonded to a face of said sheet, said first component being constituted by a plurality of longitudinally juxtaposed blocks, said sheet having a longitudinal length greater than at least the width of two of said blocks, whereby in one position the blocks are adapted to interengage one with the other, and in another position the element can be stored in rolled form.

2. A pair of building elements according to claim **1** wherein the blocks of one element of said pair interengage with the blocks of another element of said pair, the pair of elements thereby forming a substantially rigid structure.

3. A pair of building elements according to claim **2**, wherein the two individual elements are separated by a third element serving to insulate said first mentioned elements against transmission of sound, heat, moisture or the like.

4. A building element according to claim **1** wherein each said block is substantially of a T-shape and said T-shaped block is bonded at the upper plane of its horizontal limb to said second component.

5. A building element according to claim **4**, wherein after straightening of the element said second component is bonded to rigidifying members.

6. A reinforced building element comprising a first component of rigid non-metallic material, which material withstands compressional and/or shearing forces, and a second component of flexible material in sheet form which withstands tensional forces acting in the plane of said sheet in any direction, a face of said first component being adhesively bonded to a face of said sheet, said first component being constituted by a plurality of longitudinally juxtaposed blocks, said blocks being adapted to interengage one with the other, each block being substantially of a T-shape and said T-shaped block being

bonded at the upper plane of its horizontal limb to said second component.

7. A building element according to claim 6 wherein after straightening of the element, said second component is bonded to rigidifying members.

8. A pair of building elements according to 6 wherein the blocks of one element of said pair interengage with the blocks of another element of said pair, the pair of elements thereby forming a substantially rigid structure.

9. A pair of building elements according to claim 8, wherein the two individual elements are separated by a third element serving to insulate said first mentioned elements against transmission of sound, heat, moisture or the like.

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