

INSULATING PANEL AND BUILDING STRUCTURE

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The present invention relates to advancements in the field of insulating building panels and methods of manufacture thereof. More particularly, it concerns improvements in the field described in U.S. Patent No. 4,241,555.

Many types of prefabricated panels have been developed for a wide variety of building applications and one particularly advantageous development in the field is described in U.S. Patent No. 4,284,447. A system of constructing buildings with the foregoing panels is described in U.S. Patent No. 4,094,110.

According to the present invention there is provided an insulating rectangular building panel comprising a core of expanded cellular plastics material having parallel front and back surfaces and reinforced with reinforcing strips, at least along the longitudinal and transverse edges of the panel, the reinforcing strips comprising: at least two longitudinal strips of U-shape each of which extends the full length of the panel with its side portions embedded in said core and the web connecting the side portions set within the front surface of the core so that the surface of the web remote from the bulk of the core is flush with the surface of the core; at least two further longitudinal strips of U-shape each of which extends the full length of the panel with its side portions embedded in said core and the web connecting the side portions set within the back surface of the core so that the surface of the web remote from the bulk of the core is flush

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with the surface of the core, the side portions of the strips on the front surface being offset from the side portions of the strips on the back surface of the core; a front transverse strip adhered to each of the two
5 transverse edges of the front surface of the core, and a back transverse strip adhered to each of the two transverse edges of the back surface of the core, the front transverse strips being spaced from the back transverse strips and each of the transverse strips on
10 each surface of the panel being adhered to all of the longitudinal strips on the same surface (front or back) of the panel.

The insulating building panel of the present invention
15 is formed as a four-sided sheet that may be planar or curved in one or two directions. The panel is formed of expanded plastics material (herein otherwise called "plastic") so as to have a cellular structure and thin reinforcing strips of particular configuration, which
20 may be formed of metal or plastic, are bonded to the opposite faces of the expanded plastic at least along the edges thereof. For ease of description the expanded plastic portion of the panel is herein termed a "core" although, in fact, such portion forms the
25 major element of the panel and need not be encased in a cover or shell.

Preferably, the expanded plastics panel core has offset or stepped edges with two adjacent edges being
30 complementary to the other two edges of the four-sided panel. Such a core may be formed in a mold wherein beads of material such as polystyrene are heated, as by steam, to expand and join together into a cellular structure having closed cells. Reinforcing strips of

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thin metal, for example, formed in a U-shape, e.g. as shallow channels with turned edges, are bonded to opposite faces of the core, and this can be done during core formation. The strips are disposed longitudinal
5 of the core with the turned edges of the strips facing inwardly of the mold so that they are embedded in the core. The strips are offset on opposite faces of the panel and the depth of the strip edges need be only a small fraction of the core thickness so that no high
10 conductivity heat path exists through the panel. The reinforcing strips have a substantial rigidity against bending because of the shallow channel configuration thereof and thus are readily handled and positioned for bonding with the cellular core.

15 There may additionally be provided thin reinforcing strips having an L-shaped configuration, i.e. a shallow channel with one side removed. These strips are bonded to panel edges and may have a width equal to the width
20 of a channel strip plus a channel depth. One flat reinforcing strip per panel is also employed and by a particular arrangement of strips on the front and back surfaces of the panel with strips overhanging two adjacent panel edges, a lightweight structural
25 insulating panel is formed which is adapted for connection as by sheet metal screws to contiguous abutting panels to form a building structure.

30 The exterior of the structure formed of the panels hereby may be adapted to be coated with concrete or the like to provide the requisite final structural strength and rigidity and rebar may be incorporated in this portion of the structure if additional strength is

required. The back or inner face of the walls or the like formed of the insulating building panels hereof may be finished in a variety of ways. Thus, for example, the inner surface may be plastered and/or
5 various types of sheet-like material such as wood or composite veneer or the like bonded thereto.

The present invention is illustrated by way of example, with respect to a preferred embodiment thereof, in the
10 accompanying drawings, wherein:

Figure 1 is a front elevational view of a panel in accordance with the present invention;

15 Figure 2 is a side elevational view of the panel of Figure 1;

Figure 3 is a rear elevational view of the panel of Figure 1;

20 Figure 4 is an enlarged broken transverse sectional view taken in the plane 4-4 of Figure 1;

Figures 5, 6 and 7 are partial sectional views taken in
25 the planes 5-5, 6-6 and 7-7 of Figure 1, respectively;

Figure 8 is a broken transverse sectional view taken in the plane 8-8 of Figure 1;

30 Figure 9 is a partial transverse central sectional view of the panel of Figure 1 attached to like laterally contiguous abutting panels;

Figure 10 is a partial central vertical sectional view of the panel of Figure 1 attached to like contiguous abutting panels above and below same; and

- 5 Figure 11 is a partial sectional view showing the mounting or wire mesh on panels hereof for application of concrete or the like.

10 The panel illustrated in Figures 1 through 7 comprises a reinforced insulating panel 11 having a "core" 12 of cellular expanded plastics material having reinforcing strips in a particular arrangement, as described below. The shape of the core determines the shape of the panel and, while variations therein are possible, the
15 illustrated core has parallel planar front and rear surfaces 14 and 16, respectively, with parallel side edges 17 and 18 and parallel top and bottom edges 21 and 22. The core 12 and thus the panel 11 is herein illustrated and described with respect to a flat or
20 planar configuration; however, it is noted that the panel may be curved either longitudinally, laterally, or both. Similarly, the dimensions of the core and thus the panel may be varied according to the application; however, panels of substantial size are
25 contemplated by the present invention. Thus, for example, a building panel may have a length of about 2.75 m (9 feet) and a width of about 92 cm (3 feet) or so, with a thickness of 7.6 to 10.1 cm (3 to 4 inches).

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The core 12 of the present invention is formed of a lightweight expanded plastics material to have good insulating properties and at least limited structural

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rigidity so that the core is in fact substantially rigid. The core may be formed of a variety of materials such as expanded polystyrene, polyethylene or polyurethane having an appropriate density to provide good thermal insulation and structural strength. As an example, the core may be formed of expanded polystyrene having a density of the order of 17.7 Kg/m³ (1.lb. per cubic foot) to 96.1 Kg/m³ (6.lbs. per cubic foot), and advantageous tested prototypes have been formed with a density of 32.0 Kg/m³ (2.lbs. per cubic foot). Preferably the expanded plastics material is formed as a closed cell structure to maximise the thermal insulating properties thereof.

Considering further the physical configuration of the core 12 of the panel 11, same is formed with offset or stepped side edges 17 and 18, as illustrated in Figure 4. More particularly, the side edge 17 is formed with a longitudinally extended lateral rib or projection 26 which, in the illustrated embodiment, has a rectangular cross-section to form a square shoulder with the remaining surface of the side edge 17. This projection or rib 26 is disposed on the side edge 17 adjacent the front face 14 of the core. The other side edge 18 of the core has a longitudinally extending lateral indentation 27 with the same dimensions as the projection 26 and also disposed adjacent the front face 14 of the core. It will thus be seen that the projecting rib 26 is adapted to fit into and mate with an indentation such as the indentation 27 on an identical panel abutting the panel illustrated in Figure 4. This is further described and discussed below.

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The top and bottom edges 21 and 22 of the core are formed similar to the side edges in that an upward projection 28 extends across the front of the top edge 21, and a mating indentation 29 extends across the front of the bottom edge 22. It will be seen that the top and bottom edges of the core have vertical shoulders adapted to butt together on contiguous like panels.

10 The panel of the present invention includes, in addition to the core described above, a plurality of reinforcing strips which are particularly located and configured to complete the panel as a structural element having very good heat insulating properties.

15 These reinforcing strips may be formed of various materials such as a light gauge steel (as low as 29 gauge). Referring first to Figure 4 of the drawings, there will be seen to be provided at least first and second light reinforcing strips 31 and 32, with each

20 being formed as a shallow channel of thin metal, plastic or the like. The strip 31, for example, is formed with a thin, central elongated web 33 with the lateral edges 34 turned or bent at 90° to the web 33 to form the shallow channel configuration, again as

25 illustrated in Figure 4. The channel 31 is disposed at the corner of the back surface 16 and side edge 17 with the web lying in the plane of the back surface 16, one side 34 embedded in the panel at surface 16, and the other strip side 34 lying in the inset plane of the

30 side edge 17, as illustrated. The strip 31 is inset into the core 12, as shown, and this may be accomplished as described below, but preferably including an adhesive bonding to the core. The

reinforcing strip 32 is disposed in like manner at the opposite corner of the back surface 16 with a side edge 18. An additional like channel 36 is shown to be disposed in inset relation to the back surface 16 of the core and extending longitudinally thereof along the centre of the core.

A further reinforcing strip 41 which may be identical to the strip 31 is disposed along the corner of the front surface 14 and side edge 18 of the core in inset relation thereto in the same manner as the strip 32 is disposed on the rear surface. An additional like channel shaped reinforcing strip 42 is disposed longitudinally of the front surface 14 of the core in extension longitudinally thereof at the centre of this front surface. This central longitudinal strip 42 is also inset in the front surface of the core with the sides thereof extending perpendicularly into the core itself. At the corner of the front surface 14 and edge 17 of the core there is provided another reinforcing strip 43 which is inset in the front surface 14, but which has only one edge 44 turned at 90° to extend into the core and which is located to provide the other side of the strip an extension laterally outward beyond the rib 26 of the side edge 17. The width of the strip 43 may be equal to the width of the strip 42 plus one side thereof so that the strip 43 may be formed from the same stock as the other strips. The distance that the strip 43 extends from the lateral edges 17 of the front face 14 may be equal to the depth of the rib or projection 26 from the remainder of the side edge 17, for example, and in one structure of the present invention these dimensions may be 2.5 cms. (one inch).

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All of the vertical reinforcing strips described above are inset in the core with the back or the webs or the like thereon aligned with the core surfaces and the inturned edges directed inwardly of the core, as shown in Figure 4. The turned edges of the reinforcing strips have a depth substantially less than the thickness of the core so that under no circumstances can the reinforcing strip on one side of the core touch or engage the reinforcing strip on the other side and it will be noted that the strips on the front and back surfaces are offset so that the strip edges are not aligned. The foregoing is particularly important in the attainment of the high insulating properties of the present invention for any metal path through the core would provide a heat path therethrough to materially decrease the heat insulating properties of the panel. It is also noted that all of the vertical reinforcing strips are coextensive with the length of the core surface upon which they are disposed.

The present invention also provides the lateral reinforcing strips, at least along the top 21 and bottom 22 of the panel. These strips are illustrated in Figures 5, 6, 7 and 8 and it will be seen therefrom that two different strip configurations are employed. A first flat planar strip 51 extends across the top of the surface 14 in extension above the rib or projection 28 along the top edge 21 of the panel. This strip 51 overlies the embedded vertical strips 41, 42 and 43 and engages the front surface 14 of the core therebetween. The strip 51 is adhered to the core and ends of the strips 41, 42 and 43 by a suitable bonding agent. At the top of the back surface 16 there is provided a

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reinforcing strip 52 which may be identical to the vertical strip 43 described above, except as to the length thereof. This strip 52 is disposed against the rear surface 16 at the top thereof with the turned edge of the strip abutting the top edge 21 of the core and this strip is adhered to the core and the ends of the vertical reinforcing strips 31, 32 and 36, which it overlies, by a suitable bonding agent. Strips 53 and 54, with the same shape as the strips 52, are adhered to the core 12 and lower ends of the vertical strips 41-43 and 32, 33, 36 respectively.

The panel of the present invention, as described above and illustrated in Figures 1 through 8 is adapted to be joined together with like panels to form a building structure. Thus, for example, panels may be joined together to form a wall of a building or a roof of a building. There is illustrated in Figure 9 a panel 11, shown in lateral cross-section, and abutting and joined to like panels 11a and 11b, also shown in cross-section. It will be seen that the side edge projection or rib 26 of panel 11 fits into the mating side edge indentation 27a of panel 11a with the reinforcing strip 43 of panel 11 overlying the reinforcing strips 41a of panel 11a. Similarly, the side edge projection or rib 26b of panel 11b fits into the side edge recess 27 of panel 11 with the reinforcing strip 43b of panel 11b overlying the reinforcing strip 41 of panel 11. The panels are joined together by sheet metal screws 61 driven through the overlying reinforcing strips 43-41a and 43b-41, as illustrated. It will be seen that a plurality of panels joined together, as shown, will in fact form a

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structural wall and such wall is adapted to be further operated upon, as described below.

5 Similar connections of panels may also be made in the vertical direction, as illustrated in Figure 10 wherein a panel 11 is shown to be abutted at the top by a panel 11c and at the bottom by a panel 11b. It will be seen that the top edge projection 28 of panel 11 fits into the bottom edge indentation 29c of panel 11c, with the
10 upper cross reinforcing strip 51 of panel 11 overlying the bottom cross reinforcing strip 53c of panel 11c. Sheet metal screws 61 are extended through these overlapping reinforcing strips and into the core to lock the panels together. A similar arrangement is
15 provided at the bottom of panel 11 and top of panel 11b, as illustrated.

The channel shaped reinforcing strips of the present invention are particularly advantageous, not only in
20 the resultant structure of the panel hereof, but also in the manufacture thereof. It will be appreciated that the turned edge or edges of a reinforcing strip provide the strip with the capability of resisting bending. This then materially improves the
25 longitudinal compression strength of the strip and also facilitates handling of same during manufacture of the panel. The illustrated panel is formed in a mold wherein the reinforcing strips are first positioned and then the mold is closed and filled with polystyrofoam
30 pellets, for example. The addition of heat, as by directing steam into the mold, causes the pellets to expand and bond together into a closed cellular structure. Preferably an adhesive is applied to the

inner surface of the reinforcing strips when they are inserted in the mold and the application of heat to expand the plastic core will cause this adhesive to become operable so that the strips are not only
5 embedded in the core, but are also adhered thereto. The strips are thus permanently bonded to the core and the turned edges of the channel reinforcing strips extend into the core itself to improve the bonding and also to materially strengthen the resultant panel.
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A building structure formed with panels of the present invention may be adapted to be coated or covered on both sides, and the exterior of the building may, for example, be coated with concrete. In order to provide
15 a means for the concrete to be retained against the front face of a panel, for example, there may be provided a wire mesh 71, as illustrated in Figure 11, which is mounted in spaced relation to the front face 14 of the panel by spacer blocks 72. A sheet metal
20 screw 73 with a washer 74 under the head thereof extends through the spacer block 72 and is threaded through a panel reinforcing strip 42, for example, with the wire mesh being held under the washer 74. The wire mesh 71 extends over or across a plurality of panels 11
25 and mesh edges may be woven together to provide a continuous mesh covering that becomes embedded in a concrete shell forming the exterior of the building structure. The building structure is adapted to receive a coating of concrete which may, for example,
30 be applied through a nozzle or by hand and which encompasses the wire mesh as a continuous shell. The inner surface or rear surface of the panel 11 is adapted to be covered, possibly by plaster, or as

illustrated in Figure 11, by a thin wood or composite veneer 76 which may be adhered to the panel by suitable adhesive or bonding agent. The resultant building structure has extremely good heat insulating properties as well as being structurally sound and relatively easily and quickly erected and completed. Wiring and piping may be placed in the walls formed by panels of the present invention; however, it is noted that no metal connections extend through the wall to provide path for heat transfer.

Building panels in accordance with the present invention may be employed in a variety of different ways for varying applications. Thus, for example, a panel may be prefinished for use in permanent, panelized constructed housing or for relocatable housing. Thin set brick, stucco, or wood panelling can be applied to the exterior side and the interior surface may be covered with plaster, dry wall, or panelling. Such panels are commonly used on monolithic poured concrete slabs on block foundations. The panels are positioned and connected by the application of self-tapping sheet metal screws and the joints are then covered by feature strips. It will be appreciated that relocatable housing or the like formed in the manner identified above is very lightweight, aside from the foundation or concrete slab, so that an entire unit can be airlifted, if necessary.



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CLAIMS

1. An insulating rectangular building panel comprising a core of expanded cellular plastics material having parallel front and back surfaces and reinforced with reinforcing strips, at least along the longitudinal and transverse edges of the panel, the reinforcing strips comprising: at least two longitudinal strips of U-shape each of which extends the full length of the panel with its side portions embedded in said core and the web connecting the side portions set within the front surface of the core so that the surface of the web remote from the bulk of the core is flush with the surface of the core; at least two further longitudinal strips of U-shape each of which extends the full length of the panel with its side portions embedded in said core and the web connecting the side portions set within the back surface of the core so that the surface of the web remote from the bulk of the core is flush with the surface of the core, the side portions of the strips on the front surface being offset from the side portions of the strips on the back surface of the core; a front transverse strip adhered to each of the two transverse edges of the front surface of the core, and a back transverse strip adhered to each of the two transverse edges of the back surface of the core, the front transverse strips being spaced from the back transverse strips and each of the transverse strips on each surface of the panel being adhered to all of the longitudinal strips on the same surface (front or back) of the panel.



2. A panel as claimed in claim 1 wherein the reinforcing strips include an overlap flange which extends from one of the longitudinal edges and one of the transverse edges of the panel, both flush with the same (front or back) surface of the panel for use in joining the panels one to another, edgewise.
3. A panel as claimed in claim 1 or 3 wherein at least one pair of opposite edges thereof have complementary offset stepped formations for edgewise mating of adjacent panels along said opposite edges.
4. A panel as claimed in claim 3 wherein both pairs of opposite edges of said panel are formed with said complementary offset stepped formations.
5. A panel as claimed in any one of claims 1 to 4 and comprising a wire mesh held spaced from one of the surfaces of the panel by standoff blocks and sheet metal screws extending through the wire mesh and into one or other of the reinforcing strips, for supporting on said surface a coating such as concrete.
6. A panel as claimed in any one of the preceding claims, wherein a protective and decorative covering is adhered to one surface of the panel.
7. A combination of panels as claimed in claim 2 or any one of claims 3 to 6 as appendant to claim 2 wherein panels are arranged to abut one another at their edges, with all of the said overlap flanges which are directed towards an adjacent panel overlying a reinforcing strip of said adjacent panel so that screws



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may extend through the overlying flange and the reinforcing strip below said flange, to join together adjacent panels of the combination.

- 5 8. An insulating building panel substantially as hereinbefore described with reference to, and as shown in the accompanying drawings.
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