A low density concrete building panel and method of manufacturing is provided with one or more carbon fiber or steel reinforcements which may include window and door openings which can be easily transported and erected at a building site.
1" THICK HD FOAM STRIPS ADDED TO PERIMETER AND AROUND OPENINGS
"blow-molded"

1 1/4"

Fig. 10E

6"

Fig. 10E

ALTUS Residential Rib Internal bar chair for #4 or #5
"blow-molded"

Fig. 10G

Fig. 10H

ALTUS Residential Rib Perimeter
Bar chair b
RESIDENTIAL WALL PANEL SECTION

(poured face down on a form liner)

- Fastener friendly™ 20 gauge galv-alum strips w/ staggered composite anchor pins laminated to 1.5 pcf r-1/2 foam strip

- 7-1/4" overall (to match standard 2 x 8 dm. lumber)

- Intermittent shear grid w/#5 bar

- 1-3/4" face w/ 1/4" reveal

- Carbon fiber grid in face (tensioned to facilitate one pass concrete placement)

Notes:
- Rib/studs 24" o.c.
- R-13 std.
- 22 PSF nominal weight (2K SF/oad)
PRESTRESSED CONCRETE BUILDING PANEL AND METHOD OF FABRICATING THE SAME

FIELD OF THE INVENTION

[0001] The present invention relates to building components, and more specifically composite lightweight building panels which can be interconnected to build structures such as modular buildings or applied as cladding to building frames.

BACKGROUND OF THE INVENTION

[0002] Due to the high cost of traditional concrete components and the extensive transportation and labor costs associated therein, there is a significant need in the construction industry to provide a lightweight, precast, composite building panel which may be transported to a building site and assembled to provide a structure with superior strength and insulative properties. Previous attempts to provide these types of materials have failed due to the extensive transportation costs, low insulative values and thermal conductivity associated with prefabricated concrete wire reinforced products. Further, due to the brittle nature of concrete, many of these types of building panels become cracked and damaged during transportation.

[0003] More specifically, the relatively large weight per square foot of prior art fabricated building panels has resulted in high expenses arising not only from the amount of materials needed for fabrication, but also the cost of transporting and erecting the modules. Module weight also placed effective limits on the height of structures, such as stacked modules, e.g. due to limitations on the total weight carried by the foundations, footings and lowermost modules. Furthermore, there is substantial fabrication labor expense that can arise from efforts needed to design reinforcement, and the materials and labor costs involved in providing and placing reinforcement materials. Accordingly, it would be useful to provide a system for modular construction which is relatively light, can be readily stacked to heights greater than in previous configurations and, preferably, inexpensive to design and manufacture.

[0004] Further, in many situations panels or modules are situated in locations where it is desirable to have openings therethrough to accommodate doorways, windows, cables, pipes and the like. In some previous approaches, panels were required to be specially designed and cast so as to include any necessary openings, requiring careful planning and design and increasing costs due to the special, non-standard configuration of such panels. In other approaches, panels were cast without such openings and the openings were formed after casting, e.g. by sawing or similar procedures. Such post-casting procedures as cutting, particularly through the thick and/or steel-reinforced panels as described above, is a relatively labor-intensive and expensive process. In many processes for creating openings, there was a relatively high potential for cracking or splitting of a panel or module. Accordingly, it would be useful to provide panels and modules which can be post-fitted with openings such as doors and windows in desired locations and with a reduced potential for cracking or splitting.

[0005] One further problem associated with metallic wire materials used in conjunction with concrete is the varying rates of expansion and contraction. Thus with extreme heating and cooling the metallic wire tends to separate from the concrete, thus creating cracks, exposure to moisture and the eventual degradation of both the concrete and wire reinforcement.

[0006] One example of a composite building panel which attempts to solve these problems with modular panel construction is described in U.S. Pat. No. 6,202,375 to Klein-Schmidt (the '375 patent). In this invention, a building system is provided which utilizes an insulative core with an interior and exterior sheet of concrete and which is held together with a metallic wire mesh positioned on both sides of an insulative core. The wire mesh is embedded in concrete, and held together by a plurality of metallic wires extending through said insulative core at a right angle to the longitudinal plane of the insulative core and concrete panels. Although providing an advantage over homogenous concrete panels, the composite panel disclosed in the '375 patent does not provide the necessary strength and flexure properties required during transportation and high wind applications. Further, the metallic wire mesh materials are susceptible to corrosion when exposed to water during fabrication, and have poor insulative qualities due to the high heat transfer qualities of metallic wire. Thus, the panels disclosed in the '375 patent may eventually fail when various stresses are applied to the building panel during transportation, assembly or subsequent use. Furthermore, these panels have poor insulative qualities in cold climates due to the high heat transfer associated with the metallic wires.

[0007] Accordingly, there is a significant need in the construction and building industry to provide a composite building panel which may be used in modular construction and which is lightweight, provides superior strength and has high insulative values. Further, a method of making these types of building panels is needed which is inexpensive, utilizes commonly known manufacturing equipment, and which can be used to mass produce building panels for use in the modular construction of warehouses, low cost permanent housing, hotels, and other buildings.

SUMMARY OF THE INVENTION

[0008] It is thus one aspect of the present invention to provide a composite wall panel which has superior strength, high insulating properties, is lightweight for transportation and stacking purposes and is cost effective to manufacture. Thus, in one embodiment of the present invention, a substantially planar insulative core with interior and exterior surfaces is positioned adjacent an exterior concrete face which is reinforced with a carbon fiber grid. A plurality of reinforcing ribs are positioned substantially adjacent the insulative core and are operably interconnected to the exterior face with a plurality of carbon fiber strands. Preferably, the carbon fiber mesh grid is comprised of a plurality of first carbon fiber strands extending in a first direction which are operably interconnected to a plurality of second carbon fiber strands oriented in a second direction. Preferably, the carbon fiber mesh grids are embedded within the reinforcing ribs and exterior concrete face. Further, in one embodiment the carbon fiber grid in the exterior concrete face is tensioned during fabrication and prior to the concrete curing to provide enhanced strength to the finished product. In a preferred embodiment, a fastener friendly nailing strip is positioned...
on an interior surface of the wall panel opposite each of the reinforcing ribs for the attachment of drywall, paneling, and other interior trim materials.

[0009] It is another aspect of the present invention to provide a spacer which controls the separation of the insulative panels during fabrication to assure that the reinforcing ribs have a uniform thickness. In one embodiment, these spacers have spikes that are driven into the insulative panels, and preferably also include a retention device to support one or more reinforcing bars.

[0010] It is another aspect of the present invention to provide a composite wall panel which can be easily modified to accept any number of exterior textures, surfaces or cladding materials for use in a plurality of applications. Thus, the present invention is capable of being finished with a brick surface, stucco, siding and any other type of exterior surface. In one embodiment of the present invention, a paraffin protective covering is provided on the exterior surface for protection of the exterior surface during manufacturing. The paraffin additionally prevents an excessive bond between the individual bricks and exterior concrete wall to allow the removal of a cracked or damaged brick and additionally has been found to reduce cracking in the bricks due to the differential shrinkage of the exterior concrete layer and clay brick. Furthermore, other types of materials such as drywall and other interior finishes can be applied to the interior concrete panel as necessary for any given application.

[0011] It is yet another aspect of the present invention to provide a composite modular wall panel which can be used to quickly and efficiently construct modular buildings and temporary shelters and is designed to be completely functional with regard to electrical wiring and other utilities such as telephone lines, etc. Thus, the present invention in one embodiment includes at least one utility line which may be positioned at least partially within the composite wall panel and which accepts substantially any type of utility line which may be required in residential or commercial construction, and which can be quickly interconnected to exterior service lines. This utility line may be oriented in one or more directions and positioned either near the interior concrete panel, exterior concrete panel, or both.

[0012] It is yet another aspect of the present invention to provide a novel surface configuration of the insulative core which assures a preferred spacing between the surface of the insulative core and the carbon fiber grid. This surface configuration is applicable for a front surface, a rear surface, or both depending on the application. More specifically, the spacing is designed to provide a gap between the interior and/or the exterior surface of the insulative core and the carbon fiber grids to assure that concrete or other facing materials become positioned between the surface of the insulative core and the carbon fiber grid. This improved and consistent spacing enhances the strength and durability of the insulative panel when interconnected to the facing material, carbon fiber grids and transverse fibers and/or steel prestressing strands.

[0013] In one embodiment of the present invention the insulative core may have an interior and/or an exterior surface which is undulating, i.e., wavy alternative embodiments may have channels or protruding rails, spacer "buttons", a "waffleboard" configuration, or other shapes which create a preferred spacing between the surface of the insulative material and the fiber grids. Preferably, the spacing apparatus, channels, rails or other spacers are integrally molded with the insulative core to reduce labor and expenses. Alternatively, these spacing apparatus may be interconnected to the insulative foam after manufacturing, and may be attached with adhesives, screws, nails, staples or other interconnection means well known by one skilled in the art.

[0014] It is a further aspect of the present invention to provide a lightweight, durable building panel which utilizes concrete and expanded polystyrene materials, along with a unique geometry of carbon fiber, steel reinforcing rods, and wire mesh to create a building panel with superior strength and durability. The building may utilize one or more reinforcing materials such as carbon fiber, wire mesh or steel reinforcing bars positioned along 1) a perimeter edge; 2) an interior portion within the perimeter edge; or 3) both along the perimeter edges and within a predetermined interior portion of the building panel. Thus, in one embodiment of the present invention a lightweight, durable concrete building panel is provided, comprising:

[0015] a concrete building panel comprising an inner surface, an outer surface, a first end and a second end, and a substantially longitudinal axis defined between said first end and said second end;

[0016] a tensioned first carbon fiber grid positioned within said substantially planar concrete panel between said first end and said second end and positioned proximate to said outer surface in an exterior concrete layer;

[0017] a plurality of foam core sections positioned on said exterior concrete layer and defining a plurality of reinforcing rib channels between said plurality of foam core sections which are substantially filled with a concrete material;

[0018] at least one carbon fiber shear strip positioned within said plurality of reinforcing rib channels and extending into said exterior concrete layer; and

[0019] at least one reinforcing bar positioned proximate to said at least one carbon fiber shear strip and positioned within said plurality of reinforcing rib channels.

[0020] In a preferred embodiment of the present invention, the insulative core is comprised of a plurality of individual insulative panels. The seam of the insulative panels preferably has a cut-out portion which is used to support reinforcing materials such as rebar, carbon fiber or other material.

[0021] It is a further aspect of the present invention to provide a method of fabricating an insulative concrete building panel in a controlled manufacturing facility which is cost effective, utilizes commonly known building materials and produces a superior product. It is a further aspect of the present invention to provide a manufacturing process which can be custom tailored to produce a building panel with custom sizes, allows for modifications for windows and doors, and which utilizes a variety of commonly known materials without significantly altering the fabrication protocol.

[0022] Thus, in another aspect of the present invention, a method for fabricating low density, durable concrete building panel is provided, comprising:
a) providing a casting form having a first end, a second end, and lateral edges extending therebetween;

b) positioning a first grid of carbon fiber material into said concrete material;

c) applying tension to said first grid of carbon fiber material;

d) positioning a plurality of reinforcing strands in said casting form;

e) applying tension to said plurality of reinforcing strands;

f) pouring a first layer of concrete material into a lower portion of said form;

g) positioning a layer of low density insulative material onto said first layer of concrete material, said low density insulative material having a plurality of reinforcing rib sections extending substantially between said first end and said second end, said reinforced rib sections comprising:

1) a second grid of carbon fiber extending substantially between said first end and said second end of said low density insulative material;

2) at least one metallic reinforcing bar positioned proximate to said second grid of carbon fiber and extending between said front end and said second end of said foam core;

h) pouring a second layer of concrete within said plurality of reinforced rib sections;

i) allowing said first layer and said second layer of concrete to cure; and

j) removing said concrete building panel from said form, wherein said lightweight concrete building panel is available for transportation and use.

It is a further aspect of the present invention to provide a novel manufacturing method wherein one or more “negatives” are positioned within the casting form prior to pouring the exterior layer of concrete. The negatives create a void of concrete in a predetermined opening such as a window or door, and which can be repeatedly used in numerous castings of wall panels. In one embodiment the “negative” is a rubber plastic mat that is laser oriented to a proper position. Weights or magnets or both may be utilized to prevent inadvertent movement.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a front perspective view of one embodiment of a casting table with form liner used for fabricating a precast concrete wall panel;

FIG. 2 is a front perspective view of the embodiment shown in FIG. 1, and further depicting the placement of a window negative;

FIG. 3 is a front perspective view of the embodiment shown in FIG. 1, and showing the placement of a tensioned carbon fiber grid material and tensioned metallic strands;

FIG. 4 is a front perspective view of the invention shown in FIG. 1, and further depicting the placement of a V-Buck locator frame placed over the carbon fiber material;

FIG. 5 is a front perspective view of the embodiment shown in FIG. 1, and further depicting the dispensing of a predetermined volume of concrete into the casting table;

FIG. 6 is a front perspective view of the embodiment shown in FIG. 1 showing the concrete positioned in the casting table being vibrated;

FIG. 7 is a front perspective view of the casting table shown in FIG. 1 with the V-Buck frame placed around a window opening;

FIG. 8 is a front perspective view of the casting table shown in FIG. 1 and further depicting the positioning of high density foam strips and reinforcing material around the window opening and perimeter edges of the casting table;

FIG. 9 is a front perspective view of the embodiment shown in FIG. 1, and further depicting the placement of foam billets on top of the first concrete layer;

FIG. 10 is a front perspective view of the embodiment shown in FIG. 1 and further depicting in detail the positioning of the foam billets and the brackets used therein;

FIG. 10A is a detailed cross-sectional view of one portion of the embodiment shown in FIG. 10;

FIG. 10B is a detailed cross-sectional view of a rebar support bracket positioned between two foam billets;

FIG. 10C is an alternative embodiment of the bracket shown in FIG. 10B, and an associated plastic foam block spacer;

FIG. 10D is a cross-sectional elevation view showing additional detail of the casting table lateral edge and retention magnet;

FIG. 10E is a tension bar bracket shown penetrated into two individual foam blocks;

FIG. 10F is a top plan view of the bracket shown in FIG. 10E;

FIG. 10G is an alternative embodiment of the tension bar bracket shown in FIG. 10E;

FIG. 10H is a top plan view of the tension bar bracket shown in FIG. 10G;

FIG. 11 is a front perspective view of the casting table shown in FIG. 1, and further depicting the casting table filled with a second layer of concrete within the reinforcing ribs between the foam panel;

FIG. 11A is a cross-sectional elevation view of one embodiment of a lift anchor positioned within a reinforcing rib;

FIG. 12 is a front perspective view of the casting table shown in FIG. 1 and further depicting the interconnection of exterior nailers 46 which are interconnected to the reinforcing ribs 14;

FIG. 12A depicts detailed cross-sectional elevation views of two exterior naiier designs, and including tension bar brackets, rebar, carbon fiber, etc.;

FIG. 13 is a front perspective view of the embodiment shown in FIG. 1, and depicting the lateral side forms removed from the casting table;
FIG. 14 shows the embodiment shown in FIG. 1 with the casting table being hydraulically tilted for removal purposes;

FIG. 15 depicts the lifting of the precast table completed and removed from the casting table;

FIG. 16 shows a plurality of prefabricated concrete panels being positioned on a panel support rack; and

FIG. 17 depicts a cross-sectional partial front elevation view of one embodiment of a residential wall panel section.

DETAILED DESCRIPTION

In one aspect of the present invention, a method of manufacturing a low density concrete composite building panel 2 is provided herein. These insulated concrete panels can withstand 150 MPG wind loads and tornado driven projectiles, yet are extremely light weight to transport and erect with an average density of approximately 18 lbs/ft.4 (PSF). The exterior finishes of the wall panels can incorporate cladboard, paneled brick, stucco and plain concrete for field finishing. The interior stud surfaces are fastener friendly with 2 inch wide screw strips that run top to bottom as well as along all perimeters. Further, a “negative-liner” casting system is provided to offer a menu of rough opening sizes that can be custom tailored for the needs of the consumer.

The manufacturing process is generally initiated by providing a casting table 8 having a first end and a second end with lateral edges extending therebetween, the form providing a shell for receiving the concrete materials and other components. If window or door openings are required, a negative is laser-located and positioned within the casting table. A concrete block or other weight or magnets may further be used to prevent movement of the negative. A first grid of reinforcing materials is then positioned into the casting table. Preferably, the first grid of reinforcing materials comprises a carbon fiber grid which may be put under tension between about 1000-5000 lbs. Once the carbon fiber grid is tensioned, a predetermined amount of concrete material is placed in the casting table. The concrete may be vibrated to remove air and improve the uniform density. Further, one or more tensioned wire cables or metallic bars may be positioned in the casting table prior to the introduction of the concrete, and which are generally oriented in a longitudinal direction of the building panel 2. After the concrete is cured any excess carbon fiber grid and metal reinforcing strands are cut and trimmed from the perimeter edges of the building panel 2. Next, a layer of insulative core 4 is positioned on the interior surface of the concrete material. In a preferred embodiment of the present invention, the insulative core 4 is comprised of a plurality of individual insulative form billets 4 which have been cut to the preferred dimensions of the composite building panel form. Further, at predetermined widths and on the exterior edges of the composite building panel, a reinforcing strip 48 is provided which may include a second grid of reinforcing materials such as carbon fiber, and which extends substantially between the first and second end of the insulative core 4. Alternatively, rebar or other reinforcing materials may be positioned around the perimeter edge of the building panel 2, and along any window/door openings for increased strength and performance.

Referring now to FIG. 3, after positioning of the negative(s) 10, a carbon fiber grid is stretched along the longitudinal axis of the casting table 8. Alternatively, the carbon fiber grid material 6 could be stretched in a direction which is substantially normal to the longitudinal direction of the casting table. After the carbon fiber material 6 has been positioned over the negative 10, a preferred embodiment the carbon fiber grid material is placed into tension between about 1000-5000 lbs. As further shown in FIG. 3, a plurality of tensioned steel cables or wires are also positioned within the casting table, and are preferably put under tension between about 500-5000 lbs. In one embodiment, the tensioned strands are \( \frac{1}{4} \) inch diameter, although other sizes between approximately \( \frac{1}{4} \) to 2.0 inches could be used depending on the application and size of the building panel.

Referring now to FIG. 4, after tension has been placed on the carbon fiber grid material 6 and the tensioned wire 12, a V-Buck locator frame 26 is positioned on top of the negative, as well as any high density weights to restrict movement. The V-Buck locator frame 26 is positioned on top of the negative 10 to provide support for the reinforced window/door frame 42. As appreciated by one skilled in the art, the V-Buck locator frame and negative can be any particular size or dimension depending on the design criteria required therein.

Referring now to FIG. 5, after positioning of the V-Buck locator frame 26 over the window or door frame, concrete is dispensed into the casting table 8 by a concrete dispenser 30. The exact volume of concrete required for any given casting is preferably determined by a CAD program or other computer method to assure there is not unnecessary waste, and that there is a sufficient volumetric requirement of concrete based on the size and thickness of the building panel.

Referring now to FIG. 6, after the concrete is positioned in place, the casting table is preferably vibrated for a predetermined period of time to help improve the
density of the concrete by removing air bubbles and/or concrete voids and to help position the concrete material.

[0071] Referring now to FIGS. 7 and 8, after the concrete has been vibrated, the V-Buck 26 is placed around the reinforced window/door frame 42 and V-Buck locator frame, and is generally comprised of a wood material which allows the window frame to be interconnected to the building panel 2 after the building panel wall is erected. As shown in FIG. 8, after the V-Buck 26 has been positioned around the reinforced window/door frame 42, high density foam strips and reinforcing materials are added around the window opening 42 and perimeter edges of the building panel 2 to provide additional reinforcement. As shown from the detailed cross-sectional elevation view in FIG. 8, the reinforcing materials may include tensioned wire/bar 12, carbon fiber shear grid 80, or combinations thereof.

[0072] Referring now to FIG. 9, after the positioning of the perimeter reinforcing materials around the window/door openings and the perimeter of the casting table, a plurality of foam billets 4 are positioned in the casting table on top of the concrete layer. The foam billets 4 in this embodiment are shown as individual pieces, although as appreciated by one skilled in the art a single uniform piece of foam may be used which has individual channels positioned therein to achieve the same purpose.

[0073] Referring now to FIGS. 10-10D, additional detail is provided for the positioning of the foam billets 4 within the casting table 8 as shown in FIG. 10. The use of unique tension bar brackets 18 which are used to both provide spacing between the individual foam billets 4, and to support one or more reinforcing tension bars 12. More specifically, and referring now to FIG. 10A, a detailed cross-sectional view of the casting table 8 is shown herein, and which includes a casting table lateral rail 84 which is held in position with a magnet 82. The magnet 82 allows the casting table lateral rail to be moved to any position depending on the size of the form required for the individual application. As shown in FIG. 10A, one specific type of tension bar bracket 18 is utilized which supports a reinforcing tension bar 12 and which further includes tension bar bracket spikes 32 which are driven into the foam billet 4 for support purposes. Referring now to FIGS. 10B and 10C, alternative embodiments of various tension bar brackets 18 are shown which support the tension wires/bar 12. As further shown, the carbon fiber shear grid 80 is positioned into the exterior concrete layer 16 to provide additional structural support to the area positioned between the foam billets 4 when they are subsequently filled with concrete. Referring now to FIGS. 10E and 10F, cross sectional front elevation views of the tension bar brackets 18 used in one embodiment of the present invention are provided herein. More specifically, the tension bar bracket 18 includes one or more tension bar bracket spikes 32 which allow the tension bar brackets 18 to be driven into the individual foam billets and to provide spacing and for structural support to hold the tension bar 12. FIG. 10F is a top plan view of the embodiment shown in 10E, and providing additional detail and dimensions. Referring now to FIGS. 10G and 10H, cross sectional front elevation views and plan views of alternative tension bar brackets 18 are further provided herein in detail to show the various dimensions and geometric configuration. Generally, the tension bar brackets 18 provided herein are made of plastic or fiberglass materials, but alternatively can be made of any other materials commonly known in the art.

[0074] Referring now to FIGS. 11 and 11A, detail is provided of a specific rib with a lift loop or cable 40 being positioned therein in a lift loop pocket, and which is subsequently used to pick up the composite building panel 2 after fabrication, and allows the hidden lift loop 40 to be cut off after transportation and erection. As shown in the FIG. 11A, the lift loop 40 is positioned within the rib and concrete rib layer 14, and which is positioned in a lift loop pocket during fabrication. Preferably the lift loop 40 is comprised of high grade aircraft cable, but obviously other suitable materials could be used for the same purpose.

[0075] Referring now to FIGS. 12 and 12A, additional detail is provided which shows the concrete ribs 14 filled with concrete, and the use of exterior nailers 46 which are interconnected to the concrete ribs 14 and which are used for the interior finishing of the composite building panel 2 within a given residential or commercial structure. More specifically, the exterior nailers 46 are comprised of a foam material, in conjunction with a metallic aluminum cover sheet or wood and which are adapted for use with nails, screws, or other attachment hardware used in the finishing of the interior surface of the wall. Referring now to FIG. 13, the manufacturing process is shown wherein the side forms of the casting table 8 are removed, while the remainder of the building panel 2 is still positioned on the casting table. Referring now to FIG. 14, the panel table is hydraulically tilted with casting table hydraulic lift 48 and which elevates the building panel 2 to expose one or more lifting anchors 40.

[0076] Referring now to FIGS. 15-16, the individual building panels are shown being lifted with a lifting cable 50 which are interconnected to the lifting anchor loops 40 and are subsequently put on a panel support rack 52 for transportation.

[0077] Referring now to FIG. 17, a cross-sectional front elevation view of one embodiment of the present invention of a building panel 2 is provided herein. More specifically, the building panel 2 is comprised of a carbon fiber grid material 6 which is positioned in an exterior concrete layer 16. The exterior concrete layer is interconnected to a concrete rib 14 by means of a carbon fiber grid 80 which is further positioned proximate to a tension wire 12. In-between each of the concrete ribs 14 are individual foam billets 4 which are generally comprised of reground EPS foam with a density of between about 0.25-1.25 PCF, and with a thickness of approximately 3 to 7 inches. As shown interconnected to the individual concrete ribs 14, an exterior nailing 46 is depicted which is operably interconnected to the concrete ribs 14 by means of nailing anchor pins 86. Furthermore, a 20 gauge galvanized aluminum strip is positioned on top of the foam material and which is user friendly for attaching hardware such as screws, nails, and bolts. During interior construction of the building, additional insulation materials can be positioned along the EPS foam, as well as sufficient spacing being provided for electrical outlet boxes, wiring, water pipe positioning, and other utilities commonly used in construction. Following the positioning of these materials, the interior portion of the wall panel 2 can be finished with drywall, paneling and other traditional construction materials.
One example of a carbon fiber grid ribbon which may be used in the present invention is the “MeC-GRID™” carbon fiber material which is manufactured by Hexcel Clark-Schwebel and as described in U.S. Pat. No. 6,236,629, which is incorporated herein by reference. The interior and exterior carbon grid tape is comprised generally of looped or crossed weft and warped strands, that run substantially perpendicular to each other and are machine placed on several main tape “stabilizing strands” that run parallel to the running/rolling direction of the tape.

With regard to the concrete utilized in various embodiments of the present application, a low density concrete such as Cret-o-Lite™, which is manufactured by Advanced Materials Company of Hamburg, N.Y., may be used. This is an air dried cellular concrete which is nailable, drillable, screwable, sawable and very fire resistant.

In one embodiment, the exterior concrete layer may be comprised of a dense concrete material to resist moisture penetration and in one embodiment VISCO CRETETM is utilized which enables the high slumped short pot life liquidation of concrete to enable the concrete to be placed in narrow wall cavities with minimum vibration and thus create a high density, substantially impermeable concrete layer. VISCO-CRETETM is manufactured by the Sika Corporation, located in Lyndhurst, N.J. The exterior concrete layer is preferably about 3/4 to 2 inches thick, and more preferably about 1.75 inches thick. This concrete layer has a compression strength of approximately 5000 psi after 28 days of curing, and is thus extremely weather resistant.

In one embodiment of the present invention, a vapor barrier material may be positioned next to or on the exterior surface of the insulative core, or alternatively on the interior surface of the insulative foam core. The vapor barrier impedes the penetration of moisture and thus protects the foam core from harsh environmental conditions caused by temperature changes. Preferably, the vapor barrier is comprised of a plastic sheet material, or other substantially impermeable materials that may be applied to the insulative core during manufacturing of the foam core, or alternatively applied after manufacturing and prior to positioning of the insulative foam core.

To assist in the understanding of the present invention, the following is a list of the components identified in the drawings and the numbering associated therewith:

<table>
<thead>
<tr>
<th>#</th>
<th>Component</th>
</tr>
</thead>
<tbody>
<tr>
<td>2</td>
<td>Composite building panel</td>
</tr>
<tr>
<td>4</td>
<td>Insulative foam billets</td>
</tr>
<tr>
<td>6</td>
<td>Carbon fiber grid material</td>
</tr>
<tr>
<td>8</td>
<td>Casting table</td>
</tr>
<tr>
<td>10</td>
<td>Casting negative</td>
</tr>
<tr>
<td>12</td>
<td>Tension wire/bar</td>
</tr>
<tr>
<td>14</td>
<td>Concrete reinforcing ribs</td>
</tr>
<tr>
<td>16</td>
<td>Exterior concrete layer</td>
</tr>
<tr>
<td>18</td>
<td>Tension bar bracket</td>
</tr>
<tr>
<td>20</td>
<td>Utility conduit</td>
</tr>
<tr>
<td>22</td>
<td>Exterior cladding</td>
</tr>
<tr>
<td>24</td>
<td>Carbon fiber roll</td>
</tr>
<tr>
<td>26</td>
<td>V-Buck locator frame</td>
</tr>
<tr>
<td>28</td>
<td>Spacer</td>
</tr>
<tr>
<td>30</td>
<td>Concrete dispenser</td>
</tr>
<tr>
<td>32</td>
<td>Tension bar bracket spikes</td>
</tr>
</tbody>
</table>

The foregoing description of the present invention has been presented for purposes of illustration and description. Furthermore, the description is not intended to limit the invention to the form disclosed herein. Consequently, variations and modifications commenced here with the above teachings and the skill or knowledge of the relevant art are within the scope of the present invention. The embodiments described herein are further extended to explain best modes known for practicing the invention and to enable others skilled in the art to utilize the invention in such, or other, embodiments or various modifications required by the particular applications or uses of present invention. It is intended that the dependent claims be construed to include all possible embodiments to the extent permitted by the prior art.

What is claimed is:

1. A carbon fiber reinforced concrete building panel, comprising:

   - an inner surface, an outer surface, a first end and a second end, and a substantially longitudinal axis defined between said first end and said second end;
   - a tensioned first carbon fiber grid positioned within an exterior concrete layer between said first end and said second end;
   - a plurality of foam core panels positioned substantially adjacent to said exterior concrete layer and defining a plurality of rib channels between said plurality of foam core panels which are substantially filled with a concrete material;
   - at least one carbon fiber shear strip positioned within said plurality of rib channels and extending into said exterior concrete layer; and
   - at least one reinforcing bar positioned proximate to said at least one carbon fiber shear strip and positioned within said plurality of rib channels.
2. The carbon fiber reinforced concrete building panel of claim 1, wherein said at least one carbon fiber shear strip is comprised of an interwoven grid of individual carbon fibers.

3. The carbon fiber reinforced concrete building panel of claim 1, further comprising at least one lifting anchor interconnected to at least one of said first end, said second end, and lateral edges extending therebetween.

4. The carbon fiber reinforced concrete building panel of claim 1, wherein said plurality of foam core panels is comprised of one integral foam core panel with a plurality of reinforcing rib channels positioned therein to receive concrete and reinforcing materials.

5. The carbon fiber reinforced concrete building panel of claim 1, further comprising a nailing surface openly interconnected to said plurality of rib channels which are adapted to receive a nail, a screw, and other interconnection means.

6. The carbon fiber reinforced concrete building panel of claim 5, wherein said nailing surface comprises at least one of a foam material, a wood material and a metal material.

7. The carbon fiber reinforced concrete building panel of claim 1, further comprising a plurality of spacers positioned between said plurality of foam core panels which include a support member for holding a reinforcing bar.

8. The carbon fiber reinforced concrete building panel of claim 1, further comprising a reinforced section including at least one of a reinforcing bar and a carbon fiber material positioned around a window frame or a door frame.

9. The carbon fiber reinforced concrete building panel of claim 1, wherein said at least one first reinforcing bar is comprised of a metallic rod having a diameter of at least about 0.25 inches.

10. The carbon fiber reinforced concrete building panel of claim 1, further comprising a second reinforcing bar which is positioned proximate to at least one of a plurality of perimeter edges of said substantially planar concrete panel.

11. The carbon fiber reinforced concrete building panel of claim 1, further comprises a second carbon fiber shear strip positioned proximate to at least one of a plurality of perimeter edges of said substantially planar concrete panel.

12. The carbon fiber reinforced concrete building panel of claim 1, further comprising at least one spacer positioned at least partially around at least one first reinforcing bar, wherein there is a predetermined amount of separation between said foam core and said at least one first reinforcing bar.

13. The carbon fiber reinforced building panel of claim 1, wherein said tensioned first carbon fiber grid has a tension of at least about 500 lbs.

14. The carbon fiber reinforced building panel of claim 1, wherein said building panel has a density of no greater than about 20 lbs/ft².

15. A method for fabricating a low density concrete building panel, comprising:

a) providing a form having a first end, a second end, and lateral edges extending therebetween;

b) positioning a plurality of metal strands in said form;

c) applying tension to said plurality of metal strands;

d) positioning a first grid of carbon fiber material in said form;

e) applying tension to said first grid of carbon fiber material;

f) pouring a first layer of concrete material into said form;

g) positioning a layer of insulative material onto said first layer of concrete material, said insulative material having a plurality of reinforcing rib channels extending substantially between at least one of said first end and said second end or said lateral edges;

h) positioning a first reinforcing material in said plurality of rib channels;

i) pouring a second layer of concrete into said plurality of reinforcing rib channels;

j) allowing said first layer and said second layer of concrete to cure; and

k) removing said concrete building panel from said form, wherein said lightweight concrete building panel is available for transportation and use.

16. The method of claim 15, further comprising the step of positioning at least one lifting anchor in at least one of said plurality of rib channels.

17. The method of claim 15, further comprising positioning a second reinforced section within said form to define an opening for at least one of a window, a door, and a utility vault.

18. The method of claim 15, wherein the step of positioning a layer of insulative material comprises orienting a plurality of individual foam core panels in a predetermined pattern on said first layer of concrete.

19. The method of claim 15, further comprising the step of interconnecting at least some of said individual foam core panels prior to said step of positioning said individual foam core panels onto said first layer of concrete material.

20. The method of claim 18, further comprising the step of positioning a spacer between said plurality of individual foam core panels, wherein said second layer of concrete has a substantially uniform thickness between said plurality of individual foam core panels.

21. The method of claim 15, wherein said layer of insulative material is comprised of an expanded polystyrene material.

22. The method of claim 21, wherein said spacer further comprises a support mechanism for holding a reinforcing bar in a predetermined location.

23. The method of claim 15, further comprising the step of positioning at least one of a metallic reinforcing bar and a third grid of carbon fiber along at least a portion of a perimeter edge of said concrete building panel prior to said step of allowing said first layer and said second layer of concrete to cure.

24. A method for fabricating a low density concrete building panel having a window or door opening, comprising:

a) providing a casting form having a first end, a second end, and lateral edges extending therebetween;

b) positioning a negative to a bottom portion of the casting forms in a predetermined position which defines a window opening or a door opening;

c) positioning a plurality of metal strands in said form;

d) applying tension to said plurality of metal strands;

e) positioning a first grid of carbon fiber material in said form;
f) applying tension to said first grid of carbon fiber material;
g) positioning a framing material on or proximate to said negative;
h) pouring a first layer of concrete material into said form;
i) positioning a layer of foam core onto said first layer of concrete material, said layer of foam core having a plurality of reinforcing rib channels extending substantially between at least one of said first end and said second end or between said lateral edges;
j) positioning a first reinforcing material in said plurality of reinforcing rib channels;
k) pouring a second layer of concrete into said plurality of rib channels;
l) allowing said first layer and said second layer of concrete to cure; and
m) removing said concrete building panel from said form, wherein said lightweight concrete building panel is available for transportation and use.

25. The method of claim 24, wherein said framing material is comprised of wood.
26. The method of claim 24, wherein at least about 500 lbs. of tension is applied to said first grid of carbon fiber material.
27. The method of claim 24, further comprising trimming any excess carbon fiber from the window opening or door opening.
28. The method of claim 24, wherein at least about 500 lbs. of tension is applied to said plurality of metal strands.
29. The method of claim 24, wherein said positioning a layer of foam comprises placing a plurality of individual foam panels on said first layer of concrete in a predetermined pattern.
30. The method of claim 24, wherein positioning a first reinforcing material in said plurality of reinforcing rib channels comprises positioning a metallic reinforcing rod on a bracket which is operatively interconnected to at least one of said plurality of individual foam panels.

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