Light weight structural wall panels are made of two layers of load bearing skins, separated by a light-weight concrete, using expanded materials such as Perlite, Pulverized Fuel Ash, Styrene or foam cement to form a sandwiched construction for structural strength. The load-bearing skins, which are sprayed into a mold, are made of glass fiber, sand and cement matrix in different thickness and mix ratios. All edges of the encapsulated panels are made of the same GFRC matrix. The distance between GFRC inner & outer layers dictates the required structural strength of overall finished panel to resist wind & earthquake loadings. The sprayed layers and the core are made/cast while the concrete is green, before its initial setting-time to ensure structural integrity of components after curing.
FIG. 3B
LIGHT WEIGHT SANDWICH PANELS

[0001] This application claims priority from provisional application Ser. No. 60/701,993, filed Jul. 25, 2005.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] The invention relates to building panels. More particularly, the invention relates to panels having a stressed skin sandwich construction.

[0004] 2. Discussion of the Background

[0005] Numerous types of building panels have been heretofore proposed, each offering particular advantages and disadvantages. It is highly desirable to improve insulation and strength properties of such panels, whilst at the same time reducing their weight. In addition, there is a long-felt need for building panels that are resistant to earthquakes, as well as resistant to high winds such as occur in hurricanes and the like.

[0006] These and other problems are overcome by the present invention, as will be further described with reference to the several views, in which like numerals represent like elements.

SUMMARY

[0007] Light weight structural wall panels are made of two-layers of load bearing skins, separated by a light-weight concrete, using expanded materials—such as Perlite, Pulverized Fuel Ash, Styrene or foam cement—to form a sandwiched construction for structural strength. The load-bearing skins, which are sprayed into a mold, are made of glass fiber, sand and cement matrix in different thickness and mix ratios. All edges of the encapsulated panels are made of the same—GFRC matrix. The distance between GFRC layers—inner & outer layers—dictate the required structural strength of overall finished panel to resist wind & earthquake loadings. The sprayed layers and the core are made/cast while the concrete is green, before its initial setting-time to ensure structural integrity of components after curing.

BRIEF DESCRIPTION OF THE DRAWINGS

[0008] FIG. 1 shows the detailed construction of a typical panel according to a preferred embodiment of the invention.

[0009] FIG. 2 is a light partition slab for interior use as a partition.

[0010] FIG. 3A is an exploded view showing a floor slab provided with an adjustable hold-down device during construction to receive a loading arm of a panel holder.

[0011] FIG. 3B is a detailed view of part of FIG. 3A.

[0012] FIG. 3C is a side view of the Beta Link holding end.

[0013] FIG. 3D shows a typical vertical joint between two adjoining panels filled up by cement grout and a reinforcing bar.

[0014] FIG. 3E is a plan view of the Beta Link holding end.

[0015] FIG. 4 is a view of a mold with an inset view showing the relation of a GFRC skin to the core material and the mold.

[0016] FIG. 5 illustrates a production line.

[0017] FIG. 6 is a view of a ceiling panel according to an embodiment of the invention.

[0018] FIG. 7 is a cross-sectional view along the line VII-VII of FIG. 6.

DETAILED DESCRIPTION

[0019] Buildings can use Energy Saving Structural Panels according to a preferred embodiment of the invention to form the desired enclosures. The proposed panels, varying in size and thickness, are made of composite materials in the form of a sandwich construction. The panels can be modular and have a standard size, typically 4x10x8x6". FIG. 1 shows the detail construction of a typical panel 100, consisting of two outer layer stress skins 110 made of sprayed up glass fiber reinforced concrete (GFRC) and a light, insulating yet structural, core 120.

[0020] The skins 110 can be made of:

[0021] Cement;
[0022] Silicate sand;
[0023] Alkali resistant fiber glass;
[0024] Water; and
[0025] Additives to increase workability

[0026] The core 120 can be made of:

[0027] Cement;
[0028] Expanded Perlite stone or any other expanded mineral material to yield strength at low weight;
[0029] Sand; and
[0030] Water

[0031] In a preferred embodiment of the invention, as shown in FIG. 4, the core mix is poured into the mold 430 onto the sprayed GFRC 110 while both mixes are green to ensure proper adhesion between the layers and homogeneous bond across the product for cement matrix. The outer layer is sprayed onto the core material 120 to form a stress skin sandwich construction. The panel will be exposed to elevated curing temperatures (up to 130°F) to have the concrete panels cured in 8 hours, building enough strength for handling and erection. The overall thickness of such panels will preferably be 4"-8" or even 10". The thickness of sprayed up GFRC layers will preferably be ¾"-1½", depending on the structural integrity required. Combining fiberglass and cement matrix layers, once cured and separated by a set distance, will create a rigid concrete panel with adequate strength to withstand the typical design loads for wind, live loading and structural weights. Using expanded Perlite (or mineral material) in the concrete matrix will generate light weight, insulating, concrete, with an R value of 2/in (U=0.06 BTU/in F/hr/ft).

[0032] The insulating value of finished products can vary depending on the percentage use of Perlite and the thickness desired. The weight of such a product would be 8-12 lbs/ft² depending on the type of insulation required. Considering
the fact that normal concrete panels weigh about 70-100 lbs/ft², the proposed panels will produce lighter structures which require smaller columns and foundations, resulting in lower costs. The above described panels, using cement as the bonding matrix can be used as external panels to withstand weathering. For interior use as partitions, a combination of plaster and perlite 220 can be used to produce a light partition slab 200 (FIG. 2). The weight of each element is preferably 22-25 lbs, for a typical 18"x24"x4" block.

[0033] The proposed structural panels are built on the basis of “bone-structure” theory, i.e. having strong stress skins made of fiberglass and cement matrix, encapsulating an energy efficient insulating light concrete core made of light aggregate (i.e. perlite, styrene beads or any other light insulating material) and cement matrix. All these are cast together without using any other bonding agent other than the cement.

[0034] To make the panels according to a preferred embodiment of the invention, stress skins are sprayed into preformed molds 430 (see FIG. 4) of various sizes and shapes depending on the requirement of the design engineers. The thickness of the skins 110 may vary from ¾" to ⅞", depending on the size and loading application of the panels. The sides and bottom of the molds are sprayed at one stage and immediately filled up by light and insulating core concrete 120 varying in density from, e.g. 25 lbs to 120 lbs per cubic foot, depending on the insulation level required. The second stage (core placement) is followed by a third stage which deposits another layer of sprayed up GFRC 110 while the cement matrix 120 from all three stages is still fresh and at its initial stage of setting.

[0035] This ensures homogeneous cement bonding from the outer to inner layers 110 and through the core 120. The fiberglass cement matrix 120, which is pre-mixed, is pumped and sprayed through a special gun 510 (shown in FIG. 5) onto the required surfaces. The core material 120 is also premixed in a different mixer using light coarse and fine aggregates and cement and poured on to the freshly sprayed surface by standard pumping and vibrating methods which are well known in the art. The distance between the outer and inner layer stress skins 110 is governed by the load bearing requirement of design, which in a non-limiting example varies between 4" to 10". FIG. 5 illustrates a production line, where gun 510 fills one of a plurality of molds 430.

[0036] Different textured materials can be used at the bottom of the molds 430 to produce textured surface finishes for the exterior side of panels. The stress skins 110 are preferably reinforced with chopped Alkali-Resistant fiberglass strands, increasing the tensile property of the finished product to about 1000-1400 psi. Therefore, panels produced in this manner do not require any steel reinforcing. Curing of these concrete panels is performed under elevated temperature environments to yield 60% of its strength within 10 hours of casting.

[0037] A unique joinery system can be employed according to a preferred embodiment of the invention to resist earthquake loads: In this system an external panel 300 is attached to the main structure by a special shock absorbing device, called “Beta Link’310. The floor slabs 320 (concrete or steel deck) are provided with an adjusting hold-down device (FIG. 3A) during the construction to receive the loading arm of panel holders (Beta Link). FIG. 3C and FIG. 3E show the holding end of the Beta Link 310, which is provided with a bolt 305 and an adjusting pulley 315.

[0038] FIG. 3B details the cross section of Beta Link(TM) which is comprised of an extending load bearing arm, a V shaped shoe 360 welded to the end of the arm, and a special bolt 330 with an adjustable sleeve. The V shaped shoe 360 fits into the upper groove 390 of the panel edge and the special hold down bolt 330, through the flexible rubber pad 350, will connect the “Beta Link”310 to the panel 300. The extended arm of “Beta Link’310 is connected to the floor system by means of an adjustable sleeve (FIG. 3A). The upper part of special hold down bolt 330 used to connect Beta Link 310 to the panel 300 will receive an adjustable sleeve with a 1/4" flexible rubber washer 340. This mechanism allows for X, Y, & Z directional adjustments & leveling of the panels. Once the levels are adjusted, the next height panel will be lowered into place (FIG. 3B) and set freely on the adjustable sleeve dowel pins 370.

[0039] During the earthquake moments, the panels can act as shear walls with 2 loading points through Beta Link rubber cushions—top and bottom. The rubber padding & washers will absorb the shear loads & dissipate the resonance loads of earthquake, allowing enough flexibility & elasticity of joints without causing damage to the panels or structure. The reduced weight of panels combined with the elasticity of joints will yield an “earthquake resistant” paneling system for different structures.

[0040] All four sides of panels 300 are provided with grooves 390 to create a locking mechanism. A horizontal section through the panels (FIG. 3I) shows a typical vertical joint between two adjoining panels 300 which can be filled up by cement grout 380 and a reinforcing bar 390.

[0041] Ceiling panels 600 (see FIG. 6) according to a preferred embodiment of the invention can be constructed as 4x8 modules and are made of a single layer 110 of GFRC; ¼"-½" thick, which is sprayed into a mold 430, preferably backed with a special perlite and styrene bead mix, while the concrete 120 is green. The Panel modules are supported using standard steel I beams 650, spanned between the two structural beams 680, and topped with normal or light weight concrete to form a completed section of floor for the next level above.

[0042] The light structural concrete panels according to the preferred embodiment of the invention, manufactured in standard and specific sizes, can be used to provide cladding in high-rise buildings, commercial structures, multi-level buildings and single family houses. They provide insulation, as well as structural integrity without the use of steel or wood. For multi level structures, these panels need to be used in conjunction with a structural framing. The panels according to the invention are energy saving product, lighter than normal concrete, yet durable and strong to withstand hurricanes and earthquake loads. The above products can also yield at least 2 hrs. of fire rating, using non combustible and inflammable gravels for core materials.

[0043] As will readily be appreciated by those skilled in the art, numerous modifications and variations of the above embodiments of the present invention are possible without departing from the scope of the invention.
What is desired to be claimed in letters patent is:
1. A method of making a building panel, comprising the steps of:
   providing a mold;
   spraying sides and bottom of said mold with a stress skin material;
   filling said mold with concrete immediately after said step of spraying said sides and bottom of said mold;
   spraying said stress skin material onto said concrete while said concrete is in an initial stage of setting.
2. The method according to claim 1, wherein:
   said stress skin material comprises a fiberglass and cement matrix.
3. The method according to claim 2, wherein:
   said fiberglass is alkali resistant.
4. The method according to claim 1, wherein:
   said concrete comprises a light aggregate and cement matrix.
5. The method according to claim 4, wherein:
   said light aggregate comprises perlite.
6. The method according to claim 4, wherein:
   said light aggregate comprises styrene beads.
7. A building panel, comprising:
   a first stress skin;
   a second stress skin;
   a concrete core provided between said first stress skin and said second stress skin.
8. The building panel according to claim 7, wherein:
   at least one of said first and second stress skins comprises a fiberglass and cement matrix.
9. The building panel according to claim 8, wherein:
   said fiberglass is alkali resistant.
10. The building panel according to claim 7, wherein:
    said concrete core comprises a light aggregate and cement matrix.
11. The building panel according to claim 10, wherein:
    said light aggregate comprises perlite.
12. The building panel according to claim 10, wherein:
    said light aggregate comprises styrene beads.
13. The building panel according to claim 17, wherein:
    said building panel is a ceiling panel and comprises at least one l-beam and at least two structural beams;
    said l-beam spanning between said structural beams.
14. A system for supporting building panels, comprising:
    at least one building panel provided with a groove in at least one edge thereof;
    an adjustable hold-down device provided with a v-shaped shoe at a distal end thereof;
    an anchor configured to attach said hold-down device to a slab at a proximal end thereof; and
    a fastener configured to secure said shoe in said groove.
15. The system according to claim 14, wherein:
    said shoe is provided with a rubber surface on a side thereof facing said groove.
16. The system according to claim 14, wherein:
    said fastener is a bolt with an adjustable sleeve.
17. The system according to claim 16, wherein:
    said bolt is provided with a rubber washer.
18. The system according to claim 14, wherein:
    said anchor comprises an adjustable pulley.
19. The system according to claim 14, further comprising:
    at least one reinforcing bar placed in a space defined by said at least one groove in said building panel and a corresponding groove of an adjacent said building panel.
20. The system according to claim 19, further comprising:
    cement grout in said defined space.

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