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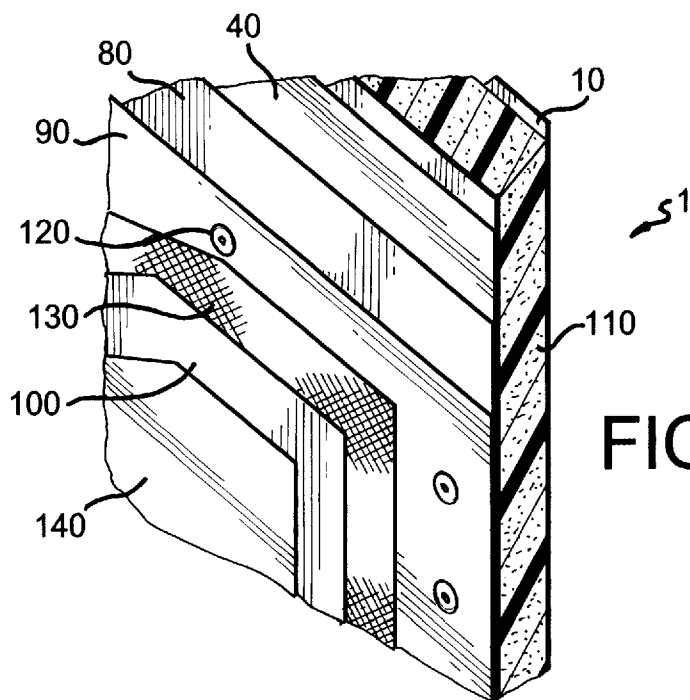


FIG. 1

(57) Abstract: A generally planar, structural insulated panel for building construction includes a pair of outer facings disposed on opposed surfaces of a plastic foam core. Both of the outer facings are gypsum cellulose fiber board such as gypsum wood fiber board. Disposed on the exterior surface of the gypsum wood fiber board on the exterior surface and between another expanded polystyrene insulation panel is a weather resistant barrier that is fastened to the gypsum wood fiber board. The exterior surface of the second insulation panel is fastened to the gypsum wood fiber board by mechanical fasteners. The insulation panels are then coated with a basecoat which has an embedded mesh reinforcement and then a finishing coat is applied to the base coating. Vinyl or aluminum metal siding can be fastened to the structural assembly by G

screw fasteners or other mechanical fasteners.

GYPSUM WOOD FIBER STRUCTURAL INSULATED PANEL ARRANGEMENT

FIELD OF THE INVENTION

[001] This invention relates generally to structural insulated panel arrangements used in a building construction system and is particularly directed to a structural insulated panel having a plastic foam core and a pair of opposed outer facings made from gypsum wood fiber board, and a panel system for providing protection of the exterior gypsum wood fiber facing from moisture damage.

BACKGROUND OF THE INVENTION

[002] Structural Insulated Panels (SIPs) are gaining increasing acceptance in the building construction industry as an alternative to the stick built approach. SIP construction employs two rigid faces on either side of a light insulating foam core. High strength bonding of the outer facings to the inner core forms a structural I-beam in the form of flat panels which are typically joined together by lumber and nails. The outer, opposed panel faces are typically formed from conventional building materials such as gypsum or cementitious composites, plywood, oriented strand board (OSB), drywall, or other rigid construction boards from 0.635 cm. to 1.905 cm. (1/4" to 3/4") thick.

[003] The prior art discloses various approaches for increasing the strength of these structural insulated panels. One approach incorporates wood members in the panel to increase its strength. But panels strengthened in this manner are subject to moisture degradation and insect infestation when used on the outside of a structure. U.S. Pat. No. 5,628,158 increases the strength of joined panels by inserting a spline in facing grooved edges of connected panels. The

spline includes an insulating core and a pair of outer facing metal strips extending the length of the spline. The metal-faced spline is affixed to the panel edges by means of a structural adhesive for securely connecting the two insulated panels. Still another approach is to strengthen structural insulated panels using metal strips that are incorporated in the panel and bonded to the insulating core and an outer facing. Another approach employs a metal facing on one or both surfaces of the structural insulated panel to increase panel strength and environmentally isolate one side of the panel from the other, but this substantially increases the cost of the panel and precludes use of the panel in many types of common structures.

[004] U.S. Pat. No.6,588,172 to Porter discloses structural insulated building panels (SIP) with plastic impregnated paper which have a first outer facing selected from the group comprising gypsum or cementitious composite material and a second outer facing which is preferably comprised of gypsum or cementitious composite. Porter does not suggest the use of a panel assembly having gypsum wood fiberboard panels on each surface and a weather resistant barrier and another insulation panel fastened to the outer surface of the exterior facing.

[005] US2005/0193676 to Palmerstein discloses structural panel for use in buildings having a first foam layer as a core and skins made from higher density, higher strength material including metals, wood products or polymers.

[006] US2005/0064145 to Hoie et al. discloses a composite building panel having a foam core sandwiched between two facings. The reinforcing facings can be cementitious board, plywood, gypsum/textile composite board or OSB.

[007] US2006/0174798 to Churchill discloses a fire-resistant wall and method of manufacture. The fire-retardant wall includes a first layer comprising an inner core, typically made of an insulated panel used in construction of buildings, and at least one second layer on each side of first layer, the at least one second

layer further comprising at least one fire-resistant board of pressed milled straw. The second layer may also include a structural board used as a building panel in construction of buildings and/or an interior wall board used for internal and external walls and ceilings of buildings, wherein such boards are positioned on the exterior side of at least one board of pressed milled straw. The wall may include gypsum board as the interior wall board

[008] US2002/0136888 to Porter discloses high strength structural insulated panel including an inner insulating core of material such as of plastic foam and at least one outer facing comprised of a rigid material such as gypsum or cementitious composite, oriented strand board (OSB), or an agricultural product such as strawboard.

[009] United States Gypsum Company has previously developed an INSULSCREEN™ 2000 exterior insulation and finish system (EIFS) insulated panel assembly system first marketed in 1992. This system used a gypsum board interior panel facing and an outer sheathing panel of OSB or cementitious composite board that was attached to wood studs, rather than a reinforced gypsum wood fiber board used in the current invention, in an assembly that included a weather resistant barrier and an exterior insulation panel of polystyrene that was fastened through the insulation panel outer panels. This earlier developed panel assembly was not a structural insulation panel system and required the use of framing e.g. wood framing, and the assembly did not recognize the benefit of using a reinforced gypsum cellulose fiber board on both the interior face of the panel and the outer sheathing panel to meet the needs of the building industry for an acceptable structural insulation panel without use of exterior OSB or cementitious composite board sheathing.

[0010] When foams are used in buildings, they require a 15 minute fire barrier, designed to slow the temperature increase of the foam during a fire, and to delay the foam's involvement in a fire. The building code definition of an approved thermal barrier is one which is equal in fire resistance to 12.7 mm

(1/2 inch) gypsum board. Such thermal barriers limit the temperature rise of the underlying polyurethane foam to not more than 250° F after 15 minutes of fire exposure complying with the standard time temperature curve of ASTM E 119. Thermal barriers meeting this criterion are called “15-minute thermal barriers” or classified as having as “index of 15.”

[0011] SIP panels manufactured using OSB and Foam do not meet this requirement and require an additional interior layer of gypsum board since the OSB layer is not suitable for interior decoration. SIP panels manufactured using gypsum boards do not have the structural capacity to be used for load-bearing walls.

BRIEF DESCRIPTION OF THE INVENTION

[0012] The present invention represents an improvement over the prior art by providing a low cost structural insulated panel having a plastic foam inner core and opposed outer facings comprised of gypsum wood fiberboard without the need for OSB or plywood or other structural wood sheathing which has previously been used on the exterior surface of panels for structural strength when gypsum or cementitious panels were used on the interior facing.

[0013] The present invention overcomes a panel bowing issue by providing two panels with equal strength and modulus values that will perform the same under the same axial load.

[0014] The present invention increase the tensile strength of a gypsum or cementitious sheet in a multi-layered structural insulated panel arrangement that renders the panel resistant to moisture and which overcomes the warping of multilayer panels that use gypsum or cement panels on one surface and OSB panels on the other surface.

[0015] Another aspect of the present invention is to provide a high strength structural panel system for building construction which is fire and moisture resistant and is thus capable of serving as a vapor barrier. In addition, the gypsum wood fiber panels provide a ready to finish surface.

[0016] A further aspect of the present invention is that the panel arrangement which uses gypsum wood fiber panels provides a load-bearing structural panel system that is already clad with a thermal barrier that meets the building code requirement for a 15 minute thermal barrier that is required with the foam insulation used in prior art SIP panels.

[0017] This invention contemplates a reinforced structural insulated panel arrangement comprising: a generally flat insulating core; first and second gypsum wood fiber board outer facings attached to opposed lateral surfaces of the insulation, a first sheet of a weather resistant barrier layer such as TYVEK® Stuccowrap Weather Resistant Barrier attached to the gypsum wood fiber panel facing that is intended to be used on the exterior side of the panel arrangement by staples or adhesive, a layer of expanded polystyrene foam insulation panel over said barrier layer which is attached to the gypsum wood fiber panel by corrosion resistant mechanical fasteners and plastic washers through the barrier to the gypsum wood fiber board facing.

[0018] Siding such as aluminum or vinyl siding can be attached to the exterior surface of the panel assembly with "G" (gypsum) fasteners or other fasteners meeting ASTM C1002-04 "Standard Specification for Steel Self-Piercing Tapping Screws for the Application of Gypsum Panel Products or Metal Plaster Bases to Wood Studs or Steel Studs" or other fasteners with appropriate washers.

BRIEF DESCRIPTION OF THE DRAWINGS

[0019] FIG. 1 is a perspective view of the structural insulating panel of the invention showing its installation with mechanical fastening to exterior gypsum wood fiber panel arrangement.

[0020] FIG. 1A is a top view of the mechanical fastener in FIG. 1 which typically is made from a screw within a plastic washer.

[0021] FIG. 2 is a cross sectional view of a wall building structure of this invention incorporating the structural insulated panel assembly with moisture barrier and insulating layer over the exterior surface of the SIP panel and exterior water resistant barrier, base coat with reinforcing mesh and finish coat and which is attached to the gypsum wood fiber panel by mechanical fasteners.

[0022] FIG. 3 is a cut-away view of the structural insulating panel system of the invention as it is installed as a wall with a roof and soffit.

[0023] FIG. 4 is a cut-away view of the structural insulating panel system as it would be installed at the intersection of the wall and roof.

[0024] FIG. 5 is a cut-away view of the structural insulation panel as a decorative reveal having an exterior groove or notch on the exterior surface of a wall.

[0025] FIG. 6 is a cut-away view of the structural insulating panel system used in the construction of a flanged window head.

[0026] FIG. 7 is a cut-away view of the structural insulating panel system used in making a flanged window jam.

[0027] FIG. 8 is a cut-away view of the structural insulating panel system used in construction of a flanged window sill.

[0028] FIG. 9 is a cut-away view of the structural insulating panel system of this invention used in the construction of an intermediate floor.

[0029] FIG. 10 is a graph of shear strength to failure for various fasteners used for joining FIBEROCK[®] brand gypsum wood fiber board sheathing to plywood.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

[0030] Referring to FIG. 1, there is shown a cross-sectional view of a building structure 1 incorporating building panels with insulating expanded polystyrene core 110 and gypsum wood fiber panel 40 over the core and a gypsum board or other cementitious board such as gypsum wood fiber board 10 on the other surface of the core 110. As seen in FIG. 1, building structure panel 1 includes first and second wall panels 40 and 10. Two-part waterborne thermosetting structural adhesive may be used to join the two outer panels 40 and 10 to the plastic foam core 110. Conventional adhesive in the form of mastic or epoxy cement may be used to join the two outer panels 40 and 10 to the plastic foam core 110. Weather resistant barrier 80 is attached to the outer facing surface of the gypsum cellulose fiberboard panel 40 and then an exterior insulation board of 2.54 cm. to 3.81 cm. (1.0 to 1.5 in.) expanded polystyrene 90 is attached to the panel 40 and weather resistant barrier 80 with corrosion resistant fasteners meeting ASTM C1002 - 04 and plastic washers 120. The exterior insulation panels are typically 1.27 to 10.16 cm. (0.5 to 4.0 inches) thick by 1.219 m. by 2.438. m (4 feet. by 8 feet) and are attached at 20.3 cm. (8 inches) off center vertical and 40.6 cm. (16 inches) off center horizontally. The mechanical fastener 120, as shown in more detail in FIG. 1A, is typically made of a screw 120B within a plastic washer 120A, and typically meet ASTM C893 and are resistant to moisture and have 3.18 cm. (1.75 in.) plastic washers 120A with corrosion resistant screws 120B. An exterior base coat 100 with an embedded reinforcing mesh 130 is then applied to the exterior surface of the exterior insulation panel 90 and an exterior textured finish coat 140 is applied over the exterior base coat 100.

[0031] Referring to FIG. 2, there is shown a cross-sectional view of a structural insulated panel generally designated as 1 in accordance with one embodiment of the present invention, installed as a wall panel structure. The structural insulated panel 1 includes a first facing 40, a plastic foam core 110 and a second opposed facing 10. An adhesive layer 30 disposed on the gypsum cellulose fiber board 40 to securely attach the facing 40 to the plastic foam core 110. Another adhesive layer (not shown) also secures the foam core 110 to facing 10. Structural insulated panel 1 is preferably positioned in a building structure with its first outer facing 40 facing outwardly and its second outer facing 10 facing inwardly relative to the building structure. In this orientation, the panel's first outer facing 40 is comprised of gypsum cellulose fiber board. The panel's second outer facing 10 is also preferably comprised of gypsum cellulose fiber board although the interior side could also be a gypsum or cementitious composite.

[0032] Referring to FIG. 3, the interior wall and ceiling comprise a gypsum cellulose fiber panel 10 over an expanded insulation core 110, such as polystyrene foam. An exterior gypsum cellulose fiber board panel 40, weather resistant barrier 60 and an exterior insulation board, usually 2.54 cm. to 3.81 cm. (1.0 to 1.5 in.) min thickness are attached to the exterior wood or steel framing with corrosion resistant fasteners (not shown) typically having 4.45 cm. (1.75 in.) diameter plastic washers. An exterior basecoat 70 with reinforcing mesh and finish coat is applied over the exterior surface of the exterior insulation board 50. A casing bead 200 and backer rod and sealant 190 are fitted between the exterior structural insulation panel system and the soffit 300.

[0033] FIG. 4 shows, the intersection of a roof and wall in which structural insulation panels with gypsum cellulose fiber board panel 40 and a weather resistant barrier 60, an exterior insulation board 50 and an exterior basecoat 70 with reinforcing mesh and finish coat over the exterior insulation board 50, are attached using corrosion-resistant fasteners 120 which, as previously described

in FIG. 1A, comprise a screw 120B inside a plastic washer 120A. As typically installed by a roofing contractor, a starter track 210 with weeps is installed over the structural insulation panel at a point of about 3.81 cm (1.5 in.) above the roof. A step flashing 220 and kick out flashing 230 are installed by the contractor and a water barrier tape 240 applied over the point where the kick-out flashing 230 is joined to the exterior surface of the wall panel.

[0034] Referring to FIG. 5, a typical decorative reveal is illustrated with an interior gypsum cellulose fiber panel 10 over a moisture barrier 20 on the interior surface of the insulation foam core 110 and a gypsum cellulose fiber board sheathing 40 with a weather resistant barrier 60 and an exterior insulation board 50 attached to the gypsum wood fiberboard panel 40 by corrosion resistant fasteners and plastic washers. A basecoat 70 with reinforcing mesh and finish coat are applied over the exterior surface of the insulation board. An adhesive layer 30 is also provided. A decorative "V" groove 250 or angle groove 260 can be routed in the insulation board 50 provided that a 1.91 cm. ($\frac{3}{4}$ in) minimum board thickness is maintained at the location of the groove.

[0035] Referring to FIG. 6, a cut-away of a typical flanged window head is shown with the flange 270 being maintained at a spacing of 0.32 cm. ($\frac{1}{8}$ in.) minimum between the structural insulation panel system and the starter track 210. The panel system of the invention has an interior gypsum cellulose fiber panel 10 sheathing an exterior gypsum cellulose fiber panel 40 over the foam insulation core 110 and having a weather barrier 60 and exterior insulation board panel 50 which is mechanically fastened to panel 40. An exterior base coat reinforcing mesh and finish coat 70 is applied to the surface of insulation board panel 50 that is not in contact with the gypsum cellulose fiberboard panel 40. Typically there is a space having a distance "S" of about $\frac{1}{8}$ inch (0.32 cm) minimum between the system and the starter track.

[0036] Referring to FIG. 7, a cut-away of a typical flanged window jamb is shown with the flanged window 270 backer rod and sealant 190 and casing bead 200 fitted to the edge of the structural insulation panel of the invention.

[0037] Referring to FIG. 8, a cut-away is shown of a typical flanged window sill with the flanged window 270 backer rod and sealant 190 and casing bead 200 fitted over the slope sill or sill wedge 280 fitted over the structural insulation panel of this invention. A water barrier tape 240 is applied to the sill and extends up to 5.08 cm. (2 in.) at each joint.

[0038] Referring to FIG. 9, a cut-away is shown of an intermediate floor made from a structural insulation panel of the invention fitted into a wall panel of the invention. In this and the other included drawings, like reference numbers indicate like elements unless otherwise indicated or apparent from the drawings or text.

[0039] Referring again to FIG. 2, there is shown a sectional view of another embodiment of a structural insulated panel 1 in accordance with the principles of the present invention. FIG. 2 is a cross sectional view of the structural insulated panel 1 shown in FIG. 1. Structural insulated panel 1 includes first and second outer facings 10 and 40 and an insulating foam core 110 disposed between the two outer facings. The inner surface of the first outer facing 10 is affixed to the panel's insulating foam core 110 by means of a conventional adhesive as previously described. This adhesive layer is not shown in the figures for simplicity. A sealant 55 is used to fill the spacing between the exterior panels 40 and the foundation or footing 290 upon which the panel arrangement is installed.

[0040] The structural insulated panel assembly 1 can further include a plastic impregnated paper sheet 20. The plastic impregnated paper sheet 20 is bonded to the inner surface of the panel's facing 10. The plastic impregnated paper sheet is also bonded to the panel's insulating foam core 110. Again, a

conventional adhesive as previously described may be used to securely bond the plastic impregnated paper sheet to the panel's insulating foam core 110. In a preferred embodiment, the panel's first outer facing 40 is comprised of a gypsum cellulose fiber board such as gypsum wood fiberboard (GWF) board and faces outwardly, while the panel's second outer facing 10 is comprised of gypsum or cementitious composite but is preferably also a gypsum cellulose fiber board such as GWF, and faces inwardly.

[0041] Thus the invention provides for a structural insulated panel comprised of an insulating foam core with opposed first and second outer facings each comprised of a gypsum cellulose fiber board such as GWF. A vapor retarder such as a plastic impregnated paper sheet can optionally be disposed between the interior gypsum facing layer or sheathing and the insulating core by adhering the paper sheet to the panel's insulating foam core and the outer facings. The paper sheet is impregnated with urethane or polyisocyanurate plastic in a preferred embodiment which serves as a fire resistant vapor barrier near the panel's inner surface to prevent moisture from escaping from the warm interior of a building structure through the insulating foam core to the outside. The high strength plastic impregnated paper sheet also substantially increases the tensile strength of the panel to withstand large transverse loads. The strength of the panel may be further increased by also impregnating the paper sheet with fiberglass.

[0042] A structural insulated panel in accordance with the present invention may include one or more such plastic impregnated paper sheets where panels of high strength are required. The plastic impregnated paper sheets may be layered and sized in accordance with the stress profile of the structural insulated panel to further increase the panel's tensile strength while employing the minimum required amount of plastic impregnated paper. The plastic impregnated paper sheet may be applied to a gypsum composite facing to substantially increase the strength of the facing and to environmentally isolate one side of the panel from the other.

[0043] The weather resistant barrier 80 is an air infiltration and moisture barrier. A number of weather barriers are available commercially including Building Felt (typically 15 pounds); Reef Industries GRIFFOLYN[®] Vapor Retarders; Kraft Grade D Kraft paper; Tenneco Building Products, AMOWRAP[™] woven polypropylene with a perforated coating; Simplex Products Division BARRICADE[™] woven polyethylene with a perforated coating; Owens Corning PINKWRAP[®] woven polypropylene with a perforated coating; Simplex Products Division R-Wrap porous polyethylene film laminated to a scrim; Reemay, Inc. TYPAR[™] spun-bonded polypropylene with a perforated coating; E. I. DuPont de Nemours & Co. , Wilmington, Delaware, TYVEK STUCCOWRAP[®] Home Wrap spun-bonded polyethylene; BASF SENERWRAP[™] 20-mil thick, self-sealing, self-healing rubberized asphalt coating laminated to a polyethylene film and liquid applied membranes available from BASF as SENSERSHIELD[™] and Parex LIQUID MEMBRANE 395a (Key Coat) 100% acrylic based, trowel able adhesive and weather-resistive barrier membrane. A typical resistance barrier found to have utility in the assembly of this invention is TYVEK STUCCOWRAP[®] brand Weather Resistant Barrier sold by El DuPont de Nemours & Co. of Wilmington, Delaware.

[0044] The expanded foam core or layer insulation 110 and the exterior grooved insulation panels used over the weather resistant barrier 80 on the exterior surface gypsum wood fiber board sheathing 40 are made from lightweight foamed polymer such as polystyrene or polyurethane. The foam core is further described in US Pat. No. 6,523,324 issued on February 25, 2003, the disclosure of which is incorporated herein by reference in its entirety. Commercially available expanded polystyrene is available from Dow Chemical Company under the tradename STYROFOAM[®].

[0045] The exterior base coat can be a cement and acrylic emulsion, such as the commercially available Parex Basecoat and Adhesive 12, Parflex Basecoat BASF SENERQUICK[™] Adhesive water reducible, non-cementitious,

translucent white adhesive, BASF NC-II Base which is a pre-mixed 100% acrylic polymer-based, non-cementitious base coat and adhesive; BASF Alpha Dry Base Coat, which is a dry-mix polymer adhesive and base coat containing Portland cement for mixing with water; BASF Alpha Genie Base Coat, which is a 100% acrylic, fiber reinforced base coat, adhesive and leveler additive that is mixed prior to use with Type I or Type II Portland cement; or BASF SENERTHIK® brand base liquid & FIBERLATH MESH, which is a 100% acrylic polymer resin-based liquid. The exterior base coat is used with an embedded mesh which can be a metal mesh or an open-weave glass fiber reinforcing mesh which is twisted multi-end strands treated with a polymer coating e.g. polyvinyl chloride solution, for alkali resistance for compatibility with Portland cement. Commercially available mesh can be SENERGY® brand Reinforcing Mesh from BASF WALL SYSTEMS, Jacksonville, Florida: Dryvit Standard Mesh, Intermediate Mesh, Corner Mesh, PANZER 15 Mesh, PANZER 20 Mesh, ULTRAMESH from Dryvit Systems Inc., West Warwick, Rhode Island; L.S. Reinforcing Mesh; Standard Plus Mesh; 4 in. Reinforcing Mesh and Detail Mesh, all available from Dryvit Systems, Inc., West Warrick, RI ; STO Reinforcing Mesh from STO Corp, Atlanta, Georgia; and Parex Standard, Specialty and Impact Mesh from Parex Inc. Reda Georgia.

[0046] A typical exterior base coat which was previously sold commercially by United States Gypsum Company, Chicago, IL, USA under the brand name USG EXTERIOR BASECOAT, consisted of: 40 to 50 percent portland cement (ASTM C150) with a minimum of 4 percent polymer and silica sand. This bagged product was mixed with water to trowelable consistency. Alternatively the basecoat may be an acrylic sand solution mixed with Type I Portland Cement. The acrylic mixture consisting of sand and additives shall have a minimum solids content of 67 percent.

[0047] A typical mesh was previously sold commercially by United States Gypsum Company, Chicago, IL, USA under the brand name USG EXTERIOR STANDARD MESH REINFORCEMENT and had a weight of no less than 4.0 oz/ft². The mesh should be alkali resistant and may be formed from either woven or non-woven glasses coated with an organic alkali resistance coating.

The mesh should have a tensile strength no less than 150 pounds/inch when evaluated according to ASTM D578 and D579. Heavier mesh with a weight up to 25 oz/ft² may be used where improved impact resistance is required.

[0048] The Exterior Finish or finishing coat applied over the Base Coat and embedded mesh is typically an acrylic co-polymer based coating. The finish coat typically comprises 55 to 65 percent silica sand or dolomite sand with a minimum of 8 percent dry acrylic solids. The product should be premixed and supplied in ready-to-apply buckets. Tinting may be field or factory added. The product should pass 4 in. mandrel bend determined per ASTM D522. No deleterious effects at 2000 hours caused by accelerated weathering per ASTM G53. No mildew growth at 28 days per ASTM D3273. Salt spray resistance when applied to basecoat and 1 lb/yd³ expanded polystyrene shall be greater than 500 hours with no deleterious effects per ASTM B117. No deleterious effects after 14 days when tested over basecoat and 1 lb/ft³ expanded polystyrene per ASTM D2247. Bond between the finish coat and basecoat over 1 lb/yd³ expanded polystyrene must be a minimum of 15 psi when tested per ASTM C297. Insulation must fail cohesively. Bond failure of samples tested after 24 hours of water immersion shall exhibit failure between the basecoat and the finish. No deterioration after freeze thaw testing per ICBO AC24, section 6.5.2.

[0049] A number of commercially available finish coatings including the various finish and coating options offered by Dryvit under the following categories: (i) AMERISTONE™ 100% acrylic based finish with multi-colored quartz aggregates; (ii) CUSTOM BRICK™ Polymer Finish which has the architectural finish in the Look of brick, Stone, Slate and Tile for Vertical Surfaces; (iii) DEMANDIT® brand interior/exterior Acrylic PMR Coating in Standard and custom colors; (iv) DPR FM™ Finishes of 100% acrylic, DPR finish designed for use in the Dryvit PM wall System; (v) QUARTZPUTZ E, SANDPEBBLE E and SANDPEBBLE® fine E finishes of lightweight, premixed 100% acrylic-based coatings in standard and custom colors; (vi) LYMESTONE™ premixed

100% acrylic-based finish designed to replicate the appearance of limestone blocks; (vii) MEDALLION SERIES™ Finish (PMR) dirt and mildew resistant Finishes for demanding building environments; (viii) METTALIC DEMANDIT® interior/exterior 100% acrylic coating offered in three distinctive metallic colors i.e. silver, gunmetal and bronze; (ix) SANDPEBBLE® fine NT aggregate textured 100% acrylic based Dirt-Pickup Resistant Finishes; (x) SANDPEBBLE®NT aggregate textured 100% acrylic-based Dirt Pickup Resistant Finishes; (xi) STONE MIST® exterior and interior quartz aggregate finish; (xii) STUCCOAT® Finishes durable integrally colored textured wall finish for application over stucco, concrete and masonry; (xiii) TAFS™ (Texture Acrylic Finishes) high performance finish solutions for stucco, concrete, masonry, tilt up, ICF and other compatible substrates; (xiv) TERRANEO® trowel applied stone finish that simulates cut stone and granite; (xv) TUSCAN GLAZE™ tint able acrylic stain that can be applied to acrylic or elastomeric finishes to provide an “Old World/Antique Look”; (xvi) WEATHERLASTIC® flexible elastomeric exterior finishes and (xvii) WEATHERLASTIC® Smooth flexible waterproof elastomeric exterior coating. Other commercial finishes include Parex DPR Coating of 100% acrylic-based non-textured coating and acrylic copolymer and colored quartz aggregates sold under the FLEXFINE 426, FLEXSAND 427 FLEXSWIRL 428, FLEXTEX 429, CERASTONE, and SPRAYSTONE trade names; and BASF SERNERFLEX®, SILCOAT® and SENERLASTIC™ Finishes.

[0050] The gypsum wood fiber board panels that are preferably used as both surface layer panels on both surfaces of the insulation core in the building panel assembly of this invention are typically commercially available gypsum wood fiber board such as FIBEROCK® brand gypsum wood fiber board available from United States Gypsum Company, Chicago, IL, USA. Gypsum wood fiber board used in this invention may be made by the process shown in U.S. Pat. No. 5,320,677 of M. Baig which is incorporated herein by reference in its entirety.

[0051] A particular embodiment of the structural insulation panel assembly of this invention is made with a 31.78 Kg. /m³ (2 lbs./ft³) expanded polystyrene foam core with 1.27 cm. (½ inch) FIBEROCK[®] brand gypsum wood fiber (GWF) panels adhesively bonded to each surface by a commercial adhesive such as MorAd[®] adhesives available from Rohm and Haas Company, Philadelphia, PA. The surface panel to be used on the exterior side of the SIP panel is then covered with of a very fine high density polypropylene fiber weather resistant barrier sold by E.I Du Pont under the brand name TYVEK STUCCOWRAP[®] which is attached to the FIBEROCK[®] panel with staples. A 3.81 cm. (1.5 inch) thick expanded polystyrene panel is then attached to the barrier and FIBEROCK[®] brand gypsum wood fiberboard panel by mechanical fasteners such as “WIND DEVIL” G washers and screw fasteners available from Wind-Lock, Leesport, PA. A standard United States Gypsum Company basecoat that is reinforced with an embedded metal mesh is then applied over the polystyrene panel and a finish coat is applied.

[0052] It has been found that 11.43 cm. (4½ inch) and 16.51 cm. (6½ inch) SIP panels made in accordance with the above procedure have wind load capacities of 150 and 225 Kg/m² (30 and 45 lb/ft²), respectively, and an axial capacity of approximately 4650 Kg./linear m. (3100 pounds per linear foot) as determined under ASTM E72 - 05. In testing of direct pull out load capacity of the FIBEROCK[®] brand gypsum wood fiberboard panels used in the SIP, it was found that “G screw” mechanical fasteners would have a pull out capacity of 39.15 Kg. (87 pounds), which would allow fastening of vinyl or aluminum siding to the outer surface of the SIP panel when “G screw” mechanical fasteners, as described above under ASTM C893 are used every square foot, giving a wind load capacity of 145 Kg/m² (29 lbs./ft²).

EXAMPLES

EXAMPLE 1

[0053] SIP panels are manufactured by Stress Panel Manufacturing using 1.27 cm. (1/2 in.) FIBEROCK[®] brand sheathing panels adhesively attached on both

sides of either 8.89 or 16.51 cm. (3.5 or 6.5 in.) thick polystyrene foam. The panels were created using 31.78 kg/m^3 (2 lb/ft^3) expanded polyethylene foam (EPS foam). A total of six 1.22 x 2.44 m. (4 x 8 ft) panels were tested to determine the load capacity of the system. Tests were conducted according to ASTM E-72 -05 and ASTM E-330. The axial load tests were conducted on the panels without splines.

[0054] A 11.43 cm. (4-1/2 in.) thick panel was cut vertically into a 61 cm. (24 in.) strip and the 2.44 m. (8 ft) tall section axially loaded to failure. Loading was conducted by placing flat steel plates at the top and bottom of the specimen and placing the loading ram 1/6 of the panel thickness away from the center of the panel, as described in ASTM E-72 - 05. The load at failure was approximately 8636.4 kg. (19,000 lb), which is equivalent to an ultimate load of 14250 kg./m (9500 plf) or a design load of 4750 kg/m (3167 lb/ft.). Failure of the panel occurred from crushing of the interior FIBEROCK® Panel at mid-span.

[0055] A 16.51 cm. (6-1/2 in.) panel was cut vertically into a 30.5 cm. (12 in.) strip and the 2.438 m. (8 ft) tall section loaded to failure. The load at failure (ultimate load) was 4318.2 kg. (9500 lb), which gives a design load of 4750 kg/linear m.(3167 lb/ft.). Failure of the panel occurred from crushing of the base of both of the FIBEROCK® brand panels.

[0056] The wind-load capacity of the panels was determined using a vacuum chamber using methods shown in ASTM E-330. Rollers were placed at a spacing of 2.286 m. (90 in.), 7.62 cm. (3 in.) from the top and the bottom of the panel.

[0057] The 11.43 cm. (4-1/2 in.) thick panel was sequentially loaded to 73.4, 146.8 and 220.2 kg./m² (15, 30 and 45 lbs/ft²), prior to loading to failure. The 16.51 cm. (6-1/2 in.) panel was sequentially loaded to 146.8, 293.6 and 440.4 kg/m² (30, 60 and 90 lb/ft²) prior to loading to failure.

[0058] For a span of 228.6 cm (90 in.), the deflection limitations L/360, L/240 and L/180 are 0.635 cm.; 0.953 cm. and 1.27 cm. (0.25, 0.375 and 0.5 in.), respectively. Deflections measured were significantly lower than these deflection limitations. Failure loads for the 11.43 cm. (4-1/2 in.) and 16.51 cm. (6-1/2 in.) panels were 450.14 Kg./m² and 714.4 Kg./m² (92 and 146 lbs/ft²), respectively. Using a factor of safety of three, this suggests design loads of 150.1 and 238.1 kg/m² (31 and 49 lbs/ft²), respectively.

[0059] The tests indicate wind load capacities of 146.8 and 220.2 kg./m² (30 and 45 lbs/ft²) for the 11.43 cm. (4-1/2 in.) and 16.51 cm. (6-1/2 in.) panels, respectively, and an axial capacity of approximately 4650 kg./linear m. (3100 lbs/ft).

[0060] It has been found that 11.43 cm. (4½ inch) and 16.51 cm. (6½ inch) SIP panels made in accordance with the above example have wind load capacities of 150 and 225 Kg/m² (30 and 45 lb/ft²), respectively, and an axial capacity of approximately 4650 Kg./linear m. (3100 pounds/linear foot) as determined under ASTM E72 - 05.

EXAMPLE 2

[0061] Tests were conducted according to ASTM C514 -04 to determine the amount of force required to remove various fasteners from 1.27 cm. (½ in.) FIBEROCK® brand gypsum wood fiber panels available commercially from United States Gypsum Company, Chicago, IL, USA. Results were also obtained for 1.48 cm. (7/16 in.) panels of oriented strand board (OSB) and plywood, meeting ASTM commercially available from a number of suppliers such as Louisiana Pacific and Weyerhaeuser. Results are shown in TABLE 1, below.

[0062] From the table it was found that the 1.27 cm. (0.50 in.) FIBEROCK® brand gypsum wood fiber sheathing would not hold nails and thus for any

particular application where bonding strength was required, screws would need to be used.

TABLE 1 Nail-holding Strength in kgs

Fastener Description	0.486 cm. OSB	0.486 cm. Plywood	1.27 cm. FIBEROCK® Brand Sheathing
1-1/2 in. roofing nails	23.2	21.4	3.64
6d nails	33.2	26.4	4.55
1-1/2 in. G screws	132.7	155.5	39.54
1-1/4 in. drywall screws	101.8	131.8	38.2
1-5/8 in. drywall nails	40.9	45.9	7.27
1-3/4 in. ring shank drywall nails	52.3	31.2	7.27

[0063] In testing of direct pull out load capacity of the FIBEROCK® brand gypsum wood fiberboard panels used in the SIP, it was found that “G” screw mechanical fasteners would have a pull out capacity of 39.54 Kg. (87 pounds), which would allow fastening of vinyl or aluminum siding to the outer surface of the SIP panel when “G screw” (“gypsum screw”), mechanical fasteners, as described above under ASTM C1002 -04 are used every square foot, giving a wind load capacity of 145 Kg/m² (29 lbs./ft²).

EXAMPLE 3

[0064] Tests were conducted to determine the shear strength of various fasteners in FIBEROCK® brand sheathing. This data may be used to determine the number of fasteners required to attach SIPS panels to footers and headers.

[0065] Tests were conducted by attaching 5.08 x 15.24 x 1.91 cm. (2 x 6 x 3/4 in.) plywood to 15.24 cm. x 15.24 cm. x 1.27cm. (6 in. x 6 in. x 0.5 in.) FIBEROCK® brand sheathing and to 15.24 cm. x 15.24 cm. x 1.525 cm. (6 in. x 6 in. x 5/8 in.) FIBEROCK® brand sheathing using single fasteners. These

fasteners are either USG Exterior Sheathing Screws, standard drywall nails or 3.81 cm. (1-1/2 in.) long staples with 0.635 cm. (1/4 in.) crowns. In each case, the fastener was 1.91 cm. (3/4 in.) from the edge of the panel.

[0066] Shear strength to failure values for various fasteners used for joining FIBEROCK® brand gypsum wood fiber board sheathing to plywood obtained from the testing are shown in the bar graph in FIG. 10. For each configuration, five samples were evaluated. For screws in 1.27cm. and 1.59 cm. (1/2 and 5/8 in.) board, and for nails in the 1.27 cm. (1/2 in.) board all failures were from shear failure of the FIBEROCK® brand gypsum wood fiberboard (GWF) sheathing. For nails in the 1.59 cm. (5/8 in.) board all failures were from the nails pulling out of the board. For staples in 1.27 cm. (1/2 in.) board all failures were from the staple pulling through the FIBEROCK® brand GWF sheathing while for the 1.59 cm. (5/8 in.) board a mixture of failures was noted with some staples pulling through the FIBEROCK® brand sheathing and others pulling out of the plywood.

[0067] Results were also obtained from the specimens using OSB instead of FIBEROCK® brand sheathing. The value obtained for the OSB was approximately 40 percent greater than that obtained for the FIBEROCK® brand sheathing. Failure occurred by the fastener pulling out of the plywood.

[0068] The values obtained for the FIBEROCK® brand sheathing/FIBEROCK® brand sheathing joint were approximately 77 percent of that of the FIBEROCK® brand sheathing/plywood joint. In these tests, a shear failure occurred in the FIBEROCK® brand sheathing on the section furthest away from the screw head.

[0069] While particular embodiments of the present invention have been shown and described, it will be obvious to those skilled in the art that changes and modifications may be made without departing from the invention in its broader aspects. Therefore, the aim in the appended claims is to cover all such

changes and modifications as fall within the true spirit and scope of the invention. The matter set forth in the foregoing description and accompanying drawing is offered by way of illustration only and not as a limitation. The actual scope of the invention is intended to be defined in the following claims when viewed in their proper perspective based on the prior art.

We claim:

1. A reinforced structural insulated panel arrangement for building construction, said panel arrangement comprising:
 - a generally flat insulating core of an expanded plastic foam;
 - first and second facings attached to opposed lateral surfaces of said insulating core, wherein said first and second outer facings are respectively each gypsum wood fiber board;
 - a first sheet of weather resistant barrier attached to the exterior surface of one of the facings that is on the side of the panel arrangement that will be used on exterior sides of a building;
 - a layer of expanded plastic foam insulation panels over said weather resistant barrier layer which is attached to a building frame by corrosion resistant mechanical fasteners through the weather resistant barrier to the gypsum wood fiber board facing;
 - a basecoat with an embedded reinforcing mesh applied across the outer surface of the foam insulation panel; and
 - a finishing coat applied over the basecoat.
2. The panel of claim 1, wherein the expanded foam insulation is selected from expanded polystyrene foam and extruded polystyrene foam.
3. The panel arrangement of claim 1, further including a siding attached to the exterior surface of the panel arrangement by the use of corrosion resistant gypsum mechanical fasteners.
4. The panel arrangement of claim 2, wherein the insulation core is about 31.78 kg. /m³ (2 lbs/ft³) expanded polystyrene foam.
5. The panel arrangement of claim 1, further comprising an adhesive layer disposed between said insulating core and said first and second outer facings for bonding said facings to said insulating core.

6. The panel arrangement of claim 1, wherein the weather resistant barrier is a very fine high density polypropylene fiber or spun bonded polyethylene.
7. The panel arrangement of claim 2, wherein the gypsum wood fiber boards are glued to the surfaces of the insulation core.
8. The panel of claim 1, wherein the weather resistant barrier is stapled to the gypsum wood fiber board panel.
9. The panel assembly of claim 2, wherein the exterior polystyrene panel is about 1.27 cm. (0.5 in.) to about 10.16 cm. (4.0 in.) thick.
10. The panel assembly of claim 2, wherein the exterior polystyrene panel is about 2.54 to 3.81 cm. (1.0 to 1.50 in.) thick.

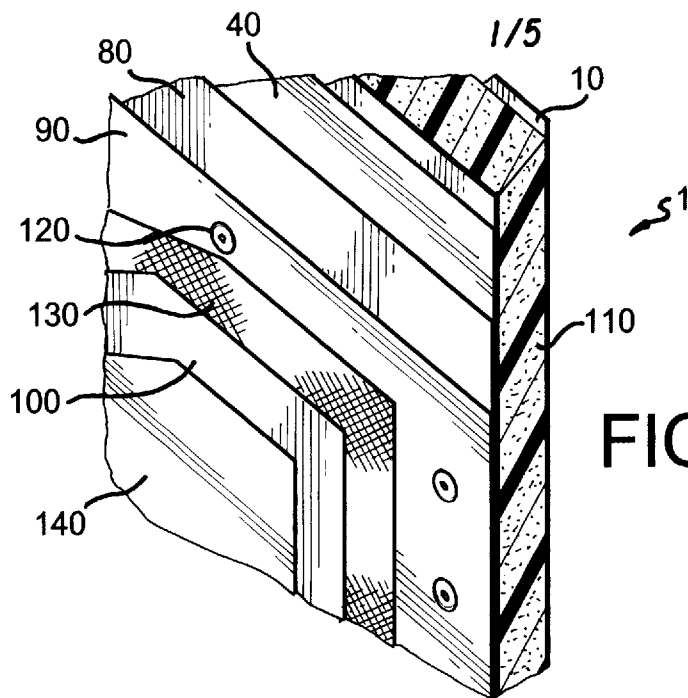


FIG. 1

FIG. 1A

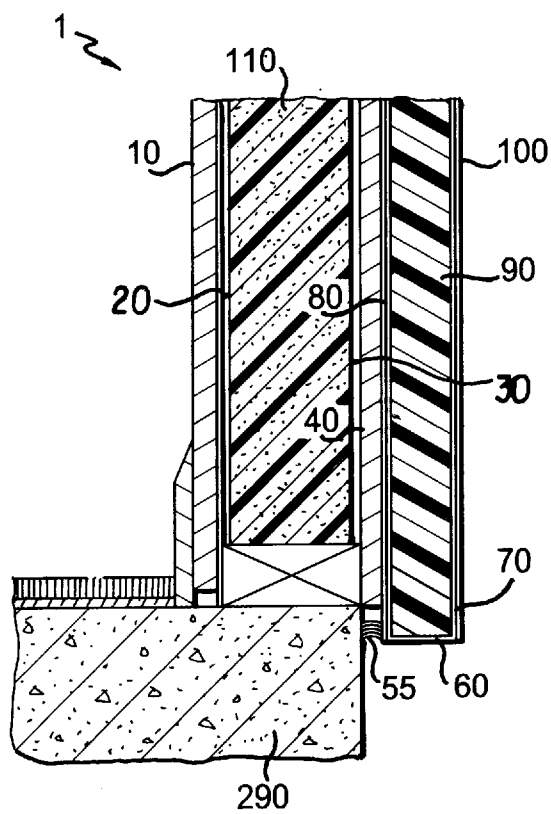
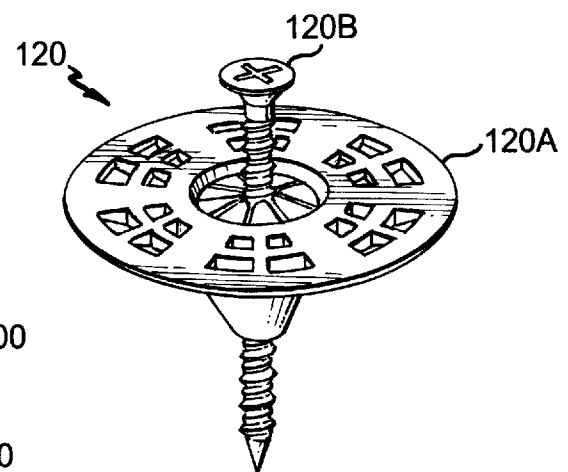


FIG. 2

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FIG. 3

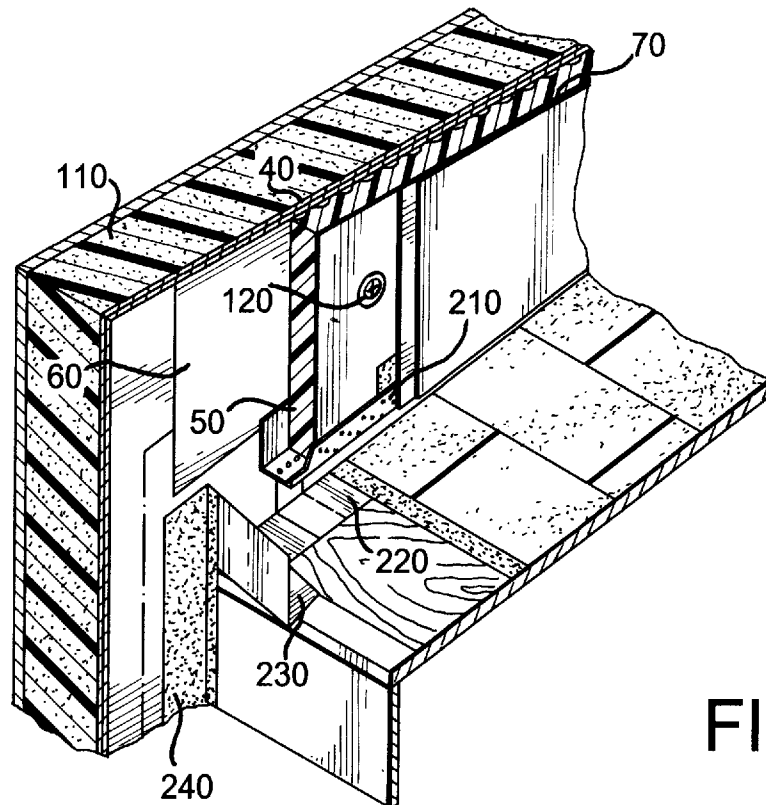
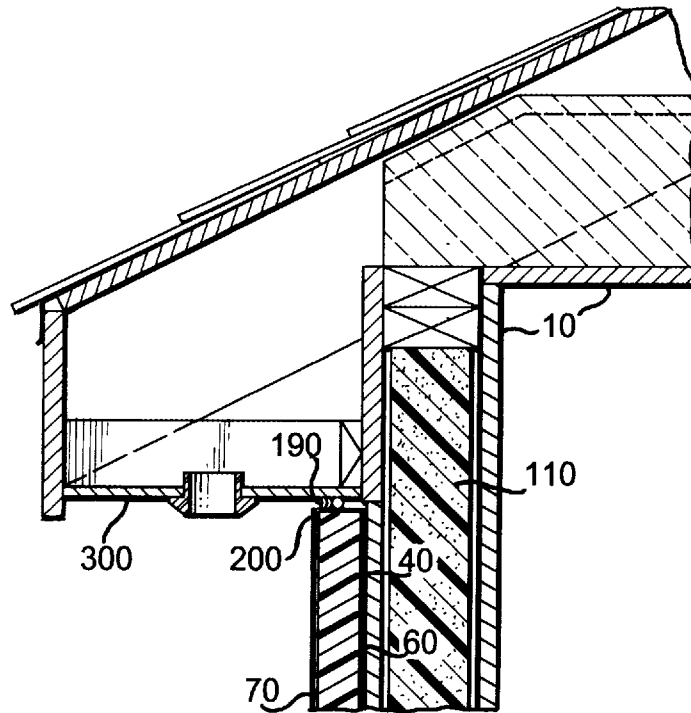


FIG. 4

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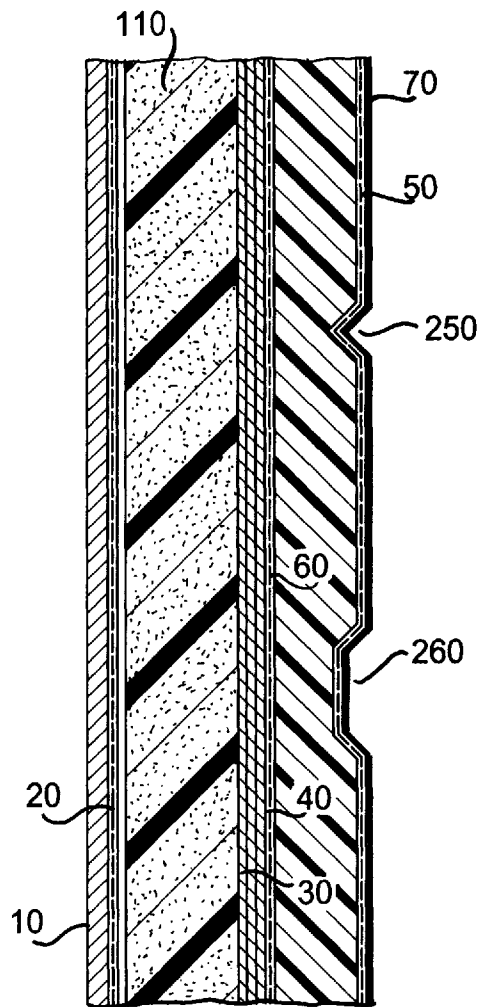
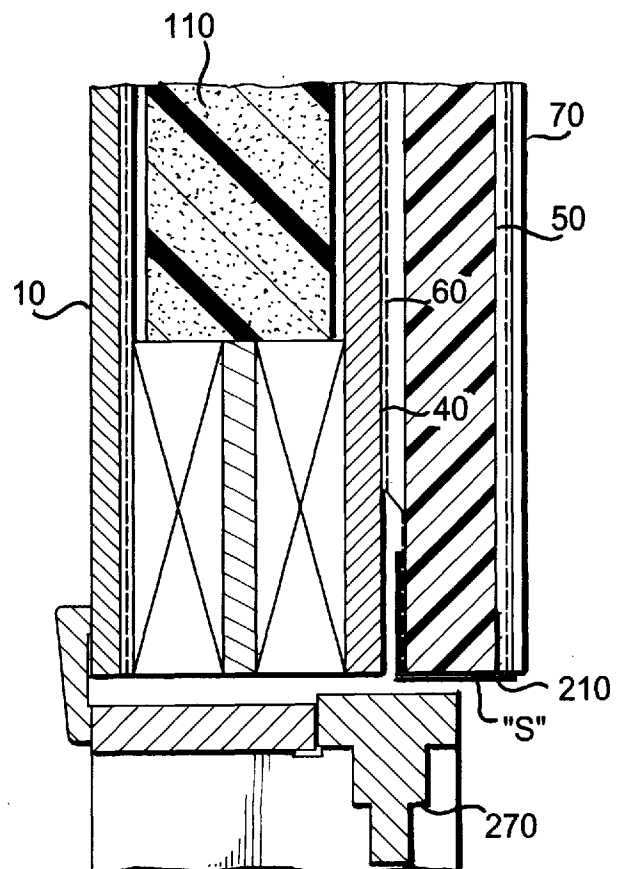


FIG. 5

FIG. 6



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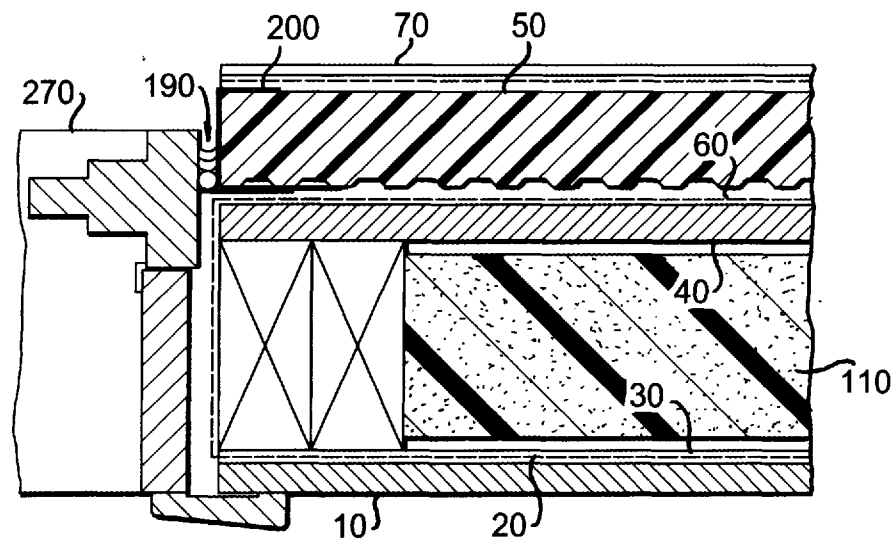


FIG. 7

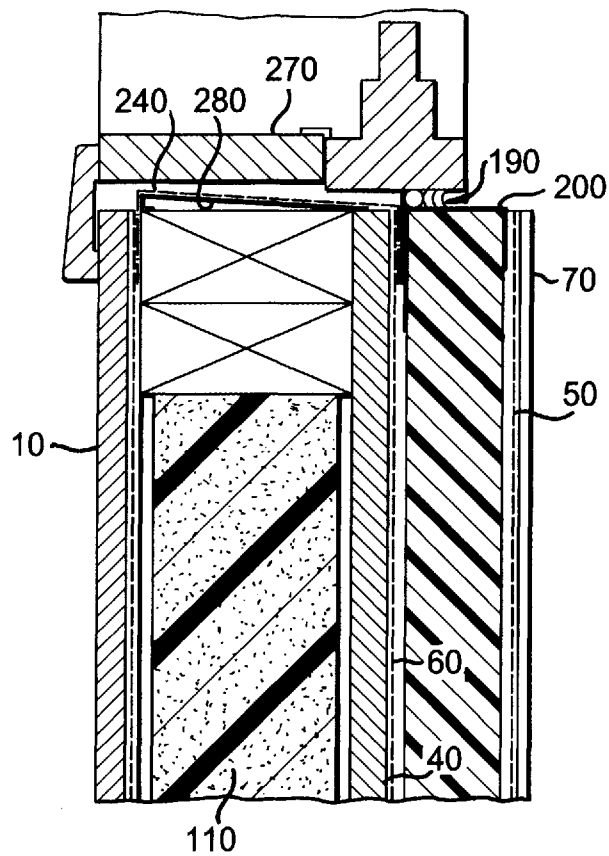


FIG. 8

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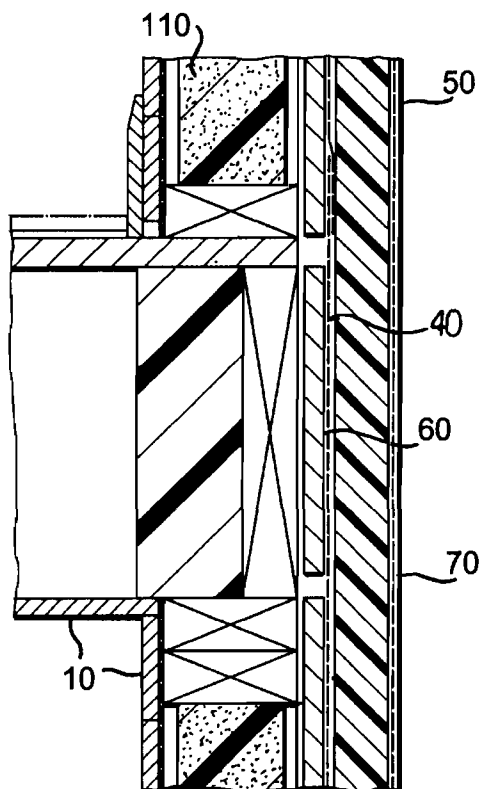


FIG. 9

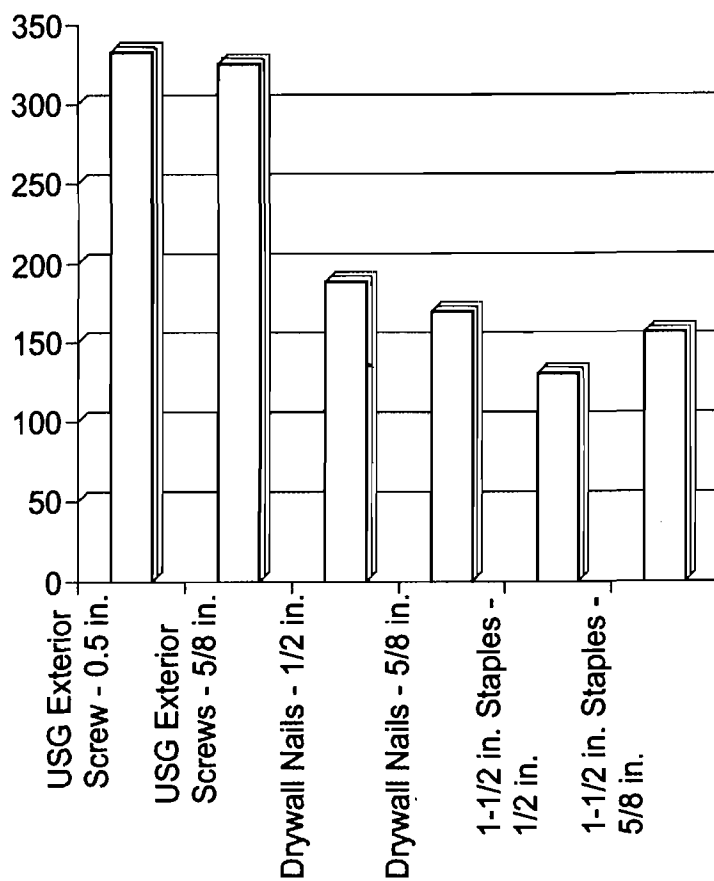


FIG. 10

INTERNATIONAL SEARCH REPORT

International application No.

PCT/US 08/59124

A. CLASSIFICATION OF SUBJECT MATTER

IPC(8) - E04C 2/34 (2008.04)

USPC - 52/794.1

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC(8) - E04C 2/34 (2008.04)

USPC - 52/794.1

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

IPC(8) - E04C (generally)

USPC - 52 (generally), 52/220.1, 267-270, 309.1, 309.4, 581.1, 794.1

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

Electronic Databases Searched:

PUBWEST (PGPB, USPT, EPAB, JPAB); Google Patents; Google Search

Search Terms Used: board, panels, gypsum, insulation, fasteners, polystyrene, tyvek, foam, siding, facings

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
Y	US 2005/0064145 A1 (HOIE et al.) 24 March 2005 (24.03.2005), entire document especially FIGS. 1 - 3, 32; paras. [0015], [0039], [0084], [0119]	1 - 10
Y	US 5,320,677 A (BAIG) 14 June 1994 (14.06.1994), entire document especially col 3 ln 9 - 13, col 5 ln 26 - 40, col 6 ln 9 - 33	1 - 10
Y	DuPont Tyvek Homewrap - Installation Guidelines. [online]. E.I. du Pont de Nemours and Company, Inc. 2004 [retrieved on 15 August 2008]. Retrieved from the Internet: <URL: http://web.archive.org/web/20070307175604/http://www.smithphillips.net/pdf+files/TyvekhomewrapBeforeInstall.pdf , entire document especially p. 1, p. 6	1 - 10
Y	US 5,979,131 A (REMMELE et al.) 09 November 1999 (09.11.1999), entire document especially FIG. 1; col 1 ln 29 - 37, col 2 ln 1 - 5, col 2 ln 46 - 52	1 - 10
Y	US 6,907,699 B2 (SCHMID) 21 June 2005 (21.06.2005), entire document especially FIG. 2; col 4 ln 67 - col 5 ln 1, col 5 ln 6 - 17	1 - 10
Y	US 4,435,938 A (RUTKOWSKI et al.) 13 March 1984 (13.03.1984), entire document especially FIGS. 1 - 3	3

☐ Further documents are listed in the continuation of Box C.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

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"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search

15 August 2008 (15.08.2008)

Date of mailing of the international search report

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Name and mailing address of the ISA/US

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