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BRUSMAN et al.

(54) **HIGH-STRENGTH INSULATED BUILDING PANEL WITH INTERNAL STUD MEMBERS**

(76) Inventors: **Bryan Daniel BRUSMAN**, Idaho Falls, ID (US); **Robert Charles Brusman**, Mill Hall, PA (US)

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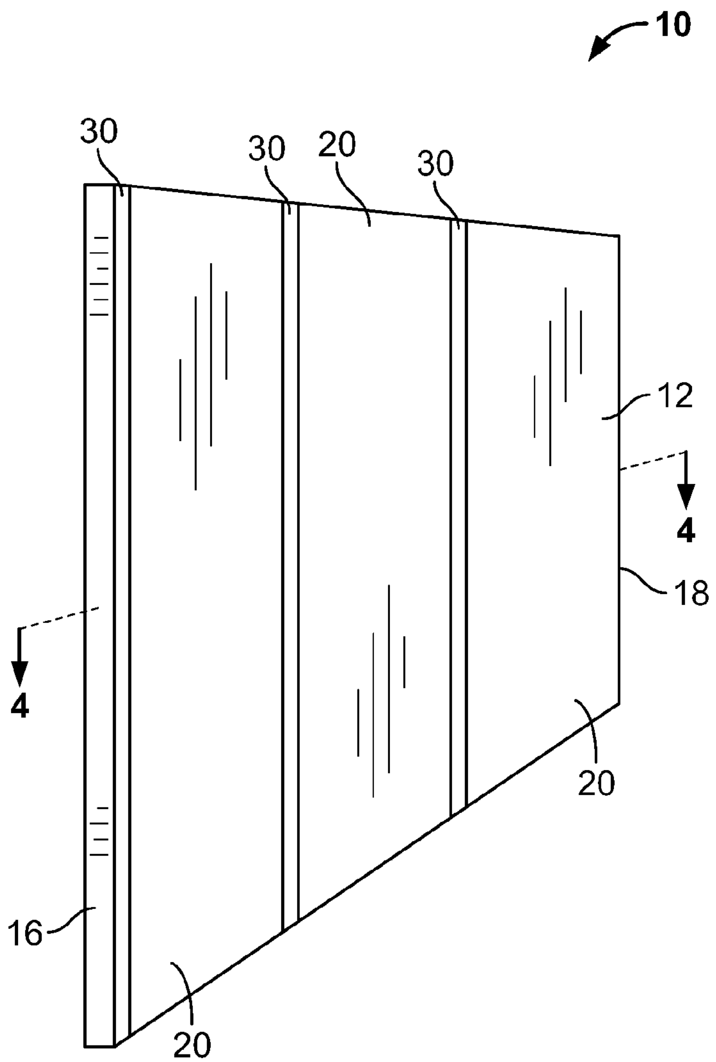
(57) **ABSTRACT**

The invention is directed to a building panel which has structural integrity. A plurality of stud members with opposed side surfaces and opposed end surfaces extend from a first face of the panel toward a second face. The plurality of stud members are spaced from each other and extend in a direction which is essentially parallel to each other. A rigid foam fills the volume of the panel which is not filled by the plurality of stud members. The rigid foam is bonded to at least one side surface of each of the plurality of stud members. The bonding of the rigid foam to the plurality of stud members results in a stable and strong panel which is capable of accommodating large shear loads.



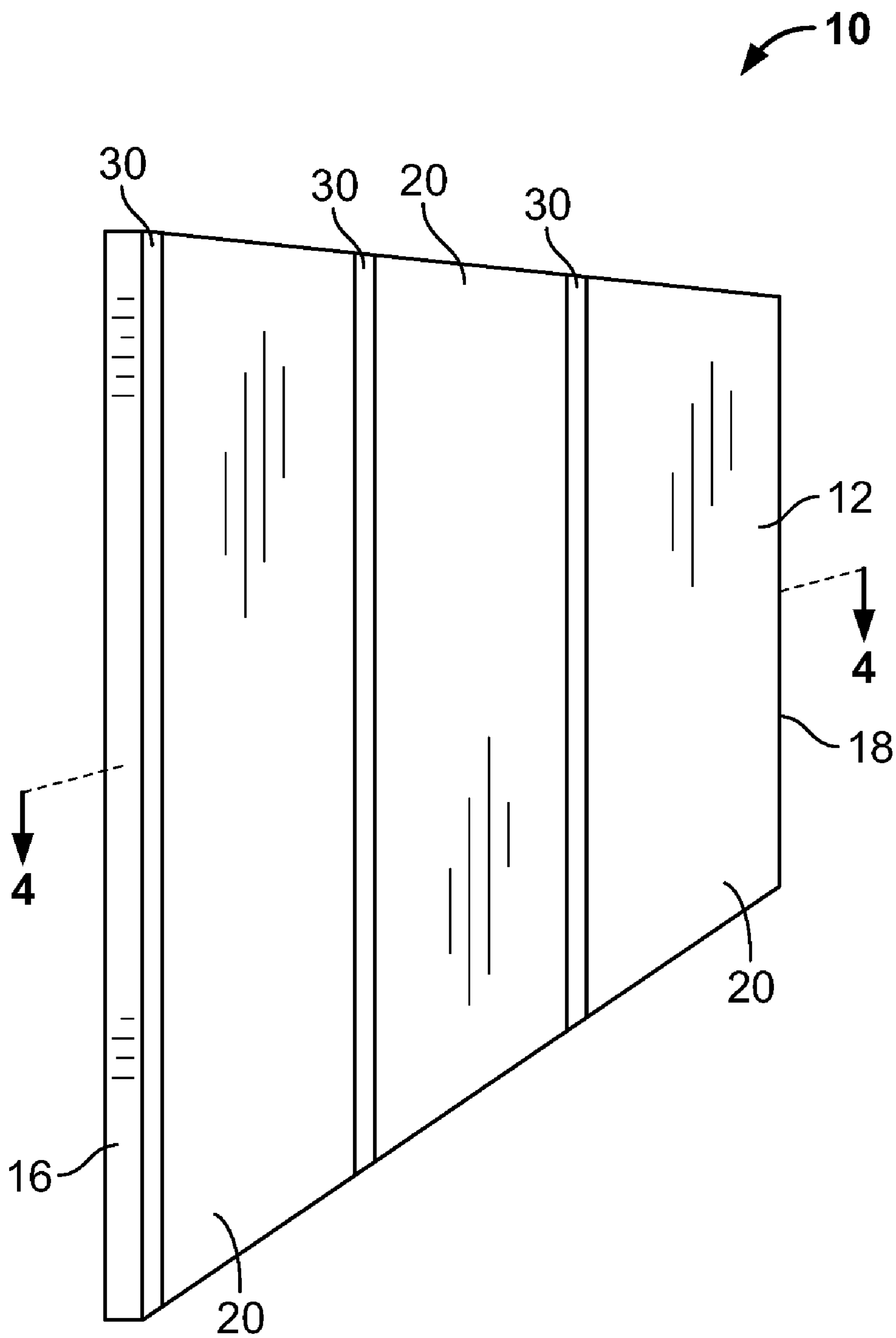


FIG. 1

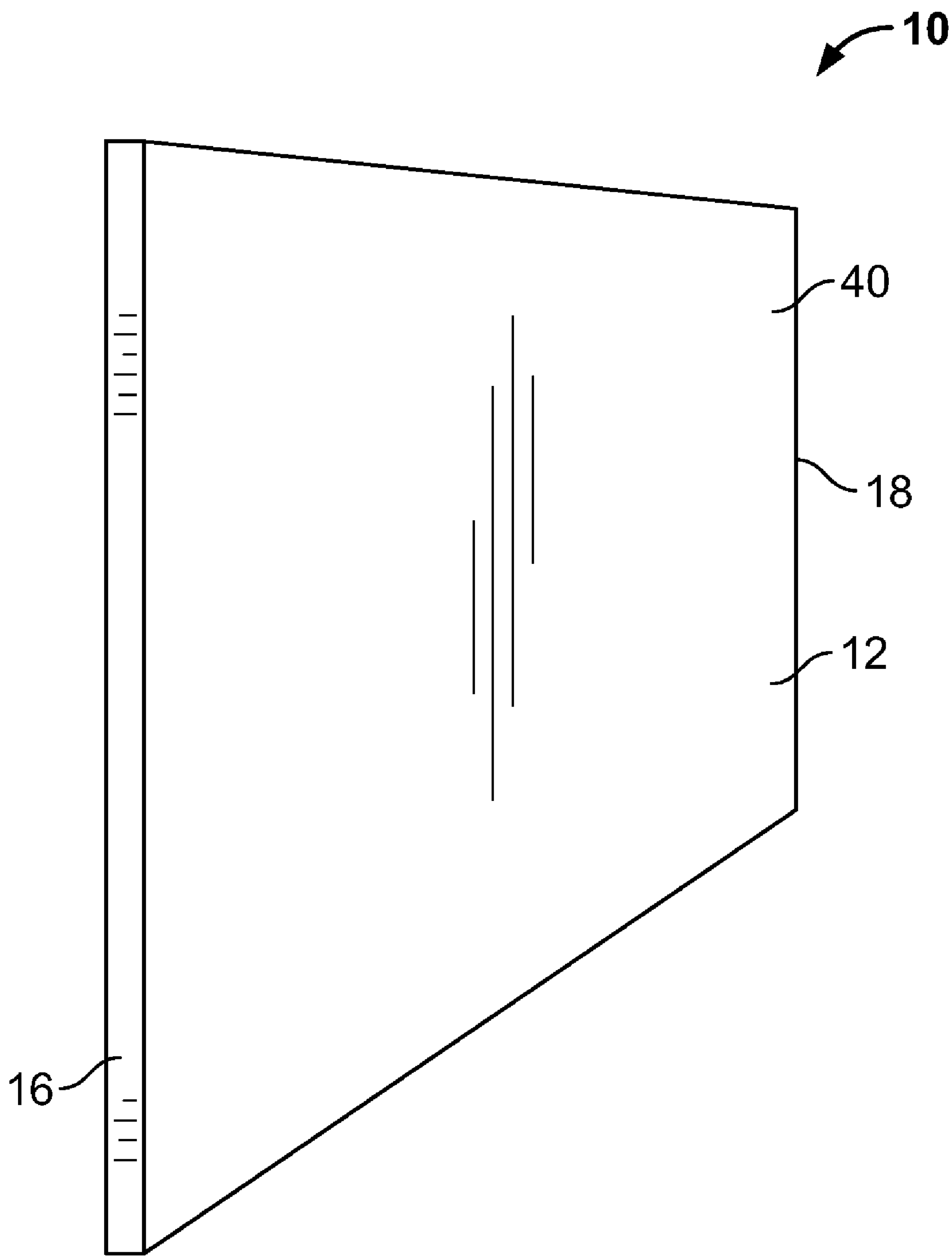


FIG. 2

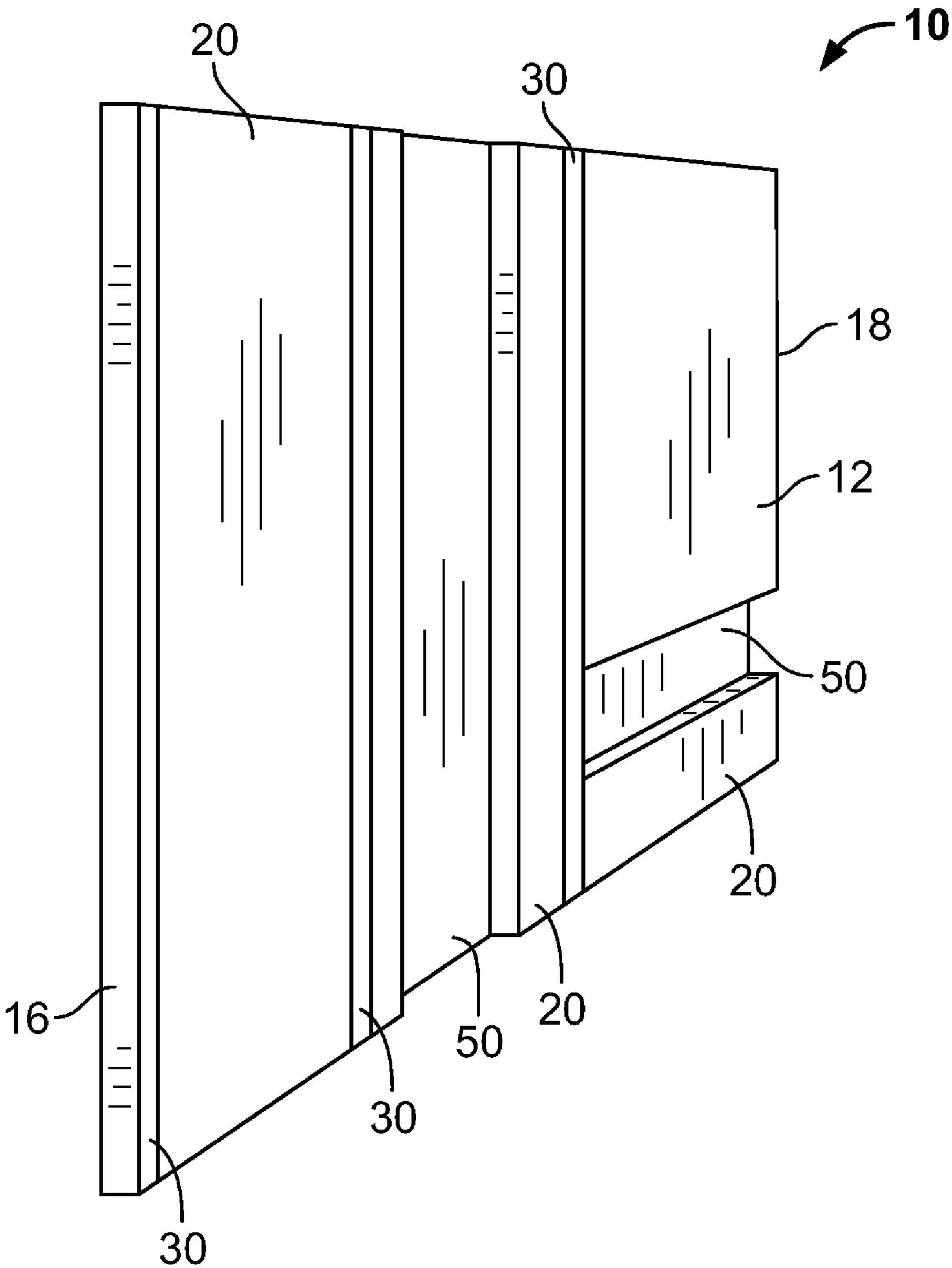


FIG. 3

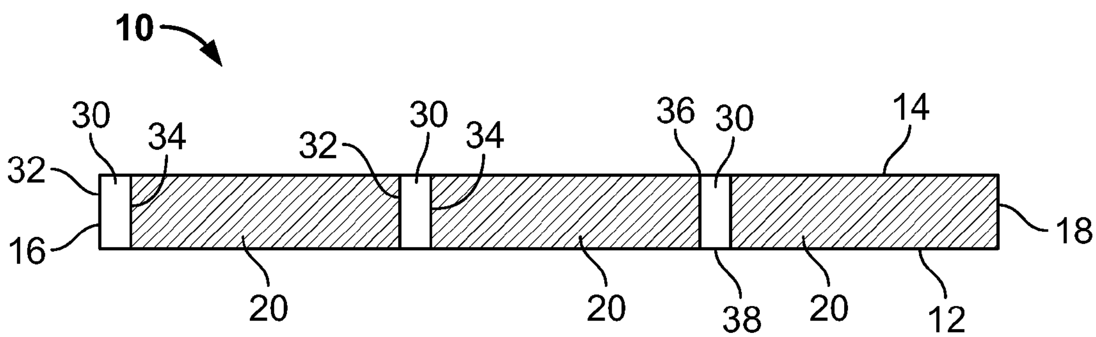


FIG. 4

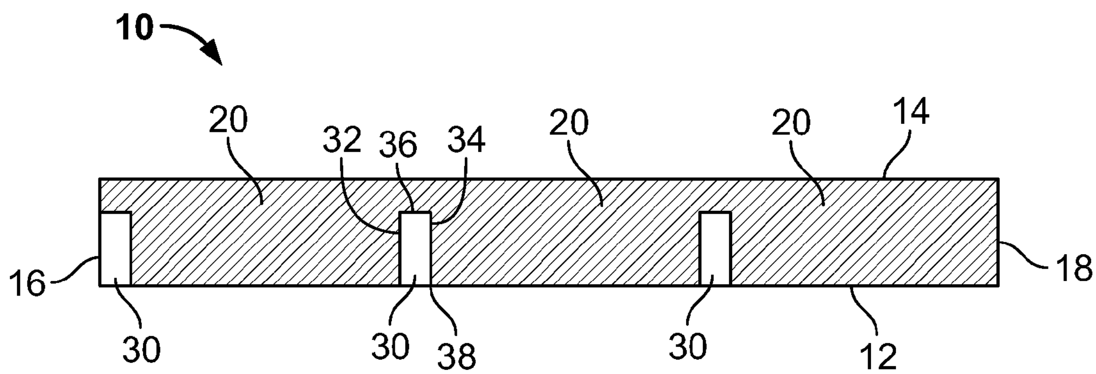


FIG. 5

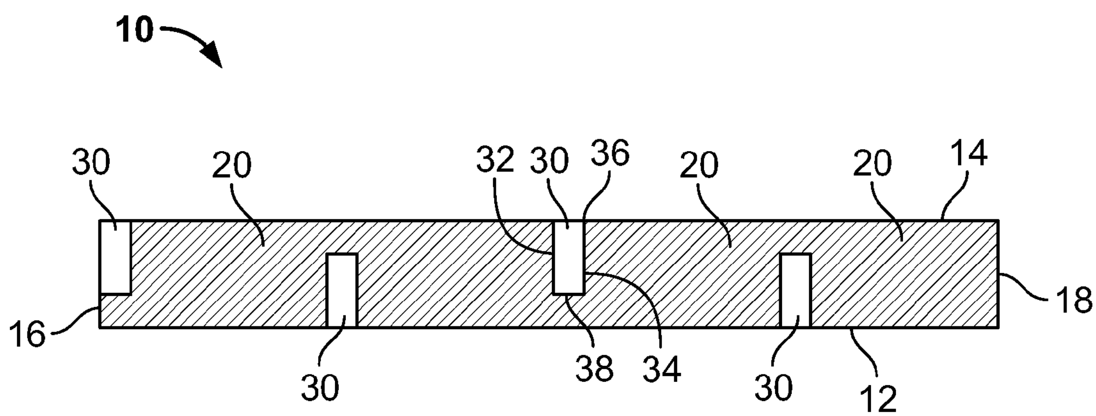


FIG. 6

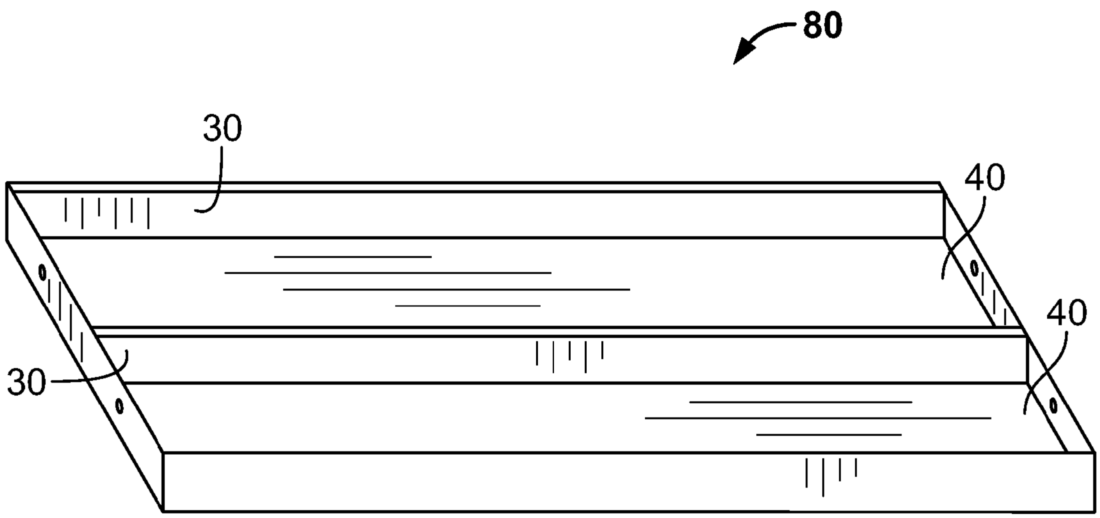


FIG. 7

HIGH-STRENGTH INSULATED BUILDING PANEL WITH INTERNAL STUD MEMBERS

FIELD OF THE INVENTION

[0001] The present invention relates to a building panel which has structural integrity. In particular, the invention is directed to a panel in which a foam is bonded to at least one side surface of each of a plurality of stud members resulting in a stable and strong panel which is capable of accommodating large shear loads.

BACKGROUND OF THE INVENTION

[0002] The construction industry is continuously attempting to find ways to reduce the time, cost, and labor associated with the construction of a structure, such as a wall, room, floor, ceiling and roof. Conventional stick building is labor-intensive, involving as separate steps, building the frame, erecting the frame, applying external sheathing and building wrap, followed by installing thermal insulation, typically fiberglass batts or blown-in cellulose. This practice generally results in less than optimal insulation because materials are inherently limited in insulating properties and construction practices are variable.

[0003] Techniques used to reduce the time, cost, and labor associated with the construction of a structure include prefabrication of various portions of a structure. Once the portion of the structure is fabricated, it is then transported to the construction site for placement in its intended location. One problem with such techniques is that the prefabricated portion of the structure is constructed with conventional materials using the techniques that would be used on the construction site. Another problem with these techniques is that the prefabricated portion is subject to damage during its transportation to the construction site.

[0004] These techniques typically also require that the structural integrity of the prefabricated portion of the building is derived solely from the frame of the prefabricated portion. In some instances, the structural integrity of the prefabricated portion of the building and the building itself is further derived from the specific way a prefabricated portion needs to be assembled with another portion of the building using connections, fasteners, and other coupling mechanisms specific to using the prefabricated portion.

[0005] Structural insulated panels ("SIPs") are an increasingly common material used in the construction of residential homes and other structures. Conventional SIPs have a sandwich-type structure, and comprise two sheets typically of a wood-based material, such as plywood or oriented strand board ("OSB"), that are bonded to an inner slab or foam insulation. Expanded polystyrene ("EPS") is typically used for the insulation, with extruded polystyrene and polyurethane foam sometimes being used. The bonded sandwich structure of SIPs has been demonstrated to provide comparable strength to conventional walls consisting of a lumber stud frame filled with slabs of fiberglass insulation. SIPs are typically fabricated as sheets of a standard size (e.g. 4 feet by 8 feet), which can then be cut to size on-site as needed prior to installation.

[0006] A number of SIP designs have been considered. For example, U.S. Pat. No. 6,279,287 to Meadows discloses a prefabricated building panel that includes first and second side panel members. A thermally insulating core is disposed between the panel members. A first panel end surface includes a pair of spaced projections defining a channel-way, while a second panel end surface includes a pair of spaced channels separated by a plug. Two adjacent building panels may be interconnected by engaging the pair of projections at the first end with the pair of channels and plug at the second end.

[0007] U.S. Pat. No. 6,599,621 to Porter discloses a flat structural panel for building construction that includes an inner insulating core of plastic foam and a pair of opposed outer facings, or sheets, bonded to the insulated core. One of the outer facings is of gypsum composite, or gypsum fiberboard, while the other outer facing is of a special plastic-impregnated OSB. The gypsum and OSB facings form the inner and outer surfaces of the panel. The facings provide high tensile strength, with the gypsum composite or fiberboard facing also providing resistance to fire and insects.

[0008] U.S. Patent Application Publication No. 20060117689 to Onken et al. discloses an insulated structural panel formed with a rigid foam core, a plurality of vertical hat channels on either face of the rigid foam core, and horizontal top and bottom L-channels on either face of the rigid foam core. The plurality of vertical hat channels on opposing faces of the rigid foam core is connected so as to compress the rigid foam core, thus adding structural strength to the insulated structural panel.

[0009] Although the axial and bending strengths of SIPs are known to be high, conventional SIPs typically require additional support along both their top and bottom surfaces. This support is typically provided by either one or more longitudinal strips of lumber secured to the top and bottom surfaces of the SIPs (commonly referred to as a "plates"), or U-shaped, longitudinally extending bands secured to the top and bottom surfaces of the SIPs. While the plates and bands contribute to the overall strength of the SIPs, they add to the quantity of material used in their construction and thereby increase cost.

[0010] Accordingly, it is an object to provide a novel structural insulated panel which can be installed with conventional tools, and which has both exceptional structural and thermal insulating properties while being light weight, easily handled, dimensionally stable and of a standard modular size.

SUMMARY OF THE INVENTION

[0011] The invention is directed to a modular panel that possesses very high R-value insulating properties and high load-bearing and shear resistance that far exceeds that normally achieved with conventional stick-building. The modular building panel combines all necessary functions—structure, maximum insulation, vapor barrier, dimensional stability and consistency—in a single product that installs with the same tools and skills as employed in conventional stick building. In a single construction step the entire wall and/or roof are completed and weather proof, ready for the finishing materials.

[0012] One aspect of the invention is directed to a building panel which has structural integrity. The panel has a first face and an oppositely facing second face. A pair of panel end walls and a pair of panel sidewalls extend between the first face and the second face. A plurality of stud members with opposed side surfaces and opposed end surfaces extend from the first face toward the second face. The plurality of stud members are spaced from each other and extend in a direction which is essentially parallel to each other. A rigid foam fills the volume of the panel which is not filled by the plurality of stud members. The rigid foam is bonded to at least one side surface of each of the plurality of stud members. The bonding of the rigid foam to the plurality of stud members results in a stable and strong panel which is capable of accommodating large shear loads.

[0013] Another aspect of the invention is directed to a panel having structural integrity for use in floors, ceilings, walls and/or roofs of a structure. The panel has a first face and an oppositely facing second face. A pair of panel end walls and a pair of panel sidewalls extend between the first face and the second face. A plurality of stud members with opposed side surfaces and opposed end surfaces extend from the first face toward the second face. The plurality of stud members are spaced from each other and extend in a direction which is essentially parallel to each other. A rigid foam fills the volume of the panel which is not filled by the plurality of stud members. A facing material extends across the first face of the panel. The facing material is bonded to the rigid foam. The bonding of the rigid foam to the plurality of stud members and to the facing material results in a stable and strong panel which is capable of accommodating large shear loads.

[0014] Another aspect of the invention is directed to a method of manufacturing a building panel. A plurality of stud members is positioned in a mold in a direction which is essentially parallel to each other, each stud of the plurality of stud members having opposed side surfaces and opposed end surfaces. The plurality of stud members are spaced from each. Foam is injected into the mold to fill the volume of the mold which is not filled by the plurality of stud members. Increased pressure and temperature are applied to allow the foam to cure, become rigid and bond to at least one side surface of each of the plurality of stud members. The panel is removed from the mold. The bonding of the rigid foam to the plurality of stud members results in a stable and strong panel which is capable of accommodating large shear loads.

[0015] Other features and advantages of the present invention will be apparent from the following more detailed description of the preferred embodiment, taken in conjunction with the accompanying drawings which illustrate, by way of example, the principles of the invention.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] FIG. **1** is a perspective view of a building panel, the panel having foam positioned between and bonded to stud members.

[0017] FIG. **2** is a perspective view of the building panel of FIG. **1** with a facing material positioned on a first surface of the building panel.

[0018] FIG. **3** is a perspective view, similar to that of FIG. **1**, illustrating conduits provided in the building panel.

[0019] FIG. **4** is a cross-sectional view, taken along line **4-4** of FIG. **1**, showing the foam in cooperation with the stud members, the stud members extending across the entire width of the building panel.

[0020] FIG. **5** is a cross-sectional view, similar to that of FIG. **4**, of a first alternate embodiment of the building panel, showing the foam in cooperation with the stud members, the stud members extending across a portion of the width of the building panel.

[0021] FIG. **6** is a cross-sectional view, similar to that of FIG. **4**, of a second alternate embodiment of the building panel, showing two rows of stud members in cooperation with the foam, each row of the stud members extending across a portion of the width of the building panel.

[0022] FIG. **7** is a perspective of a mold used in the manufacture of the building panels, the mold is shown prior to injection molding, with two stud members positioned therein.

DETAILED DESCRIPTION OF THE INVENTION

[0023] According to an embodiment of the present invention, a building panel **10** having structural integrity and a method of fabricating the building panel are provided. The building panel **10** derives its structural integrity from the bond provided between a foam or foam members **20** and spaced-apart, essentially parallel stud members **30**. In the orientation of FIG. **1**, the stud members **30** extend vertically. However, the stud members **30** may also extend horizontally, or in other orientations, without departing from the scope of the invention. The foam **20** may be bonded to the stud members **30** using injection molding methods, in which the temperature and pressure are above ambient during molding. Other known techniques may also be used to allow the foam **20** to bond to the stud members **30**. Each panel **10** may also be fabricated with wood plates or the like (not shown) on the top and bottom ends thereof. Each building panel **10** can be coupled to other building panels **10** to construct a structure, such as a room, floor, ceiling and/or roof.

[0024] Exemplary embodiments of the building panel **10** having structural integrity are shown in FIGS. **1** through **6**. In the embodiment of FIGS. **1** and **4**, building panel **10** has a first side surface **12**, an opposite facing second side surface **14**, and opposed end walls **16**, **18**. The building panel shown includes three stud members **30** and three foam members **20**, however other numbers of stud members **30** and foam members **20** may be used. The stud members **30** (as best shown in FIG. **4**) have oppositely facing side surfaces **32**, **34** and oppositely facing end surface **36**, **38** which extend between the side surface **32**, **34**. The stud members **30** may be constructed from one of metal, aluminum, wood and plastic including, but not limited to steel studs, engineered lumber or similar manufactured wood composite studs, I-joists, studs formed from finger-jointed lumber, or hollow pipes or tubes in place of wood studs. In an embodiment of the present invention, the stud members **30** may be configured as a conventional stud, a c-shaped stud, an interlocking stud, or the like. In an embodiment of the present invention, the foam members **20** are provided between the stud members **30** and are bonded to respective side surface **32**, **34** of the stud members **30** to provide increased structural integrity to the panel **10**, as will be more fully described.

[0025] In an embodiment shown in FIGS. **1** and **4**, the end surface **36**, **38** of each of the stud members **30** extend to the side surfaces **12**, **14** of the panel **10**. A respective stud member **30** is positioned at the end wall **16**. The other end wall **18** has no stud member, but is instead made an end of a respective foam member **20**. The panel **10** is typically configured with three stud members **30**, one located at and forming one edge or end wall **16** and two additional stud members **30** located at 16 and 32 inches, respectively, with the opposite edge or end wall **18** consisting of the foam member **20**, finished to mate squarely with another panels stud edge.

[0026] The foam may be made of any material having the appropriate thermal insulating, bonding and strength characteristics, including but not limited to a polyurethane, polyisocyanurate or other materials as may be appropriate for achieving other properties. For example, a dense filler material may be added to the polyurethane foam to increase mass and density for improved sound isolation.

[0027] The foam may be of a closed cell structure of expanded polyurethane, which consists of a network of closed pockets of air trapped in the polyurethane. This closed cell structure results in the foam insulation being both air-tight, which is beneficial for thermal insulation, and impermeable to moisture, which prevents the occurrence of water-related damage such as rotting and mould growth that could otherwise occur in "open cell" insulation materials such as fiberglass.

[0028] The density of the foam **20** may be controlled such that the panels **10** properties of weight, effective R-value, porosity, load and shear strength, and the like, may be altered to meet other requirements. The foam **20** may have a variable-density such that the higher density may be located at the exposed, unprotected edge or end wall **18** to confer greater resistance to damage in handling.

[0029] An exemplary building panel **10** according to the invention is a 4 foot by 8 foot by 3.5 inch thick panel comprised of standard 2 by 4 (the dimensions of which are 3.5 inches by 1.5 inch by 8 feet) parallel wood stud members **30** located on 16 or 24 inch centers. The foam **20** is molded into a matrix of rigid polyurethane foam having an approximate R-value of 7.2 per inch such that the depth of the stud members **30** determines the thickness of the panel **10** and the length of the stud members **30** determines the length of the panel **10**. The use of conventional stud members **30** and their spacing is consistent with standard framing practice. The panels **10** are compatible with all building materials, construction methods and tools currently used in the construction industry. Its 4-foot width is consistent with all construction protocols.

[0030] Other exemplary panels **10** (not shown) may be made with full stud members **30** on both end walls **16**, **18** of the panels **10** or with half stud members on both end walls **16**, **18** such that when two panels **10** are assembled, the two half stud members form a full stud member. The panels **10** may be made in lengths greater or shorter than 8 feet, may be fabricated with any spacing between stud members **30** and any number of stud members **30**. Typical common alternatives include 2 by 6 stud members spaced on 16 or 24 inch centers. Other alternatives include panels made with 2 by 8, 2 by 10 or 2 by 12 timber studs and lengths to 20 feet or greater. Such panels may be used in certain cathedral ceiling constructions. For example a panel fabricated from 2 by 8 lumber will have an effective R-value of 52. The panel may be installed directly on the rafters, providing structural support as well as insulation, thereby enabling the finish roofing materials to be installed directly.

[0031] Referring to FIG. **2**, the panel **10** is faced on one or both side surfaces **12**, **14** with a foil, film or other facing material **40**. The film **40** may be bonded to the foam members **20** and/or to the end walls **36**, **38** of the stud members **30**. The lack of the foil or film **40** does not compromise the panel's **10** strength and would only slightly reduce its effective R-value. The foil or film **40** may provide an enhanced moisture barrier and may also act as a barrier between the injected foam and an interior mold surfaces as the panel **10** is manufactured, thereby facilitating the removal of the panel **10** from the mold, as will be more fully described below. The film **40** may be fiberglass-reinforced aluminized Mylar film. The use of other facing materials include, but are not limited to, sheet metal, gypsum board, plywood, laminate, OSB, fabric, plastic film, and the like.

[0032] As illustrated in FIG. **3**, the panels **10** may be made or fabricated with channels, vias or conduits **50** molded in place to accommodate wiring, plumbing or air handling functions, including the hardware therefore. The conduits **50** extend vertically, horizontally or in any other direction required. Additionally panels **10** can be custom fabricated to include window and door openings (not shown). Utility boxes and the like could be molded in place. By molding the foam **20** in forms which accommodate these features, the density of the foam **20** can be varied around these sections to provide the proper thermal insulation required. In an alternate embodiment, an air space or conduit is provided between the foam **30** and a respective side surface **12**, **14** of the panel **10**. In this embodiment, the foam insulation **30** partially fills the panel **10**, its thickness regulated to fill the panel during manufacture from one side, leaving the air space of predetermined thickness between the foam and the side surface of the panel **10**. Panels of this construction may be useful for roof assemblies where ridge vents are employed to provide ventilation.

[0033] Referring to FIGS. **5** and **6**, other alternative embodiments are shown. In both embodiments, the stud members **30** of the panels **10** do not extend across the entire width of the panel **10**. In these embodiments, the stud members **30** are surrounded by foam **20** on both side surfaces **32**, **34** and on one end surface **36**, thereby providing a thermal break. In certain high energy efficiency constructions, exterior walls are built with double stud members **30** (FIG. **6**), staggered such that a layer of foam **30** or insulation is imposed between a respective side surface **12**, **14** of the panel **10** and a respective end wall **36**, **38** of the stud members **30**. This breaks the thermal pathway that the stud members **30** provide. As shown in FIG. **6**, panels **10** may be fabricated with two parallel rows of stud members **30** arranged such that alternating stud members **30** define opposite faces so that no stud member **30** is in contact with both side surface **12**, **14** of panels **10**. One such embodiment is a 5.5 inch thick panel which contains two parallel rows of 2 by 4 stud members.

[0034] The panels of the present invention may be made by a molding process. Referring to FIG. **7**, the stud members **30** are positioned a mold **80** of the internal dimensions of the finished panel. The reactive foam is injected or co-injected into the mold, such that the reactive foam fills the volume of the mold not occupied by the stud members **30**. If foil or film **40** is to be positioned on one or both side surfaces **12**, **14**, the foil or film **40** is placed within the mold before the reactive foam is injected. The foil or film **40** forms a barrier between the reactive foam and the inside faces of the mold **80**, thereby facilitating the removal of the finished panel **10** from the mold. As is known in the molding industry, the mold **80** is positioned in a press assembly or the like, such that pressure is applied to the outside of the mold which is sufficient to maintain the dimensions of the mold as the foam is injected therein. Other known methods of holding the mold in position may be used. Once injected into the cavity of the mold, the foam cures and bonds with the side surfaces **32**, **34** of the stud members **30**. The foam also bonds with the foil or film **40** is such foil or film is present in the mold. The density of the foam is controlled by the choice of components of the foam injected and their ratio and by the curing temperature, curing pressure, curing time and the quantity introduced into the mold. Such components may include, but are not limited to polyol and isocyanate. The parameters may be selected from data provided by the manufacturer or supplier of the foam components and the specifications of the mixing head. In the alternative, the panels **10** may be molded through the use of a continuous molding process production line in place of the individual mold process producing an identical or similar product and function.

[0035] The closed-cell, rigid polyurethane foam provides exceptional insulation per unit thickness, surpassing fiberglass and cellulose, and being formed and cured in the mold, provides a continuous, void-free structure for maximum insulation value at minimum thickness.

[0036] The panels **10** of the present invention provide both exceptional structural and thermal insulating properties while being of relatively light weight, easily handled, dimensionally very stable and are of standard modular size. The use of standard dimension stud members **30** assures that all building codes are met.

[0037] The formation of the panels **10** by molding the stud members **30** into a foam matrix **20** provides maximum insulating value while the intimate bonding of the foam **20** to the stud members **30** results in exceptional and unexpected load-bearing properties. The addition of the film **40** on one or both side surface **12**, **14** provides an additional heat reflecting benefit while ensuring that air infiltration is virtually eliminated. The exceptional thermal insulating property of the foam **20** allows walls and roofs to be built at lower thicknesses while achieving greater R-values than possible with fiberglass of cellulose insulated structures. The low density of the foam **20** results in panels **10** of light weight, greatly simplifying handling by carpenters. The molded construction of the panels **10** locks the stud members **30** in place and eliminates any warping that is characteristic of conventional stick-built assemblies. The exceptional strength of the panels **10** with respect to shear load may eliminate the need for external sheathing that is required for stick building. This can save considerable cost and labor in framing a building.

[0038] The panels **10** may be pre-assembled into full wall sections off-site and transported to the building location to enable faster framing of the structure, which would facilitate construction in unfavorable weather conditions or could extend the length of the building season. The panels **10** may be configured to construct modular buildings, wall and roof components, and shipped to the site in a single package. Their structural properties, quick assembly and relatively light weight are an advantage for handling in emergency shelter situations. The exceptional thermal insulating properties of the panels **10** enable their use in refrigerating and cold-storage buildings where they provide both structure and insulation in a single step.

[0039] The panels **10** of the present invention may be used for floors, walls, ceilings and roofs in the construction of residential and light commercial and industrial buildings using the same methods, tools and skills that carpenters employed in conventional stick-building construction. In addition, the panels **10** may be used as interior wall partitions to provide rapid construction, ease of subsequently relocating walls and to provide improved sound isolation between rooms.

[0040] While the invention has been described with reference to a preferred embodiment, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the scope of the invention. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the invention without departing from the essential scope thereof. Therefore, it is intended that the invention not be limited to the particular embodiment disclosed as the best mode contemplated for carrying out this invention, but that the invention will include all embodiments falling within the scope of the appended claims.

1. A building panel having structural integrity, the panel comprising:

a first face and an oppositely facing second face, a pair of panel end walls and a pair of panel sidewalls extend between the first face and the second face;

a plurality of stud members having opposed side surfaces and opposed end surfaces, the plurality of stud members extend from the first face toward the second face, the plurality of stud members are spaced from each other and extend in a direction which is essentially parallel to each other;

a rigid foam, the rigid foam fills the volume of the panel which is not filled by the plurality of stud members, the rigid foam is bonded to at least one side surface of each of the plurality of stud members;

whereby the bonding of the rigid foam to the plurality of stud members results in a stable and strong panel which is capable of accommodating large shear loads.

2. The building panel as recited in claim **1**, wherein the rigid foam is a closed-cell polyurethane foam which is injection molded between the stud members to provide a continuous, void-free structure for maximum insulation value at a minimum thickness of the panel.

3. The building panel as recited in claim **1**, wherein the rigid foam has a variable density whereby the higher density is located at exposed, unprotected edges to confer greater resistance to damage in handling.

4. The building panel as recited in claim **1**, wherein the first face has a layer of facing material which extends across the first face to increase the insulation value of the panel.

5. The building panel as recited in claim **4**, wherein the facing material is a fiberglass reinforced aluminized polyester film.

6. The building panel as recited in claim **4**, wherein the facing material is bonded to the rigid foam.

7. The building panel as recited in claim **1**, wherein a first side wall is formed from one of the plurality of stud members and a second side wall is formed from the rigid foam.

8. The building panel as recited in claim **1**, wherein the side walls are formed from respective stud members of the plurality of stud members.

9. The building panel as recited in claim **1**, wherein a first row of the plurality of stud members is provided which extend from the first face, the first row of the plurality of stud members has the rigid foam provided between the first row of the plurality of stud members and the second face, whereby a thermal break is provided to prevent a thermal pathway across the width of the panel through the plurality of stud members.

10. The building panel as recited in claim **9**, wherein a second row of the plurality of stud members is provided which extend from the second face, the second row of the plurality of stud members has the rigid foam provided between the second row of the plurality of stud members and the first face, the second row of the plurality of stud members is staggered from the first row of the plurality of stud members whereby a thermal break is provided to prevent a thermal pathway across the width of the panel through the plurality of stud members.

11. The building panel as recited in claim **1**, wherein conduits are provided in the panel, the conduits are provided to accommodate wiring, plumbing or air flow through the panel.

12. A panel having structural integrity for use in floors, ceilings, walls or roofs of a structure, the panel comprising:
- a first face and an oppositely facing second face, a pair of panel end walls and a pair of panel sidewalls extend between the first face and the second face;
- a plurality of stud members having opposed side surfaces and opposed end surfaces, the plurality of stud members extend from the first face toward the second face, the plurality of stud members are spaced from each other and extend in a direction which is essentially parallel to each other;
- a rigid foam, the rigid foam fills the volume of the panel which is not filled by the plurality of stud members;
- a facing material extending across the first face of the panel, the facing material is bonded to the rigid foam;
- whereby the bonding of the rigid foam to the plurality of stud members and to the facing material results in a stable and strong panel which is capable of accommodating large shear loads.

13. The panel as recited in claim **12**, wherein the rigid foam is a closed-cell polyurethane foam which is injection molded between the stud members to provide a continuous, void-free structure for maximum insulation value at a minimum thickness of the panel.

14. The panel as recited in claim **12**, wherein the rigid foam has a variable density whereby the higher density is located at exposed, unprotected edges to confer greater resistance to damage in handling.

15. The panel as recited in claim **12**, wherein the facing material is a fiberglass reinforced aluminized polyester film.

16. The panel as recited in claim **12**, wherein the facing material extends across the second face to increase the insulation value of the panel, the facing material is bonded to the rigid foam and to the plurality of stud members of the second face.

17. A method of manufacturing a building panel having structural integrity, the method comprising;
- positioning a plurality of stud members in a mold in a direction which is essentially parallel to each other, each stud member of the plurality of stud members having opposed side surfaces and opposed end surfaces;
- spacing the plurality of stud members from each;
- injecting a foam into the mold to fill the volume of the mold which is not filled by the plurality of stud members;
- applying increased pressure and temperature to allow the foam to cure, become rigid and bond to at least one side surface of each of the plurality of stud members;
- removing the panel from the mold;
- whereby the bonding of the rigid foam to the plurality of stud members results in a stable and strong panel which is capable of accommodating large shear loads.

18. The method as recited in claim **17**, wherein the density of the foam injected into the mold has a variable density whereby the higher density is injected at locations which more wear will occur to confer greater resistance to damage in handling.

19. The method as recited in claim **17**, wherein a facing material is positioned in the mold, the facing material extending across the width of the mold, the facing material bonding with the foam when the appropriate pressure and temperature are applied.

20. The method as recited in claim **17**, wherein conduits are formed in the foam during the molding process, the conduits are provided to accommodate wiring, plumbing or air flow through the panel.

21. The method as recited in claim **17**, wherein a first row of the plurality of stud members is positioned in the mold and a second row of the plurality of stud members is positioned in the mold and is staggered and offset from the first row of the plurality of stud members whereby as the foam is cured, a thermal break is provided to prevent a thermal pathway across the width of the panel through the plurality of stud members.

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