A structural panel includes perimeter rails and parallel joists having top and bottom surfaces lying in common parallel planes. Between the joists and the rails are diagonal planar bridge members extending obliquely in zigzag manner such that an end of one of the bridge members butts an opposed end of a next one of the bridge members at a side face of the joist. Planar top cover sheets bottom cover sheet are adhesively bonded to the top and bottom surfaces of the rail members, bridge members and joists. When used in a modular building, the floor has sufficient stiffness for the module to be transported from an assembly location in finished condition with all interior and exterior cladding attached and with the walls are topped by finished sandwich ceiling panels. The roof structure spanning the assembled modules is built on at the installation location.
STRUCTURAL PANEL AND MODULAR BUILDING FORMED USING THE PANEL

[0001] This application claims the benefit under 35 USC 119 from Provisional Application No. 60/822,541 filed Aug. 15th 2006.

[0002] This application relates also to the subject matter disclosed and claimed in co-pending application Ser. No. INSERT WHEN KNOWN (Attorney docket 85732-232) filed on the same date as this application by the same applicant and entitled MODULAR BUILDING FORMED USING A STRUCTURAL PANEL.

[0003] The present invention relates to a structural panel formed wholly or primarily from wood and to a modular building constructed using the panel which can be shipped to an installation site in substantially completed form to minimize on-site labour.

BACKGROUND OF THE INVENTION

[0004] The structural panel described and claimed herein is primarily designed for use in modular buildings and hence the following description refers primarily to such constructions. However the same construction can be used in many other similar and unrelated fields. The modular buildings described hereinafter are therefore merely examples of end uses.

[0005] It is known in the art to fabricate a modular building in sections for later assembly on a remote site, as in-plant fabrication is known to have a number of advantages over on-site construction. In-plant fabrication provides easier monitoring of quality and safety issues, improved repeatability and less dependency on environmental conditions. For many, modular housing may present a desirable alternative to conventional housing construction due to increasing costs and waiting periods. However, when compared to conventional housing, manufactured housing has been associated in some cases with problems such as noticeable difference in appearance, twisting and cracking of materials during travel, low quality wall construction and insulation, high rate of depreciation and high mortgage down payments. As a result, there has been a drive to improve the quality of modular homes to increase their popularity. Up to now two alternate routes have been taken in view of the twisting or movement of the structure which occurs during transportation. In one alternative, the quality of finishing of the building has been very low to accommodate that twisting. This has prevented this type of building from competing in the conventional building market. In the other alternative, much of the finishing is carried out after the modules are transported and located, but this of course cancels much of the advantage of building in the manufacturing location.

[0006] Canadian Patent No. 1,203,063 (Kaufman) published Apr. 15th 1986 teaches a prefabricated building for installation on a floor-forming foundation. The building features completed interior and exterior walls and a roof but no floor, for quick and easy on-site installation, but may be limited in size due to its one-piece construction. The building uses triple layer framing at the floor rails and double layer framing at the ceiling and special corners which are intended to provide a structure which is rigid to be lifted onto a foundation which provides the floor.

[0007] U.S. Pat. No. 4,083,154 (Klink) issued Apr. 11th 1978 teaches a modular home formed of two similar sections for connection on opposite sides of a third section to form an overall shape suggestive of an on-site construction. Each section includes its own roof portion and is formed from conventional framing techniques using floor joists, but from the figures it appears that a significant amount of on-site completion may be necessary before the building is ready for occupation. Klink does not disclose a structural panel which can be used to form such a modular building and discloses no special floor construction.

[0008] U.S. Patent Application Publication No. 2005/0252099 (Jenkins) published Nov. 17th 2005 teaches a modular home made up of two lower sections and a third upper roof section, each of which is provided with a complete interior to reduce the amount of on-site work necessary after assembly. The two lower sections are each covered by a roof portion that cooperates with the third section to complete a peaked roof. Installation of an exterior finish is carried out on-site and difficulties with transportation of the two lower sections may arise due to the significant height added by their respective roof portions, for example, should transport between the fabrication and installation sites require passing beneath a bridge.


SUMMARY

[0010] It is one object of the present invention to provide a structural panel which can be arranged to provide a high level of stiffness.

[0011] According to a first aspect of the present invention there is provided a structural panel comprising:

[0012] a first pair of parallel perimeter rail members arranged to define first sides of the panel;

[0013] a second pair of parallel perimeter rail members arranged to define second sides of the panel at right angles to the first sides;

[0014] a plurality of parallel joists extending between the first pair of perimeter rail members and parallel to the second pair of perimeter rail members;

[0015] the rail members and the joists having top surfaces lying in a common top plane and bottom surfaces lying in a common bottom plane;

[0016] each one of the second pair of perimeter rail members and the joists therebetween being connected to a next adjacent one of the second pair of perimeter rail members and the joists therebetween by a plurality of diagonal planar bridge members;

[0017] each of the diagonal planar bridge members extending obliquely between said one and said next adjacent one with one end edge fastened to a side face said one and an opposed end edge fastened to a side face said next adjacent one;

[0018] and with the diagonal planar bridge members extending obliquely between said one and said next adjacent one being arranged in zigzag manner such that an end of one of the bridge members butts an opposed end of a next one of the bridge members at a side face;

[0019] a planar top cover sheet lying in said common top plane and adhesively bonded to said top surfaces of said rail members and said joists;
and a planar bottom cover sheet lying in said common bottom plane and adhesively bonded to said bottom surfaces of said rail members and said joists.

Preferably the top cover sheet and the bottom cover sheet each comprise a layer of sheathing boards. They may however be formed from a single layer of a fabricated sheet material.

Preferably the ends of the bridge members are adhesively bonded to the faces of the joists to effectively transfer loads therebetween.

Preferably the top sheet and the bottom sheet span between the top and bottom cover sheets and are adhesively bonded to top and bottom edges respectively of the bridge members.

Preferably the butting ends of the bridge members on opposite faces of the joists are aligned so that loads form one side of the joist are transferred through the joist directly to the bridge members butting on the other side of the joist.

Preferably the bridge members comprise wood sheets such as plywood or other fabricated wooden structure such as Oriented Strand Board. However they can also be fabricated members such as aluminum sheets.

Preferably the structural panel is longer in direction between the first pair so that the joists extend in the longitudinal direction.

Preferably the rail members are of a common construction with the joists. They can therefore be laminated wood members such as 2x12 lumber, or they can be fabricated joists such as laminated boards or trusses.

In accordance with one important feature there is provided a lifting assembly for lifting the panel comprising a plurality of mounting plates extending at right angles to the top cover sheet and fastened to the panel at spaced positions thereon with each plate having a captive nut carried thereon and providing an end of the nut exposed at the top cover sheet, the lifting assembly including a plurality of threaded rods each for fastening to a respective nut so as to extend therefrom at right angles outwardly form the top cover sheet.

Preferably the lifting assembly includes a plurality of second mounting plates extending at right angles to the bottom cover sheet and fastened to the panel at spaced positions thereon with each second mounting plate having a captive nut carried thereon and providing an end of the nut exposed at the bottom cover sheet for receiving a threaded fastener attached thereto.

Preferably the lifting assembly includes a plurality of second mounting plates extending at right angles to the bottom cover sheet and fastened to the panel at spaced positions thereon with each second mounting plate having a captive nut carried thereon and providing an end of the nut exposed at the bottom cover sheet for receiving a threaded fastener attached thereto.

Preferably respective ones of the mounting plates and respective ones of the second mounting plates are clamped together through a component of the panel which extends at right angles to the top and bottom sheets so as to be fastened to the panel.

Preferably there are four components to which the plates are attached each of which extends at right angles to the joists and connects between a joist and a respective one of the second rail members.

Preferably the top and bottom sheets are formed from rectangular sheets having a longer axis and a shorter axis and are arranged with the longer axis at right angles to the joists.

According to a second aspect of the present invention there is provided a modular building comprising:

at least two separate modular base sections which are constructed so as to be separately transportable from a location of construction to a location of installation;

each modular base section including a floor structure and upstanding walls mounted on the floor structure;

the base sections being arranged to be connected so as to mate the walls to define a peripheral wall and interior walls of the modular building;

a roof to cover the peripheral wall with the modular base sections connected;

the floor structure of each modular base section comprising a structural panel according to any one of the above defined features.

Preferably the interior walls and the peripheral wall are finished with all electrical connections and plumbing installed; the interior walls and the peripheral wall are finished with all windows, doors, and interior coverings installed; and the peripheral wall is finished with all exterior coverings installed.

Preferably the roof is a separate construction from the modular base sections constructed at the installation location after connection of the modular base sections and includes trusses spanning the peripheral wall so as to bridge over at least two of the modular base sections.

Preferably each of the modular base sections includes ceiling panels covering an open top of the walls thereof such that the ceiling panels form a top cover during transportation of the modular base sections.

Preferably the ceiling panels are structural sandwich panels formed of top and bottom sheet material and a layer of foam therebetween and connected thereto.

BRIEF DESCRIPTION OF THE DRAWINGS

In the accompanying drawings, which illustrate exemplary embodiments of the present invention:

FIG. 1 is a top plan view of three structural panels according to the present invention used as floor structures for assembled sections of a first embodiment of a modular home, with floor sheathing removed for illustration.

FIG. 2 is a top plan view of one of the floor portions of FIG. 1 before the installation of floor sheathing.

FIG. 3 is a top plan view of the floor portion of FIG. 2 with sheathing installed.

FIG. 4 is an isometric view of one base section of a modular home of FIG. 1 before assembly with other sections.

FIG. 5 is a partial isometric view of the base section of FIG. 4 with a respective roof section installed thereon.

FIG. 6 is an exploded end view of the modular home of FIG. 1.

FIG. 7 is a cross-sectional view of one module of the embodiment of FIG. 1 during draping of the cover sheet.

FIG. 8 is a top plan view of a structural panel according to the present invention with top sheathing removed for illustration.
FIG. 9 is a cross-sectional view along the lines 9-9 of FIG. 8 with the panel used to form one module of the modular home.

FIG. 10 is front elevational view of three modules connected together to form a building with a roof installed on top of the three modules as a separate construction applied on site.

DETAILED DESCRIPTION

FIGS. 2 and 3 show the floor structure 10 of a base section 12 of a modular home. FIG. 1 shows how multiple base sections are assembled to define the base of a modular home. As seen in FIG. 2, each floor structure is rectangular and features a perimeter 14 defined by opposing side walls 16 and opposing end walls 18. Joists 20 are spaced along the floor structure and extend there across parallel to one another between the side walls 16 in a conventional arrangement. Where the floor structure differs from the prior art is that bridge members 22 extend obliquely between adjacent joists, as well as between end walls 18 and end joists there adjacent which form a perimeter rail structure, in order to brace components against one another to improve the overall rigidity or strength of the floor structure.

In the figures, the bridge members are arranged in a regular pattern in that they share the same length and the same angle relative to the joists, for example approximately 45 degrees, although the angles of adjacent bridge members relative to a common joist are in opposite ones of clockwise and counter-clockwise directions there from. Adjacent bridge members between neighboring joists diverge from a common point along one joist to extend toward the other joist. The joist acts like a mirror line in the sense that at the point along the length of the joist where the two adjacent bridge members diverge from one side of the joist, two adjacent joist bridge members also diverge from the other side of the joist. The bridge members extending obliquely between adjacent joists extend the full space between the side walls 16 of the floor structure perimeter. The result is that all space within the perimeter 14 of the floor structure is divided into triangles by the joists side walls 16, end walls 18, joists 20 and bridge members 22. The triangles formed in part by the side walls 16 are half the area of the others. The bridge members act as braces between the joists, between the perimeter walls and between the joists and perimeter walls, thereby providing a floor structure with significantly improved rigidity, strength and stability.

The perimeter walls, joists and bridge members of the floor structure of the illustrated embodiment are formed of lumber and are interconnected by suitable fasteners known to those of skill in the art. For example, 2x12 inch lumber may be used for the wooden components with the perimeter walls and joists fastened by screws and the bridge members and joists fastened by adhesive. It should be appreciated however, that any one of a number of suitable materials known to those of skill in the art may be used to construct the floor structures. As an example of possible alternatives to wood, the bridge members may be formed of aluminum.

As shown in FIG. 3, the frame work formed by the perimeter walls, joists and bridge members may be covered on one or both sides by rectangular sheathing 24. Providing sheathing 24 on both sides of the floor structure further improves the rigidity of the structure by adding additional resistance to relative movement between the perimeter walls. In the illustrated embodiment, the sheathing 24 is formed by rectangular plywood sheets arranged end to end within rows arranged side by side in order to cover the floor structure. Sheets of a readily available standard width, for example 4 foot wide plywood, form two rows 24A which cover the majority of the section. A third row 24B features sheets cut to a reduced width to cover the remaining area. An end sheet 24C in each row is a suitable length so as not to extend passed the perimeter of the section. Sheets of adjacent rows are staggered such that junctions between sheets in one row do not align with junctions between sheets in the next row. In other words, the cut end sheets of adjacent rows are disposed at opposite ends of the floor structure so that the full length sheets of the adjacent rows are staggered along the floor structure. This particular arrangement of sheets is presented only in an exemplary context, and like the other components of the floor structure, the sheathing is not limited to any particular dimensions or materials. For example, sheets of metal or composite materials may be used in place of wood and may be provided in any shapes and dimensions suitable for collectively covering the floor structure. It is possible to use a greater number of smaller sheets, a lesser number of larger sheets and/or sheets of different (i.e. non-rectangular) shapes to cover the same area. Furthermore, it should be appreciated that more than one layer of sheathing may be applied to either side of the floor structure. For example, it may be desirable secure a second layer of sheathing on top of a first layer fastened to the assembly of perimeter walls, joists and bridge members using adhesive or another suitable fastening method known to those of skill in the art.

The triangular cylinders formed between the top and bottom faces of the floor structure may be filled with insulation to lessen heat transfer into and out of the modular home. Passages for any duct work, venting or plumbing may be provided in the floor structure by methods known to those of skill in the art.

As shown in FIG. 4, the floor structure 10 is used to support a respective wall structure 26 extending partially along the perimeter to form one base section of the modular building. The building partially illustrated in FIG. 1 features three sections arranged side to side with a center base section 28C longitudinally offset from the two longitudinally aligned side base sections 28S disposed on opposite sides thereof. Such staggering of adjacent sections allows the peripheral shape of the building to be varied from a rectangular perimeter while using only rectangular sections of the same size. For example, three sections measuring approximately 28 by 11 feet can be used to assemble a modular home having the square footage of an approximately 28 by 33 foot rectangular home without the bluntness of straight exterior walls. The floor structures of the illustrated embodiment measure 28' by 11'-3". As a result, the two wider rows of the sheathing each use three 4'x8' plywood sheets and one end sheet cut to 4'x4' and the narrower third row uses three sheets of 8' length cut down to a width of 3'-3" and one end sheet cut to 3'-3"x4'. Again, it should be appreciated that these dimensions are presented in an exemplary context and may be varied.

In FIG. 1, the path along which the wall structures of the base sections extend to define the exterior walls of the building is indicated at 30. From this, it should be appreciated that the base section of FIG. 4 is one of the side sections 28S of FIG. 1, as the wall structure 26 extends along both
perimeter ends 18 and one perimeter side 16 of the floor structure 10. It should be appreciated that the number of sections assembled to form a building may be varied from that shown in the figures.

[0062] Due to the increased rigidity of the floor structure 10 provided by the bridge members 22, more weight can be supported without relative movement between the floor components during transport and the stiffness prevents cracking of the finishing caused by distortion of the structure. As a result, the wall structure 26 can be provided with a finished exterior side 32, finished interior side 34 and any necessary elements in-between while still at the fabrication plant, as the rigid floor structure should be able to handle the weight increase. For example, it may be possible to equip the wall interiors with plumbing, electrical components and insulation and apply interior and exterior finishes such as drywall and stucco respectively. The rigidity of the floor structure 10 acts to reduce the likelihood of shifting in the wall structure 26 supported thereon during transport and assembly of the base sections, thereby reducing the risk of cracking, twisting or other damage that may occur to elements supported in or on a wall structure supported by a conventional modular building floor framework. Flooring 36 and furnishings (not shown) may even be provided at the fabrication plant to further reduce the need for completion of the building at the installation site. As shown by hidden lines at 37, interior walls may be provided atop the floor structure. The illustrated position of the interior wall 37 should be considered in an exemplary context only.

[0063] As shown in FIG. 1, connectors 38 interconnect the base sections once they are suitably positioned side by side on a foundation. The connectors 38 extend through the mating perimeter side walls of adjacent floor structures and clamp them together to prevent separation. Each connector 38 features a central rod 40 extending through the mated perimeter side walls 16 and end members 42 secured to opposite ends of the central rod 40. Spacers 44 are shown as boards stacked face to face to extend laterally from each perimeter side wall 16 into the respective floor structure. Each board is cut to a suitable length and shape to fit within the triangular spaces formed in the floor structures due to the bridge members 22, this length varying with the distance from the perimeter side wall at which the board is to be stacked in the spacer assembly. Each end member 42 is secured in clamping contact with the face of the respective spacer 44 opposite the perimeter side wall to block separating motion of the mated perimeter walls.

[0064] Different types of foundations on which a modular home can be supported are known to those of skill in the art, including footers, runners, slab or pad, basement and pit-set. Just like prior art modular homes, the base sections of the present invention can be supported on each of these foundation types.

[0065] As shown in FIG. 6, each base section may be provided with a respective roof section 50 to be supported on the wall structure of the base section. Fabrication of the modular home roof in such sections allows larger homes to be produced without having to build the roof on-site or facing the difficulty of transporting a one-piece factory-built roof of excessive size. The roof sections may be installed on the base sections prior to transport where the resulting size will allow safe transport to the installation site while complying with any regulations concerning such transport. Alternatively, each roof section may be transported separate from its respective base section. While this increases the number of deliveries made to the installation site, it keeps the size of each delivery smaller to improve safety and help ensure compliance with transport regulations. With this approach, the roof sections 50 may installed on-site either before or after installation and assembly of the base sections on the foundation. Where the roof sections are properly aligned with and installed on their respective base sections before assembly thereof, positioning a base section into place for assembly will automatically position the respective roof section into place.

[0066] As seen in FIG. 5, the side base section 28S of the modular building is provided with a respective side roof section 50S which includes an overhang 52 extending past the exterior 32 of the wall structure extending along the perimeter side wall 16 of the floor structure on the side opposite the center base section 28C. Another overhang 54 is provided extending past the exterior 32 of the wall structure at each perimeter end wall 18 of the floor structure. It should be appreciated that the center roof section 50C overhangs only at the ends so as to allow proper mating of the side base and roof sections and center base and roof sections along the mating perimeter side walls. A peaked roof can be formed using side roof sections of triangular shape with the center roof section having a lower rectangular portion 56 having the same height as the triangular side section where the sections mate and a triangular portion 58 supported atop the rectangular portion. The triangular portion of the center roof section continues the upward slope of the side sections to a peak 60. It should be appreciated that roofs of different shapes may be similarly divided into sections for support atop the base sections.

[0067] The roof sections can be completed at the fabrication plant to include the interior ceiling, exterior roof finishing (e.g. shingles), lighting fixtures, electrical wiring, vents/ducts, electrical conduits positioned to align with respective conduits in the wall structures for easy connection of wiring during roof installation, etc. With the floor structures providing sufficient rigidity to support interior and exterior finishes of the wall structure and furnishings, and the roof sections similarly having completed interior (ceiling) and exterior (shingles) finishes and lighting fixtures, the actual on-site labour required to prepare the building for occupation is minimal. As shown in FIG. 6, the roof sections may be fastened to the respective base sections from the exterior, for example by bolts 62, through the wall structure beneath the overhangs at an oblique angle to the walls and ceiling.

[0068] When transporting base sections having substantially completed interiors, which may have flooring, walls finished with paint or panelling and even furniture, without the corresponding roof sections installed, each base section should be covered in some way to protect the interior from exposure to rain, dust, debris, etc. FIG. 7 shows a base section which has had a sheet of transparent plastic 64 stretched over it to enclose the interior. This plastic layer spans between top edges 66 of the wall structure 26 to cover the full width and length of the section’s interior. After transport of the base section to the installation site, a hole can be cut in the plastic sheet 64 through which substances that have accumulated on the cover can be drained. For example, should rain collect on the sheet 64, a receptacle 70 can be placed in the center of the interior to catch water and the drainage opening 68 can be opened directly above the
receptacle. The sheet may tend to sag in the center under the weight of the water, or the center may be pulled downward to encourage flow toward the center for drainage therefrom. The receptacle may be a container requiring manual removal of the water from the interior, or may be a conduit through which the water will flow out from the interior. To remove the cover after draining thereof, the sheet can be cut along the top edges of the wall, leaving a small strip of plastic hanging down from the top of the wall and extending therealong. The cut-out portion of the plastic can be disposed of, and the remaining strip can be covered with moulding along the junction of the walls and ceiling with the roof installed. The cutting step may be carried out before or after the roof section is installed. In cases where interior walls are included, the sheet can be sealed along the upper edge of each wall so that draining can be carried out on a room by room basis. People of skill in the art will appreciated that although the illustrated sections have only a single room, they can be divided into rooms and passageways by installation of further walls.

As mentioned above, the interior of the base section should be enclosed, not just covered to prevent exposure from above. An opening other than the top of the section may be similarly covered by an additional, or even the same, plastic sheet. Thus the same sheet can be used to cover the top and an open side of the base section which mates with a respective open side of an adjacent section during assembly. The sheet 64 spanning the open top simply extends downward from the top edges 66 downward along the wall structure at the intersection of each end with the open side to the perimeter side wall 16 of the floor structure 10, thereby spanning the open side. With the sheet sealed to base structure, the interior is kept clean and dry during transport. While a side covering should drain on its own and thus not require the step of providing a drainage opening therein, the same removal process may be used by cutting along the wall ends 72 and perimeter side wall 16 if there is to be some sort of covering or seal over the juncture between mated base portions which can cover any remnant plastic in the interior. Otherwise, care should be taken to prevent the sheeting at least to a point outward of the interior so as not to detract from the interior’s appearance. Similarly, the sheeting atop the exterior of the structure can be removed this way to eliminate the need for cover remaining plastic left by cutting along the top edges 66 within the interior, but this would have to take place before installation of the roof.

Should the mating side of the base section not include a partial interior wall 37 but instead be open fully thereacross, then the sheet may tend to sag between the ends along the open side. However, this may provide some degree of automatic draining of rain water from the top of the base section, as it may flow toward the aforementioned sagging portion and then continue downward to the ground.

Turning now to FIGS. 8, 9 and 10, a modified arrangement of structural panel includes a first pair of parallel perimeter rail members arranged to define first sides of the panel and a second pair of parallel perimeter rail members 18B arranged to define second sides of the panel at right angles to the first sides. The panel is formed also by the parallel joists 20 extending between the first pair 18A and parallel to the second pair 18B. Each of the second pair of perimeter rail members and the joists therebetween are connected to a next adjacent one by a plurality of diagonal planar bridge members 22 with the diagonal planar bridge members extending obliquely between said one and said next adjacent one with one end edge fastened to a side face of the joist or rail in zigzag manner such that an end of one of the bridge members butts an opposed end of a next one of the bridge members at a side face. The bridge members are formed of a wooden sheet such as plywood or aspenite. The structural panel is longer in direction between the first pair 18A so that the joists 20 extend in the longitudinal direction and bridge the ends 18B.

A planar top cover sheet 24 formed by individual sheets of a wood material lies in a common top plane defined by the joists, rails and bridge members and is adhesively bonded to said top surfaces of the rail members and joists and a symmetrical planar bottom cover sheet 24A is adhesively bonded to the bottom surfaces of the rail members, bridge members and joists.

The ends of the bridge members 22 are adhesively bonded at 22A to the faces of the joists and the butting ends 22A of the bridge members on opposite faces of the joists 20 are aligned.

The panel includes four transverse lifting rails 80 connected between the rails 18B and the first joist 20 and formed from the same material as the joists. A lifting assembly for lifting the panel comprising four pairs of mounting plates 81, 82 extending at right angles to the top cover sheet and each pair fastened to the panel at the lifting rail 80. Each plate 81 carries a captive nut 83 thereon and provides an upper end of the nut exposed at the top cover sheet 24. Each nut 83 cooperates with a respective one of a plurality of threaded rods 85 each so as to extend therefrom at right angles to the top of the module where a suitable fastener 86 is located for lifting the module. The lifting assembly further includes the second mounting plates 82 fastened to the panel on the opposite side of the rail 80 by fasteners 87 extending through the rail with the mounting plate 82 having a captive nut 84 carried thereon and providing an end of the nut 84 exposed at the bottom cover sheet for receiving a threaded fastener which can act as a tie down for the panel.

The top and bottom sheets are preferably formed from rectangular sheets having a longer axis and a shorter axis and are arranged with the longer axis at right angles to the joists.

The modular building using the stiff floor panel is shown in FIGS. 9 and 10 and includes at least two separate modular base sections 90, 91 and 92 which are constructed so as to be separately transportable from a location of construction to a location of installation. Each modular base section has a floor structure 93 and upstanding walls 26 mounted on the floor structure. The base sections are arranged to be connected at an installation location so as to mate the walls to define a peripheral wall 26A and interior walls 26B of the modular building.

The floor structure of each modular base section has sufficient stiffness alone independently of the stiffness of the walls to provide stiffness for the modular base section to allow the modular base section to be transported and installed with the interior and peripheral wall finished and with the modular base section separate from the other modular base sections.

The interior walls and the peripheral wall are finished with all electrical connections schematically indicated at 100 and plumbing 101 installed. The interior walls and the peripheral wall are finished with all windows, doors,
and interior drywall 95 installed and the peripheral wall is finished with all exterior siding or stucco 94 installed. The roof 103 is a separate construction from the modular base sections and includes trusses spanning the peripheral wall so as to bridge over at least two of the modular base sections. The roof is arranged so as to be constructed using conventional materials at the installation location after connection of the modular base sections. Each of the modular base sections includes ceiling panels 96 covering an open top of the walls thereof such that the ceiling panels form a top cover during transportation of the modular base sections. The ceiling panels are structural sandwich panels formed of top and bottom sheet material 97, 98 and a layer of foam 99 therebetween and connected thereto. A finishing layer 99A of drywall can be applied on the inside. An insulating material to supplement the foam 99 can be applied on top of the panels when the roof is complete in conventional manner.

Each of the modular base sections has a width of 12 feet and a length of 40 feet as this provides a convenient size for shipping without road or rail restrictions.

Since various modifications can be made in my invention as herein above described, and many apparently widely different embodiments of same made within the spirit and scope of the claims without departure from such spirit and scope, it is intended that all matter contained in the accompanying specification shall be interpreted as illustrative only and not in a limiting sense.

1. A structural panel comprising:
   a first pair of parallel perimeter rail members arranged to define first sides of the panel;
a second pair of parallel perimeter rail members arranged to define second sides of the panel at right angles to the first sides;
a plurality of parallel joists extending between the first pair of perimeter rail members and parallel to the second pair of perimeter rail members;
the rail members and the joists having top surfaces lying in a common top plane and bottom surfaces lying in a common bottom plane;
each one of the second pair of perimeter rail members and the joists therebetween being connected to a next adjacent one of the second pair of perimeter rail members and the joists therebetween by a plurality of diagonal plunger bridge members;
each of the diagonal pluner bridge members extending obliquely between said one and said next adjacent one with one end edge fastened to a side face said one and an opposed end edge fastened to a side face said next adjacent one;
and with the diagonal pluner bridge members extending obliquely between said one and said next adjacent one being arranged in zigzag manner such that an end of one of the bridge members butts an opposed end of a next one of the bridge members at a side face;
a planar top cover sheet lying in said common top plane and adhesively bonded to said top surfaces of said rail members and said joists;
and a planar bottom cover sheet lying in said common bottom plane and adhesively bonded to said bottom surfaces of said rail members and said joists.

2. The structural panel according to claim 1 wherein the top cover sheet and the bottom cover sheet each comprise a layer of sheathing boards.

3. The structural panel according to claim 1 wherein the ends of the bridge members are adhesively bonded to the faces of the joists.

4. The structural panel according to claim 1 wherein the top sheet and the bottom sheet are adhesively bonded to top and bottom edges respectively of the bridge members.

5. The structural panel according to claim 1 wherein the butting ends of the bridge members on opposite faces of the joists are aligned.

6. The structural panel according to claim 1 wherein the bridge members span between the top and bottom cover sheets.

7. The structural panel according to claim 1 wherein the bridge members comprise wood sheets.

8. The structural panel according to claim 1 wherein the structural panel is longer in direction between the first pair so that the joists extend in the longitudinal direction.

9. The structural panel according to claim 1 wherein the rail members are of a common construction with the joists.

10. The structural panel according to claim 1 wherein there is provided a lifting assembly for lifting the panel comprising a plurality of mounting plates extending at right angles to the top cover sheet and fastened to the panel at spaced positions thereon with each second mounting plate having a captive nut carried thereon and providing an end of the nut exposed at the top cover sheet, the lifting assembly including a plurality of threaded rods each for fastening to a respective nut so as to extend therefrom at right angles outwardly form the top cover sheet.

11. The structural panel according to claim 10 wherein the lifting assembly includes a plurality of second mounting plates extending at right angles to the bottom cover sheet and fastened to the panel at spaced positions thereon with each second mounting plate having a captive nut carried thereon and providing an end of the nut exposed at the bottom cover sheet for receiving a threaded fastener attached thereto.

12. The structural panel according to claim 11 wherein respective ones of the mounting plates and respective ones of the second mounting plates are clamped together through a component of the panel which extends at right angles to the top and bottom sheets so as to be fastened to the panel.

13. The structural panel according to claim 12 wherein there are four components to which the plates are attached each of which extends at right angles to the joists and connects between a joist and a respective one of the second rail members.

14. The structural panel according to claim 1 wherein the top and bottom sheets are formed from rectangular sheets having a longer axis and a shorter axis and are arranged with the longer axis at right angles to the joists.

15. A modular building comprising:
at least two separate modular base sections which are constructed so as to be separately transportable from a location of construction to a location of installation; each modular base section including a floor structure and upstanding walls mounted on the floor structure;
the base sections being arranged to be connected so as to mate the walls to define a peripheral wall and interior walls of the modular building;
a roof to cover the peripheral wall with the modular base sections connected;
the floor structure of each modular base section comprising a structural panel according to claim 1.

16. The modular building according to claim 15 wherein the interior walls and the peripheral wall are finished with all electrical connections and plumbing installed; the interior walls and the peripheral wall are finished with all windows, doors, and interior coverings installed; and the peripheral wall is finished with all exterior coverings installed.

17. The modular building according to claim 15 wherein the roof is a separate construction from the modular base sections constructed at the installation location after connection of the modular base sections and includes trusses spanning the peripheral wall so as to bridge over at least two of the modular base sections.

18. The modular building according to claim 15 wherein each of the modular base sections includes ceiling panels covering an open top of the walls thereof such that the ceiling panels form a top cover during transportation of the modular base sections.

19. The modular building according to claim 18 wherein the ceiling panels are structural sandwich panels formed of top and bottom sheet material and a layer of foam therebetween and connected thereto.

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