COMPOSITE BUILDING STRUCTURE

A composite building structure particularly suited for homes and for modular components of homes includes structural members and associated panel members which may in part be prefabricated and assembled with minimal labor. The structural or beam members such as joists, rafters, and stud walls, are fabricated in roughly T-shaped or inverted T-shaped form. Each such beam or other member comprises a first tension or transverse timber firmly secured or bonded to an edge of a second timber or main compression member having a free edge. Bonding is preferably by gluing. Supplemental compression members are secured to the second timber along a line spaced from the free edge to help support panel elements set between or on two beams. These supplemental members may be short lengths of dimension lumber such as 2 x 4's, 2 x 4's and the like. These reinforce the main compression member and the enhanced strength of the beams permits wider spacing between them and use of wider panels. Panels for walls, floor, ceiling and roofs are supported by the free edges of these beams and in part by the supplemental compression members. They may be reinforced by struts or sub-beams which are supported on the supplemental compression members or on flanges of the first or tension members. The latter are finished on their exposed surfaces to serve as dividers of attractive appearance between the panels. The structure thus reduces timber requirements and/or provides stronger construction at reduced costs, as it permits use of scrap or short length materials in part.

10 Claims, 7 Drawing Figures
COMPOSITE BUILDING STRUCTURE

BACKGROUND AND PRIOR ART

Numerous efforts have been made in the past to reduce the cost of new housing construction. Prefabricated homes, built in part or wholly of preassembled parts, have been proposed and built to some extent but have had limited success. This is due, at least in part, to aesthetic considerations; such homes have not been widely accepted because of lack of style or attractiveness or because of excessive similarity, and limited variety and adaptability.

The cost of putting together housing materials, and of the materials themselves, has contributed to housing shortage and to excessive costs. Labor costs for detailed cutting, fitting assembling, nailing in place, and trimming have been even more serious than material costs in limiting the production of attractive, low-cost housing. For wide spans requiring the use of long joists, studs, beams and rafters, costs are particularly high. Prefabricated trusses are used increasingly but these also are costly. Good construction methods usually rule out the use of short lengths of timber for room-size spans where a strong continuous beam or column is required. Many short pieces of good timber which ought to be useful are discarded. This is true particularly with short lengths of dimension lumber, such as the widely used 2 × 4, 2 × 6, and similar structural shapes and sizes. Such short lengths are often wasted outright or cut up into blocks, used as fire-stops, etc., where less useful materials could be employed just as well.

Various proposals have been made in the prior art for fabricating wooden beams, using plywood, for example, as in U.S. Pat. No. 1,377,891, to Knight, Davison U.S. Pat. No. 2,372,768, Willatts U.S. Pat. No. 3,079,649, Bosenius U.S. Pat. No. 2,886,857, and others. It has also been suggested as in the old Grubb patent, U.S. Patent No. 466,035, that panel elements between beams may be supported on strips secured to the sides of such beams, The Swiss Pat. No. 256,421 shows a variety of T-shaped wooden beams, both upright and inverted, and French Pat. No. 1,308,139 shows a fabricated wooden beam of plywood having a conventional lower flange or head and having side members above secured to the main upright web member below its top and at their side edges. Some of these features are found in the present invention but they are combined in a novel manner with panel elements, both reinforced and unreinforced, as will be explained.

Conventional studs, joists, rafters, etc., as used to support conventional wall board and conventional flooring or ceiling materials, need to be rather closely spaced to give adequate strength for weight support, wind resistance, etc. However, some of the wall boards now available are of greater strength than some older materials and can permit wider spacing between supports. By using stronger timbers as studs, joists, etc., these can be spaced farther apart than with conventional materials. This is true especially for floors and roofs. When the panel material between joists or studs is of adequate strength and rigidity, spacings of 24 and even 32 inches may be permissible in lieu of traditional 16-inch spacings. By use of reinforcing transverse members, even wider spacing may be tolerated. However, the extra cost of the necessary stronger timbers, of conventional types and produced in conventional ways, usually cancels out the savings that might be otherwise made by wider spacing of structural members.

It is an object of the present invention to design relatively inexpensive structural members and structural combinations having not only adequate strength but which also comprise attractive facing elements, thus reducing finishing costs. Such members can be fabricated, in part at least, of relatively inexpensive pieces such as short lengths of timber that are not useful in conventional practice. A further object is to facilitate the assembly or fabrication of modules, large building sections or components such as walls or wide panels, floor, ceiling, or roof panels or other housing components, by the use of novel fabricated structural members, in combination with transversely reinforced panels.

A still further object is to use the reinforced beams mentioned above with transverse panels, which may be reinforced where needed for strength, in floors or roofs. This permits wider spacing between the main support elements, with consequent reductions in assembly and nailing costs. It permits also the use of thermally insulated pre-formed structural panels or units which greatly facilitates construction at minimal cost, as will be explained below. The present invention therefore comprises a system of strengthening the main supports, which are spaced at wider intervals, and of using at least partially prefabricated panel elements, which may be decorative and/or insulated, with such reinforcement as may be desired, all at minimal fabrication costs and without sacrifice of structural strength.

SUMMARY

The invention comprises the design and use of unusually strong structural timbers of roughly “T” cross-section and supplementally reinforced, such as joists, beams and rafters, fabricated of multiple pieces. Such a timber includes a continuous length head or tension member firmly bonded preferably by adhesive, to a stem type or to compression member. The latter, in some cases, may be pieced together of short lengths of timber which would be unacceptable for structural strength members in prior art building practices. By bonding the tension and compression components together, the tension member may be used in many cases as an ultimate facing or trim piece. Supporting flanges for panels between beams and decorative panel separation elements are produced integrally with the joist or beam, reduction trimming or finishing requirements, both in materials and labor. The structural members thus are designed to take full advantage of the relative greater strengths which most timbers possess in tension rather than in shear or compression. The strength of the adhesive bond at least is as strong as the weaker member. By combining such structural members with pre-cut and/or prefabricated structural or decorative panels, buildings of adequate strength can be built at reduced costs.

BRIEF DESCRIPTION OF DRAWINGS

FIG. 1 is a fragmentary perspective view, partly in section, of a typical modular ceiling and roof or floor and ceiling construction, according to the present invention.

FIG. 2 is a sectional view of a modified reinforced structural member, alternative to those shown in FIG. 1.
FIG. 3 shows in plan the under side of a reinforced panel arrangement.

FIG. 4 is a sectional view taken on line 4—4 of FIG. 3.

FIG. 5 is a sectional view taken on line 5—5 of FIG. 2.

FIG. 6 shows a modification of the structure of FIG. 2 applied to a sloping roof.

FIG. 7 shows a fragmentary perspective view of a floor using a structural members of FIG. 1.

DESCRIPTION OF PREFERRED EMBODIMENT

Referring now to the drawings, FIG. 1 shows in perspective a typical floor and ceiling or roof module. This is supported by beams 6, 7, each made up of a relatively wide vertical dimension timber 11 having high compressive strength such as a 2 x 8, 2 x 10 or the like, resting on edge and firmly bonded on its bottom edge to a "head" or transverse continuous tension member 15 of high tensile strength in the form of a 2 x 4 or the like. The glued joint is shown 17 and preferably should be sound and strong. In some cases it is not absolutely necessary to use glue but it is generally preferred.

The beam comprised of parts 11, 15 rests on suitable end supports, not shown. It will be noted that the upper edge of the main compressor timber is free and unobstructed.

In FIG. 7, similar members 8 and 9 are shown resting on a firm end support member 10.

The members 15, FIG. 1, are exposed to serve as trim strips between panels 19 which rest on the upper flanges 20 and 21 of head or tension elements 15. They may be chosen for attractive grain or other surface appearance which makes them desirable for use as trim strips.

It will be emphasized that in all cases the upright or stem member of the "Tee" and the head, that is, elements 11 and 15, will be firmly secured together at 17. Gluing and pressure bonding is much preferred because it makes it possible to apply the full tensile stress in the beam to the continuous tensile member, i.e., that which is continuous for the full length of the beam. The compression elements such as 26 and 27, FIG. 1, may not have to be continuous in some cases although for best construction they may be. This will depend to some extent on the weight and character of the load to be supported.

Inasmuch as lumber is substantially stronger in tension than in compression, usually at least twice as strong, with only a few exceptions, it is desirable to supplement the compression member, that is, the upper parts 11 of beams and joints with the additional compression member 15. These are used to fill a double purpose, as will be explained.

Similar reinforcements can be applied to vertical members shown in FIG. 7. In some cases these are short lengths of 2 x 2 or similar strips nailed to the adjacent sides of the upright member 11 along a line parallel to but below its upper edge, the spacing depending on the structure to be supported. These will serve to help support panel elements described below. Such a construction can be practiced in connection with any of the beams described above. A particular embodiment suitable for heavy floor support, with this arrangement, is shown in FIG. 7. This will be mentioned below.

The upper part of FIG. 1 shows a roof or upper floor panel 28 having its edges 29 resting on the top edges of members 11 and abutting laterally against similar panel members. Each of these panels is reinforced on its lower face with transverse timber elements 30, three such being shown in FIG. 3. These are spaced preferably at 16 inch intervals for a four foot wide panel, which is standard in American plywood industry. One edge of panel 28 laps onto a member 30 by a distance half the thickness of member 30 as seen in FIG. 1, while the other edge of a pre-formed panel is free and has no member 30 attached: successive panels thus are secured together by fastening the free edge 55, FIG. 4, of a new panel to the top of exposed edge member 30 of the previous panel. A succeeding panel 28A will have its reinforcement 30A attached to the edge of panel 30 and 50 on. FIG. 3 may be considered, for example, as representing a four by eight foot panel of plywood 28 whose end edges rest on alternate members 11, while short (slightly less than four feet length) timber elements 30 with a gap between them to accommodate the middle beam element 11, all rest with their ends on flange elements 26 and 27. FIG. 3, in this description, may thus be taken as looking upward at the bottom of the top layers of FIG. 1, panel 19 of FIG. 1 being absent or removed in this case. See FIG. 4 for the sectional view of the reinforced panel 28, 30. In FIG. 1, both edges of panel 28 are shown extending to the middle of the upper surface of an upright main timber 11 of the beam. In this case, the beams 6 or 7, composed of elements 11, 15, 26 and 27, are disposed at a spacing from each other which is substantially greater than normal spacing between joists or rafters, and may be as much as four feet. The high tension strength of members 15 makes this possible. The strut or compression strength of members 26 and 27 of course augments the compressive strength of member 11 and enhances the full structural strength of each beam assembly 6 or 7, (or 8 or 9, etc., as in FIG. 7).

The grooved or otherwise decorated panel 19, FIG. 1, may rest with its marginal edges lying on the upper ledges or flanges of members 15. Grooves 100 may extend parallel to the beams 6, 7, so that the 2 x 4 exposed members 15 form both a separator and a decorative trim between them. If desired, of course, the grooves 100 may be disposed perpendicular to members 15, for slightly greater strength. The flanges of paneling, decorative in various ways, may be used. In view of the fact that they bear no load, it ordinarily is not necessary to reinforce the panels 19, which may be up to 4 feet in width and up to eight feet long but they may be reinforced if desired. Also, in many cases, it is not necessary to nail the edges of the panels 19 to the upper surfaces of members 15, although this may be done if desired. In FIG. 2, member 90 represents a modified floor beam or ceiling member. It can be used to support a floor or a horizontal or sloping roof structure. Thus, each beam 90 consists of an upright or stem member 31 arranged to be stressed in compression and a lower and continuous tension member 35 firmly bonded, as by gluing at 37, to the lower edge of member 31. In order to give further rigidity and to strengthen the member in compression, as already mentioned, lengths of 2 x 2 or 2 x 4, indicated at 38 and 39, FIG. 7, are nailed to opposed faces of member 31. If short pieces are used, they are placed so as to abut tightly in end-to-end relationship with each other and preferably also to abut against structural members at the extreme ends of the beam. These strips or support members 38 and 39, need not necessarily to be
bonded to member 31 by gluing, although it may be desirable in some cases for them to be so secured.

A flat roof structure is shown in FIG. 2. It is prefabricated as a panel 40, consisting of an upper sheathing layer 37, a lower layer 33, and a layer or batt of insulating material 34. See also FIG. 5. The flanges or edges 41 of upper panel 32 rest on the top of member 31. There they abut against an edge 42 of a similar member. The preformed insulated panel 40 has internal frame elements 43 of suitable width to space the panels 32 and 33 and thus frame in the insulation batts 34. See FIG. 5. Members 43 are of sufficient thickness to give all needed strength to the whole assembly 40, so it may be used as a roof panel. Ordinarily they are spaced at 24 inches, but other spacings may be used. Plumbing and electrical lines 44 and 45 may be inserted through the insulation batts and through beam elements 31, as shown in FIGS. 2 and 5. The lower panel elements 33 rest upon the upper edges of members 38 and 39, the line of location or spacing of the latter members below the top of timbers 31 being adjusted so that the full thickness of insulated panel 40 is exactly accommodated. That is, the members 38 and 39 are either of such a width as to rest on tension member 35 and give support to the edges of panel element 33, while panel 32 rests on the top edge of member 31, or they are adjusted upwardly to fit. With this arrangement, the main beam consists of stem member 31, bottom member 35, and side members 38 and 39. Where member 31 is a ten-inch nominal width timber, the members 35, 38 and 39 preferably are nominal 2 x 4's, lower panel member 33 is a conventional one-half inch thick plywood, and blocks or reinforcing members 43, the ends of which are above members 38 and 39 (through the plywood layer 33) are preferably 2 x 6 or 1 x 6 pieces. Obviously, other dimensions may be used for all these parts.

In FIG. 6, preformed insulated panels 63, generally similar to those of FIGS. 2 and 6, serve to support a sloping roofing 65. Bottom members 35 and a side member 38 are seen; these are secured to an upright element 31 on which the top edges of top panel or plywood layer 66 rests. The framing or structural support members 68, which are identical to members 43 in FIG. 5, have their ends resting on members 38, 39 through the intervening thin plywood layer 69. A transverse support element 70 is shown resting on a flange of member 35.

In FIG. 7, a strong floor structure is shown which comprises a main support beam or foundation 10 on which beams 8 and 9, previously mentioned and essentially similar to beams 6 and 7 of FIG. 1, are supported at their front or right end. Similar support of course will be provided at their opposite ends. A front or left end beam has a main upright element 81, a bottom member 82 and one side flange or support member 83. A panel of plywood 84, supported by reinforcing timbers 85 at suitable intervals, such as 12 inches, 16 inches, or more, as desired or needed, rests with its marginal edges on top of members 81, 9. Its middle part rests on beam 8. A second panel 88 abuts against the far edge of panel 84, and so on, as will be obvious. Beams 81, 8 and 9, and others in series, not shown, are spaced at such distances as can be permitted, considering the strength of the paneling and its reinforcements between the beams, as well as the strength of the beams themselves. The high strength of beams such as 6, 7, 8, 9 (or 90, FIG. 2), makes it possible for them to be placed, or in a floor, ceiling, or roof with wider spacings than normal, giving a structure presenting wide panels of attractive appearance, separated by exposed beam elements, and all with adequate strength. Furthermore, the width of the combined members at the top or loaded side of the beam often makes it possible to cut miscellaneous pieces of sheathing material to fit the span without waste. Since as noted above, the timber usually is much stronger in tension than in compression, the extra width of members 38 and 39, combined with the thickness of stem member 31, gives a strong compressive member towards the top of the beam to balance the strong tensile member 35 at its bottom. The extended edges of the latter are used to support ceiling panel elements of any suitable material. In some cases these panels may not be used. As described above in connection with FIG. 1, ceiling panel members in many cases may simply be laid in place without nailing or other fastening being supported on the edges of the tension member 15 or equivalent which forms the lower head of the beam. In this case, exposed member 15 should be made of reasonably attractive material such as planed or other attractively surfaced lumber of suitable quality, so that they will form an attractive exposed surface. While use in ceilings is an important application, it will be understood that the beams may be used as studing or other wall support, with vertically or horizontally extending members 15 serving as attractive panel separators.

It will be obvious to those skilled in the art that various additional modifications not specifically described above can be made within the spirit and purpose of the invention. It is intended to cover all aspects of the invention as broadly as the prior art properly permits. What is claimed is:

1. A composite building structure which comprises, in combination, a pair of spaced beams each comprised of a first tension member of dimension lumber firmly secured to the bottom edge of a second wider compression member of dimension lumber, at least one additional compression member of dimension lumber and at least one substantial compressive strength firmly secured to a side face of the second member along a line spaced from the upper free edge of said second member and projecting towards the other beam of said pair of beams, and a panel member supported by its marginal edges on the said upper free edge of the second member, said panel member being further supported indirectly by the further or additional compression member secured to the second member, the strength of the said beams being such that the spacing between them and the width of the panel supported by them are substantially greater than in conventional practice.

2. Structure according to claim 1 in which the panel is further reinforced by strut members extending between said pair of beams and supported at their ends on said additional compression elements.

3. Structure according to claim 1 in which at least one of said beams has an additional compression element secured to each face of the second timber.

4. Structure according to claim 1 in which the panel comprises two spaced layers of material and supporting and spacing timber means between said spaced layers, said timber means being adapted to be supported at their ends on said additional compression elements, and insulation material packed between said layers.

5. Structure according to claim 4 in which service conduits are passed through the insulation material.
6. Structure according to claim 1 in which a decorative panel is supported by projecting edges of the first timber and between the second timbers of said pair of beams, and in which the exposed surface of said first timber constitutes a decorative border or separator for said decorative panel.

7. Structure according to claim 1 in which the panel supports a roof.

8. Structure according to claim 1 in which the panel supports a sloping roof.

9. Structure according to claim 1 in which the panel supports a floor.

10. Structure according to claim 1 in which the panel supports a roof or an upper floor and in which a second panel supported by extending flanges of the first timber constitutes a ceiling for a lower room or area.