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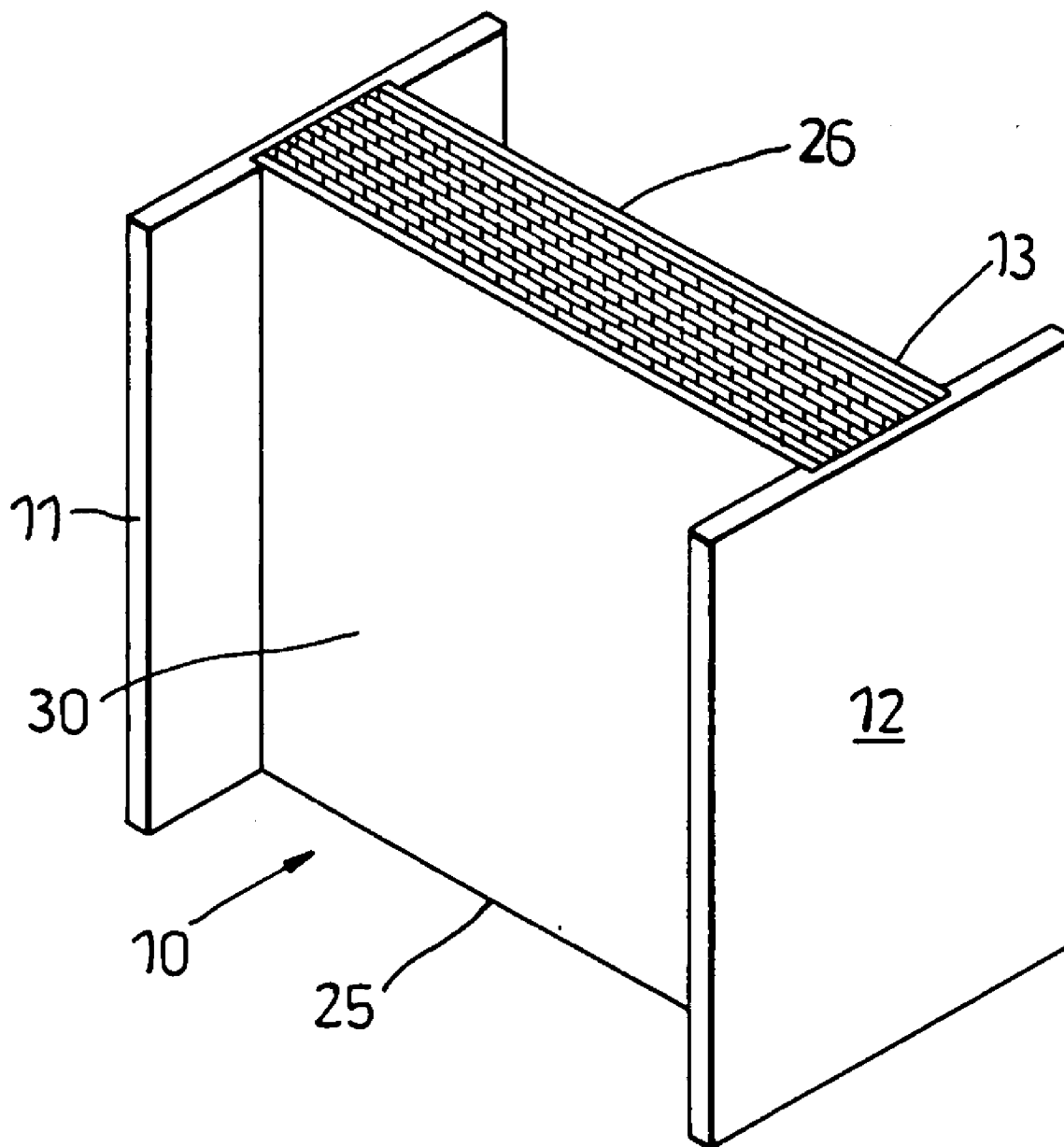
(19) **United States**(12) **Patent Application Publication** (10) **Pub. No.: US 2004/0226255 A1****Holloway**(43) **Pub. Date:****Nov. 18, 2004**(54) **COMPOSITE BEAM****Publication Classification**(76) **Inventor:** Wynn Peter Holloway, Banbury (GB)(51) **Int. Cl.⁷** **E04C 3/30**(52) **U.S. Cl.** **52/729.1; 52/720.1**

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PAUL E. MILLIKEN**9061 WALL STREET, NW****MASSILLON, OH 44646-1676 (US)**(57) **ABSTRACT**(21) **Appl. No.:** **10/799,990**(22) **Filed:** **Mar. 12, 2004**(30) **Foreign Application Priority Data**

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A wooden composite "I" Beam **10** comprising upper and lower plywood flanges **11,12** interconnected by a web **13** comprising a pair of widely spaced apart planar side walls **25 26** formed from wood or wood derivative material. The cavity formed within the web **13** is filled with a core of cellular material **17** corrugated cardboard or paper which is adhered to the side walls and flanges using adhesive resin.



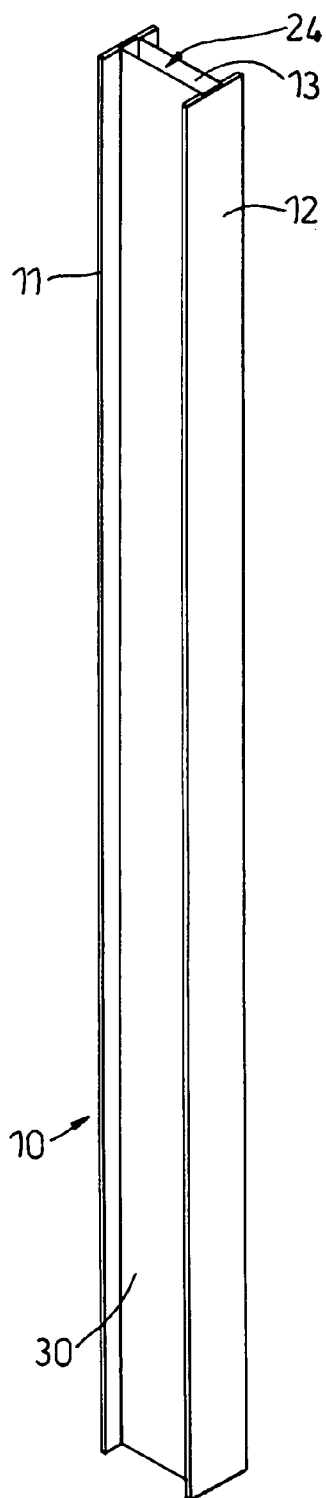


Fig. 1

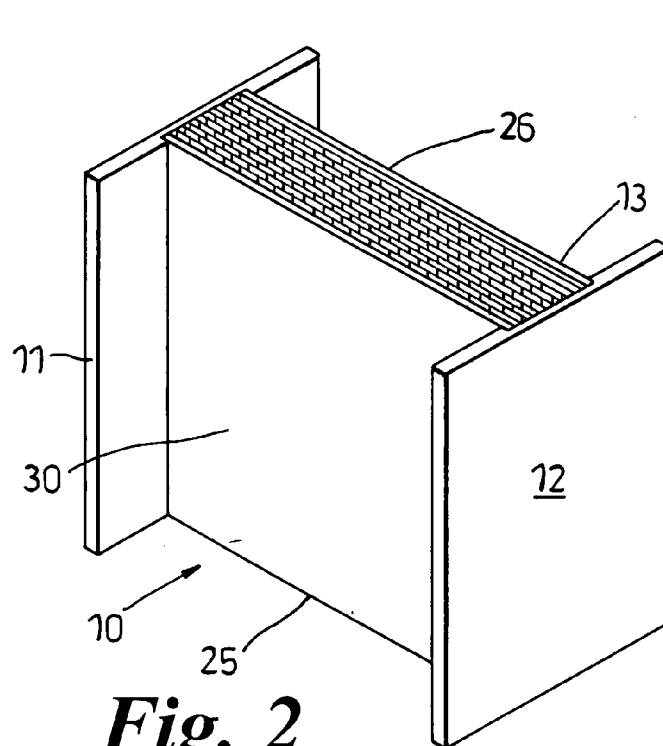


Fig. 2

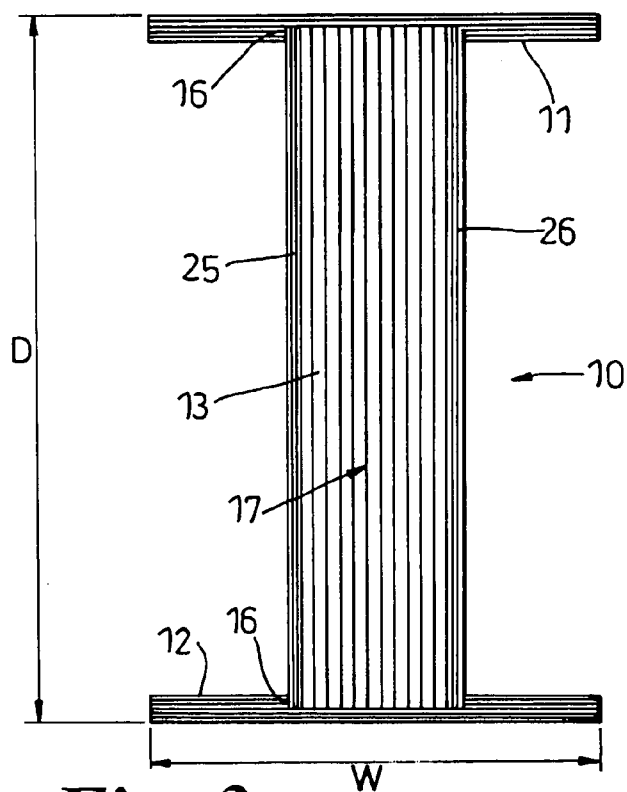
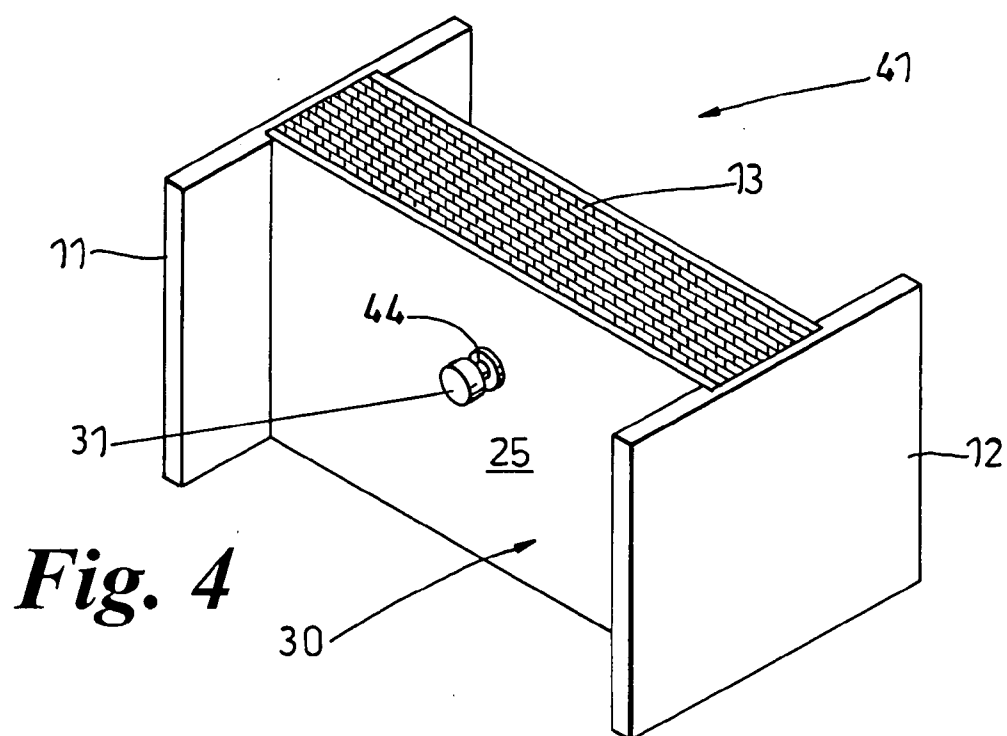
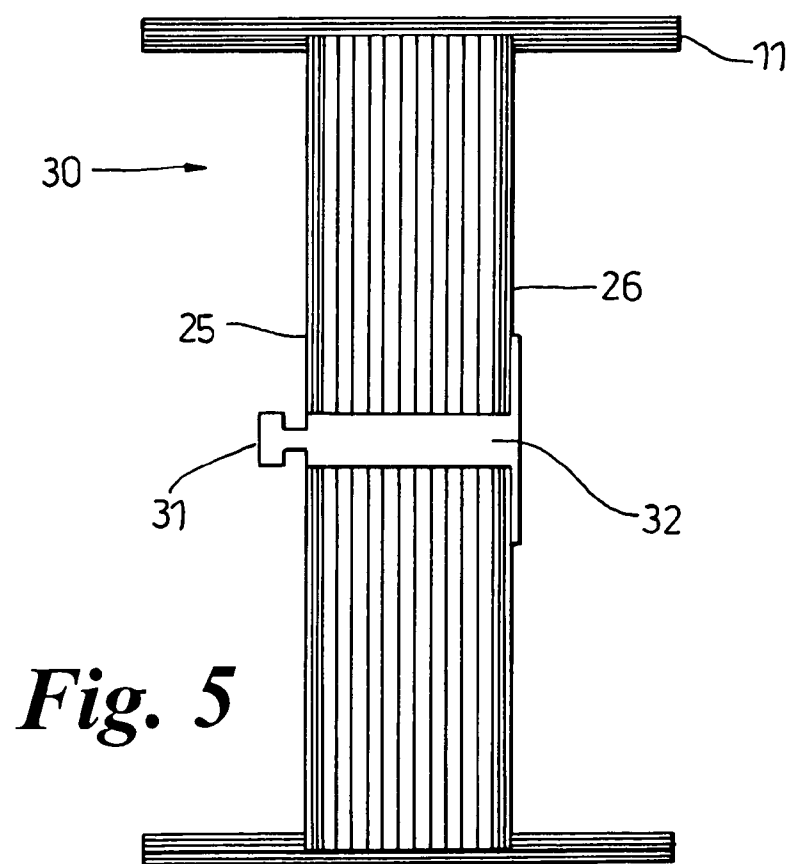


Fig. 3



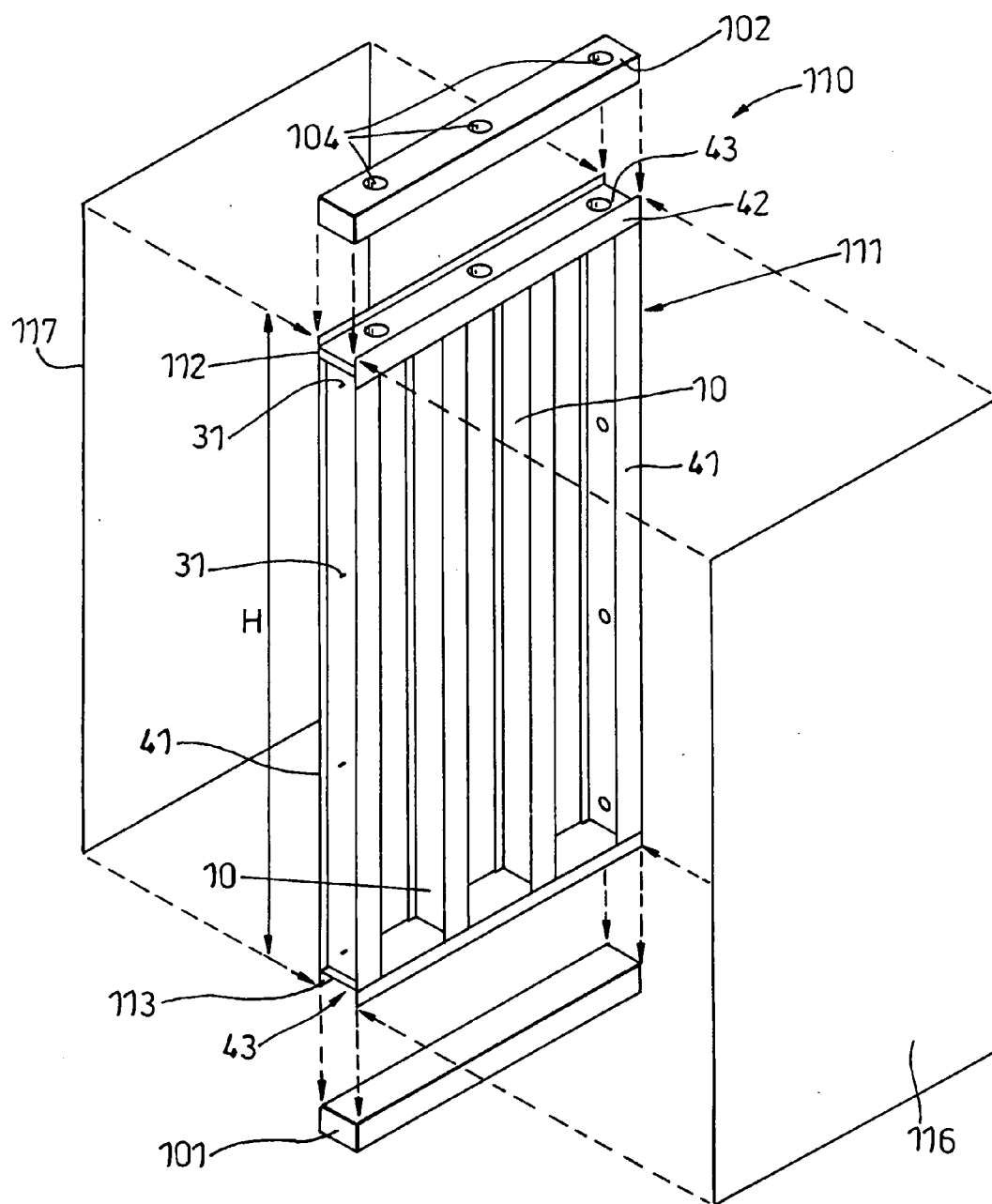


Fig. 6

COMPOSITE BEAM

FIELD OF THE INVENTION

[0001] This invention relates to composite beams and especially to beams for construction of walls, floors, ceilings and roofing panels in particular for use in buildings.

BACKGROUND OF THE INVENTION

[0002] The present invention relates to building construction and in particular to the construction of dwellings formed from spaced apart inner and outer walls in which the inner wall provides a load bearing structure which support the upper floors and roof structure etc., and the outer wall is formed of a weather resistant material e.g brickwork, timber cladding etc. A known construction of building is the Canadian timber frame house.

[0003] The present invention relates to composite beams which can be particularly, but not exclusively, used in the construction of the above buildings.

[0004] The present invention may be utilised in building panels disclosed in applicant's co-pending patent application GB-A-2391 027.

[0005] Many attempts have been made to produce composite beams which do not bend under their own weight. Composite beams are described in U.S. Pat. No. 4,191,000 in which the top and bottom timber flanges are connected by a plywood web. In a further development shown in U.S. Pat. No. 6,460,310, the flanges are formed from laminated wood and include a fibre reinforcement. The flanges may be interconnected by two spaced apart webs of plywood or OSB(oriented strand board). French patent application FR-A-2691,993 again describes a composite beam having laminated wood flanges including reinforcing layers and a web comprising two spaced apart wooden or metal panels.

SUMMARY OF THE INVENTION

[0006] According to the present invention there is provided a wooden

[0007] Composite beam having a central cavity surrounded by walls and filled with a core of corrugated paper or cardboard, the core being adhered to the walls surrounding the cavity.

[0008] Preferably the beam is an I beam comprising upper and lower plywood flanges interconnected by a web comprising a pair of widely spaced apart planar side walls formed from wood or wood derivative material, the cavity being formed within the web.

[0009] The flanges are made from plywood having a suitable thickness and width depending upon the size of the beam, for example a 100 mm deep×75 mm wide(4"×3"), 150 mm deep×70 mm wide(6"×2¾") or 160 mm deep×100 mm wide(6.5"×4") beam may use plywood about 6 mm in thickness. Deeper beams for use with longer spans may use thicker plywood. The 6 mm ply may comprise at least three plies and preferably 5 plies.

[0010] The mutually perpendicular adjacent plies produce an extremely rigid material in directions within the plane of the wood.

[0011] The side walls may be made from hardboard, plywood, or cardboard, preferably between 2-5 mm in thickness.

[0012] The core comprises a plurality of layers of corrugated paper or corrugated cardboard which are each coated in a suitable adhesive resin and laminated together. The adhesive subsequently cures or dries after assembly of the core. The corrugations may run between the flanges or substantially parallel thereto, and in the preferred arrangement the corrugations in adjacent layers are normal to each other. The corrugations in one layer may be smaller in dimensions than the corrugations in an adjacent layer.

[0013] The sidewalls are adhered to the core using a suitable adhesive resin and the assembled web including the core is adhered to the flanges also using a suitable adhesive resin. Suitable adhesive resins may be selected from any suitable liquid glue which dries or cures to a water resistant form, such glues include polymeric resins e.g. an epoxy resin, a

[0014] polyester resin, acrylate resins, water based PVA(polyvinylacetate), and two part phenolic based resins.

[0015] The width of the flanges on each side extend beyond the supporting web by about ⅓ of their total width.

[0016] Composite beams according to the present invention are structurally very rigid and don not bend under their own weight having an extremely high bending moment per unit mass. A typical 75 mm×75 mm I beam weighs about 400-500 gms/metre length.

[0017] I Beams of the above type may be used in the construction of building panels having a rectangular frame having the two faces covered in board material, the frame comprising top and bottom rails, preferably formed from "U" or "H" section water resistant composite, with the two rails being joined together by a plurality of spaced apart wood composite "I" beams extending therebetween.

[0018] The term "board" includes various boards derived from timber including hardboard, cardboard, plywood, plaster board, OSB (oriented strand board).

[0019] Such a panel may form a modular load bearing panel which can be used for the construction of an inner wall, floor, ceiling or roof of a building.

[0020] When constructing an internal wall for a building, in particular a load bearing wall, adjacent wall panels are linked together by posts having side portions which are engagable within the recessed sides of the I beams. The posts are a slide fit within the recessed sides of the I beams between the flanges on the respective I-beams, as is described in GB 2391 027.

[0021] Preferably the posts are hollow having plywood sidewalls and a central cavity filled with corrugated paper or cardboard. The posts may be fixed to the panels by means of shouldered dowels secured to the web of a respective I-beam engaging in clips secured on the post, preferably within the hollow post.

DESCRIPTION OF THE DRAWINGS

[0022] The invention will be described by way of example and with reference to the following drawings in which:

[0023] FIG. 1 is an isometric view of an I beam according to the present invention,

[0024] FIG. 2 is an enlarged portion of the isometric view of FIG. 1,

[0025] FIG. 3 is a cross section of the I beam shown in FIG. 1,

[0026] FIG. 4 is an isometric view of a second I beam also in accordance with the present invention,

[0027] FIG. 5 is a cross-section through the beam shown in FIG. 4, and

[0028] FIG. 6 is an isometric exploded view of a wall panel and including I beams according to the present invention.

DETAILED DESCRIPTION OF THE INVENTION

[0029] Referring to FIGS. 1 to 3 there is shown an I beam 10 which is a composite beam having plywood flanges 11,12 linked by a composite central web 13 so that recesses 30 are formed either side of the web 13. The overall depth D and width W of the beam 10 will be determined by the end use of the beam and material used for its construction. The present Examples shown in FIGS. 1-5 relate to 162 mm×100 mm beam but it will be understood that other I beams, for example, 100 mm×75 mm or 150 mm×70 mm can be made in accordance with the invention.

[0030] The flanges 11,12 are formed from plywood having a thickness of about 6.0 mm with the grain of the outer veneers extending longitudinally of the beam 10. The flanges 11,12 have a width W of about 100 mm and have a central groove 16 on their inner surface to accommodate the web 13. The groove has a width to suit the particular web, in this case 38 mm and a depth of about 3.0 mm.

[0031] The web 13 is composite structure comprising two spaced apart sidewalls 25,26 with a light weight cellular material core 17 filling the cavity therebetween. The two side walls 25,26 may be formed from one of plywood, hardboard, or card board and preferably have thickness of between 2-6 mm depending upon the material chosen, in this case 3 mm plywood.

[0032] The core 17 filling the cavity comprises corrugated paper or cardboard, preferably comprising a plurality of layers thereof laminated together. The corrugations may run between the flanges 11,12 or substantially parallel thereto, and in the preferred arrangement the corrugations in adjacent layers are normal to each other. In another arrangement, the corrugations in pairs of adjacent layers may be arranged so that the corrugations in one layer are smaller than the corrugations in the other layer with the corrugations extending in the same direction.

[0033] The core is made from sheets of corrugated paper which are each coated in an adhesive, preferably PVA and laminated together, the resin then being dried and cured. The core is then cut from the dried/cured resin impregnated laminate. The sidewalls 25,26 are then laminated with the

core using a suitable water resistant adhesive, which again may be PVA, to form the web. The web 13 including the core 17 is then adhered to the flanges 11 & 12 also using a suitable water resistant adhesive, for example a two part phenolic resin adhesive available from Borden Chemicals, with the web being secured in the opposed grooves 16 in the flanges.

[0034] The two flanges extend beyond the web 13 on each side thereof by about 1/3 of their total width, in this example 21 mm.

[0035] Composite beams according to the present invention are structurally very rigid and do not bend under their own weight. Bending tests were carried out on 150 mm×70 mm beam having 5.5 mm plywood flanges 11,12, with a web 13 comprising two 4.5 mm plywood sidewalls 25,26 with a 15 mm corrugated paper core 17 with the corrugations extending between the flanges. The tests were carried out using the method specified in EN 408:1995E but using limited samples.

[0036] The results may be summarised as follows:

Load to Failure	approx 6050 kN
Bending Strength	approx 15.7 N/mm ²
Bending Stiffness	approx 3920 N/mm ²

[0037] Immersion tests on composite beams according to the present invention were carried out. The results are given in Table 1. below and compared with a dry sample which is given value of 100.

TABLE 1

Immersion test			
Water 15° C.	Failure	Bending	Modulus
Dry	100	100	100
1 day	86	86	135
2 day	91	91	80

[0038] A second embodiment 41 of the I beam is shown in FIGS. 4 & 5. The I beam 41 is substantially similar The dowels 31 may each be attached to a support plate 32 which bears on the opposite sidewall 26. A plurality of such dowels 31 are spaced along the side wall 25 and are used for assembly of adjacent panels as will be described later.

[0039] With reference to FIG. 6, there is shown a wall panel 110 which is a module for building the internal load bearing wall of a dwelling or other building. The panel 110 has predetermined standard dimensions for matching with and assembly to other modular panels, for example width W of 1200 mm, thickness T of 150 mm, and height H of 2400 mm. Other panels according to the present invention may have difference to at least some of the above dimensions.

[0040] Each panel 110 has a rectangular frame 111, having top and bottom rails 112,113 interconnected by a plurality of I Beams 41 & 10 which form the sides and vertical struts of the frame 111 and are spaced at predetermined distances apart across the width of the panel. A preferred spacing between I beams 41 & 10 is 400 mm. The frame 111 is

covered on one face, which is use faces externally of the building, with water resistant board **116** and its other face which in use faces inwardly of the building with a second board **117**. The externally facing board **16** is preferably 8-9 mm plywood or OSB and the internally facing board is a laminated board which may comprise plywood, plaster-board, fibre board, calcium board, or magnesium oxide board laminated with a layer of melamine on its exposed surface. The laminated layer may be provided with a finished decorative surface or may be suitable for painting or wall papering. The internal and external boards **17** & **16** respectively are bonded to the beams **14**.

[0041] The top rail **112** comprise a "H" shaped section channel formed from water resistant wood composite, preferably 12 mm plywood and the bottom rail **113** is a substantially "U" section rail. The H shaped rail **112** has open sided recesses **43** which face both inwardly and outwardly of the frame **111**. The inwardly facing recess **43** received stepped end portions of the I beams **41**, **10** and the outwardly facing recess receives a strip **102** used for fixing panels **110** to an upper panel during construction. The bottom rail **113** is orientated with its recess downwards and the wall panel **110** is mounted to a floor or base by use of a sole plate **101**. The sole plate **101** has a height or thickness slightly in excess of the depth of the recess **43** in the bottom rail. The recess within the bottom rail **113** of each panel can be slidably located over the sole plate **101** which has previously been secured to the floor. Nails or other fixings can then be used to secure the panel to the floor strip.

[0042] A fire test according to BS 476:20:1987 was conducted on a building panel with composite I beams according to the invention, OSB on one face and Magnesium oxide board on the other face. The OSB unexposed face remained unaffected during the test.

[0043] The beams **41** are arranged with the dowels projecting outwardly of the panels **110** and adjacent panels **110** may be linked together using a jointing post (not shown but described in detail in GB-A-2391 027. The jointing posts located within the recesses **30** on the beams **41** and engage with the dowels **31**. Each dowel **31** has a groove **44** which provides an undercut shoulder which co-operates clips on the jointing post on assembly.

[0044] If desired, wall panels **10** may be placed on top of previously assembled walls up to three stories in height. A jointing strip **102** is utilised between panels. By using modules of different widths the vertical joints between the panels in one layer may be offset relative to the vertical joints in another layer.

What is claimed is:

1. A wooden composite beam having a central cavity surrounded by wood or wood derivative walls and filled with a core of corrugated paper or corrugated cardboard, the core being adhered to the surrounding walls.

2. A beam as claimed in claim 1 wherein the beam is an I beam comprising upper and lower plywood flanges interconnected by a web comprising a pair of spaced apart planar side walls formed from wood or wood derivative material, the cavity being formed within the web.

3. A beam as claimed in claim 2 wherein each plywood flange extends beyond the supporting web on each side thereof by about $\frac{1}{3}$ of its total width.

4. A beam as claimed in claim 2 wherein the side walls are made from one of hardboard, plywood, or cardboard.

5. A beam as claimed in claim 2, wherein the side walls are formed from a lesser thickness material than the material of the flanges.

6. A beam as claimed in claim 2, wherein the core comprises a plurality of layers of corrugated paper or cardboard which are each coated in a suitable adhesive and laminated together.

7. A beam as claimed in claim 6, wherein the corrugations in the different layers of the core all run in the same direction.

8. A beam as claimed in claim 6, wherein the corrugations in adjacent layers of the core are normal to each other.

9. A beam as claimed in claim 6, wherein the corrugations in one layer may be smaller in dimensions than the corrugations in an adjacent layer.

10. A beam as claimed in claim 2, wherein the wood grain in the outer veneer of the plywood flanges extends longitudinally of the beam.

11. A beam as claimed in claim 3, wherein the transverse width of the cavity within the web is between 20-35% of the width of the flanges and typically 25-35%.

12. A beam as claimed in claim 2 and further including a plurality of dowels mounted on the web and spaced longitudinally along its length.

13. A building panel having a rectangular frame with both faces covered in board material, the frame comprising top and bottom rails which are joined together by a plurality of spaced apart wood composite "I" beams as claimed in claim 2 extending therebetween.

14. A building panel having a rectangular frame with both faces covered in board material, the frame comprising top and bottom rails which are joined together by a plurality of spaced apart wood composite beams extending therebetween, the outer beams being beams in accordance with claim 12.

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