United States Patent

Bott

INDUSTRIALISED BUILDING STRUCTURE

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ABSTRACT

A building structure includes a wall comprising upper and lower wall sections (30,31) disposed edge-to-edge and parallel one above the other; and a floor panel (49) connected to the wall adjacent the neighboring edges of the wall sections by connector means (57,58) which pass at least partially through both the upper and lower wall sections thereby also securing the upper and lower wall sections together.

12 Claims, 7 Drawing Figures

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Abstraction of Patent

[57] A building structure includes a wall comprising upper and lower wall sections (30,31) disposed edge-to-edge and parallel one above the other; and a floor panel (49) connected to the wall adjacent the neighbouring edges of the wall sections by connector means (57,58) which pass at least partially through both the upper and lower wall sections thereby also securing the upper and lower wall sections together.

12 Claims, 7 Drawing Figures
INDUSTRIALISED BUILDING STRUCTURE

This invention relates to industrialised building structures in either assembled or non-assembled form.

In one aspect the invention provides a set of building components including upper and lower wall sections adapted to be erected in parallel edge-to-edge relationship one above the other; a floor panel, and connector means, the connector means being adapted to connect the floor panel to the erected wall adjacent the neighbouring edges of the wall sections by passing at least partially through the upper and lower wall sections, thereby also securing the upper and lower wall sections together.

The set of components may also comprise retaining means adapted to be disposed on the opposite side of the wall from the floor panel, the connecting means being adapted to pass through the wall sections to the retaining means.

Thus the invention also provides a building structure including a wall comprising upper and lower wall sections disposed edge to edge and parallel one above the other; and a floor panel connected to the wall adjacent the neighbouring edges of the wall sections by connector means which pass at least partially through both the upper and lower wall sections, thereby also securing the upper and lower wall sections together.

There may be retaining means on the opposite side of the wall from the floor panel, the connector means passing through the wall sections to the retaining means.

An edge of the floor panel and the retaining means together may define a structure which encloses the neighbouring edge of the upper and lower wall sections.

The retaining means may be constituted by a plate.

Alternatively the retaining means may be constituted by an edge of a further floor panel disposed on the opposite side of the wall from the first-mentioned floor panel.

The neighbouring edges of the wall sections may abut, and may be keyed to locate them relative to each other.

The wall sections may each consist of one or more wall panels comprising a peripheral frame and two parallel spaced apart layers of rigid insulating material within the frame, the frame including top and bottom members of channel section in which the layers are received, the layers being maintained spaced apart by inwardly projecting ridges extending along the webs of the channel section members.

The ridges may be defined by U-section deformations in the webs, the deformations defining outwardly-facing grooves in the webs, the said outwardly facing channels in the abutting edges of the upper and lower wall sections receiving keys which locate the wall sections relative to each other.

When a wall section consists of a plurality of said wall panels, the wall panels constituting the section preferably are rigidly secured together side by side.

The side edges of the wall sections each may be provided with a column, the columns on corresponding sides of the upper and lower wall sections being connected together.

The building structure may include two said walls in parallel spaced apart relationship, the floor panel extending between the walls, a transverse wall also extending between the walls and being provided with a bracing structure which supports the first-mentioned walls against deformation due to wind loads. The transverse wall may be connected to the first-mentioned walls by means of the said columns.

The transverse wall may comprise upper and lower sections, the said bracing structure comprising a frame of deep cross section extending horizontally between the first mentioned walls, its ends bridging the joints between the respective upper and lower sections of the first-mentioned walls. The horizontally extending frame may be stiffened by slabs of rigid insulating material within the frame.

The building structure may have a pitched roof (e.g., mono-pitched or ridged) supported from frames mounted on the first-mentioned walls, each frame comprising a number of struts, the roof having purlins supported from vertical plates attached to the struts whereby the load on each purlin is distributed between a plurality of the struts of each frame.

The purlins may be lattice purlins. Alternatively they may comprise upper and lower longitudinal members joined together by shear plates. The plates may have flanges on which the purlins are supported.

The structure alternatively may have a flat roof which includes a prefabricated sheet of elastomeric material extending over the top of the building structure and bonded thereto.

In another aspect the invention provides a building structure having a pitched roof supported from frames mounted on walls of the building structure, each frame comprising a number of struts, the roof having purlins supported from vertical plates attached to the struts whereby the load on each purlin is distributed between a plurality of the struts of each frame.

The invention will be described merely by way of example with reference to the accompanying drawings, wherein:

FIG. 1 is a perspective view of a pair of houses according to the invention,
FIG. 2 is a vertical section through a load-bearing wall and first floor deck of a house shown in FIG. 1,
FIG. 3 is a horizontal section on line 3 — 3 of FIG. 1 through a joint between a load-bearing party wall and a lower transverse wall panel,
FIG. 4 is a horizontal section line 4 — 4 of FIG. 1 through a joint between an end wall and an upper transverse wall panel,
FIG. 5 is a vertical section on line 5 — 5 of FIG. 1,
FIG. 6 is a cut-away perspective view of the roof of the house of FIG. 1,
FIG. 7 is a section on line 7 — 7 of FIG. 6.

Referring to FIG. 1, there is shown a perspective view of a pair of semi-detached houses 10, 12 according to the invention. According to conventional architectural drawing practice, the left-hand house 10 is reversed to show the rear elevation.

The houses consist of load-bearing end walls 14, 16, a load-bearing party wall 18, and transverse fenestration walls 20, 22. The fenestration walls do not carry significant vertical loads but are braced as described hereafter to transmit wind loads between the walls 14, 16, 18.
The load-bearing walls 14, 16, 18 are surmounted by apex wall sections 24 (only one shown) which support a pitched roof 26.

The external finish of the houses of course is a matter of choice; in the illustrated houses, the finish is cement rendering to the end walls 14, 16 and to the ground floor portions of the transverse fenestration walls 20, 22, the rendering being keyed to the walls by wire lathing. The second floor portions of the transverse walls are clad with horizontal steel planks but could also be rendered. Examples of other alternative treatments are timber ship lap, tile hanging or shingles.

Referring also to FIG. 6, the load-bearing walls 14, 16, 18 comprise upper and lower wall sections 30, 31 disposed parallel and edge to edge one above the other. Each section 30, 31 is reversible and consists of a number of metal-framed panels 32a, b, c, d rigidly interconnected side-by-side.

Each panel 32 comprises two parallel layers of wood wool slabs 34, 36 (FIGS 2 and 3), faced on their exposed surfaces with plaster board 37. The layers of slabs 34, 36 are mounted spaced apart in a steel frame made up of profiled channel section members, so as to form a cavity wall. The top and bottom edges of the frame are formed by respective single channel members 38, 40 (FIG. 2) extending the full width of the panel, and the side edges of the frame are each formed of two side-by-side channel sections 42, 44 (FIG. 3).

The adjacent channels 42, 44 of neighbouring panels 32a, b, c, d abut each other back to back (best seen in FIGS. 1 and 6). They are keyed together by keys (not shown) engaging grooves 41 in the webs and are also welded together. The abutting channels 42, 44 thus form parallel I-sections, rigidly connecting the panels 32 together. Because the wood wool slabs are rigid they provide vertical shear layers and strengthen the frame 38, 40, 42, 44, particularly parallelogram distortion. Members 45 identical to the members 42, 44 are arranged back-to-back to the several slabs 34, 36 in each panel 32.

The layers of wood wool slabs 34, 36 are maintained spaced apart by the channels 42, 44, 45 and by inwardly projecting U-shaped ridges 47 formed centrally along the webs of the top and bottom channel section members 38, 40. These ridges rest in outwardly-facing grooves in the webs of the members 38, 40. In the lower of these grooves are welded two short keys 48 which serve to locate the abutting channel sections 38, 40 of the upper and lower wall sections 30, 31 accurately upon one another.

Both the upper and lower wall sections 30, 31 are provided at both side edges with structural channel-section side columns 46 which are welded back-to-back to the channel sections 42, 44 at the edges of the wall sections.

Spanning between the walls 14, 16 and 18 at upper-floor level are floor decks or panels 49, 50 (FIG. 2). The floor panels each consist of a peripheral rectangular frame of steel channel-section members 51, 52, 53 together with intermediate channel-section steel joists 54 (only one shown) which span between the channel section members 53 forming the sides of the frame adjacent to the upper floor walls 20, 22. The joists are welded to the members 53 (only one shown) at 56.

The peripheral frame members 51, 52 of the floor panels 49, 50 lie adjacent the abutting top and bottom edges of the wall sections 30, 31 forming the wall 18.

The top and bottom channel members 38, 40 of these sections 30, 31 are provided with holes in their flanges which register with similar holes in the frame members 51, 52 of the floor panels. Two sets of tie-bolts 57, 58 constituting connector means are passed through the majority of these holes (and through holes provided in the wood wool slabs 34, 36) and are tightened to pull the edges of the two floor panels hard against the wall sections 30, 31. The floor panels are thus secured to the wall 18 and moreover the tie-bolts 57, 58 secure the upper and lower wall sections of the wall 18 together because the bolts 57 pass through the upper sections 31, the bolts 58 pass through the lower sections 30, and both sets of bolts are securely anchored in the floor panels. The frame members 51, 52 of the floor panels form a structure which encloses and firmly grips the abutting edge frames 38, 40 of the upper and lower wall sections. This further strengthens the wall by preventing any tendency for the centre of the wall remote from the columns 46 to bow.

The remainder of the holes in both flanges of the members 38, 40 and in frame members 51, 52 receive bolts which are shorter than the bolts 57, 58 and which do not pass completely through the channel members 38, 40. Each shorter bolt instead engages a respective nut which is welded to the inside of the nearest flange of the channel member 38 or 40. Similarly to the bolts 57, 58 these shorter bolts connect the floor panels 49, 50 to the top and bottom wall sections 30, 31 and also assist in connecting these sections to each other.

The shorter bolts increase the fire resistance of the structure. A fierce fire on one side only of the wall 18 may result in failure of the heads or the nuts on the bolts 57, 58. Then if the shorter bolts were not provided, the floors on both sides of the wall would immediately become unsafe. However, the shorter bolts secure the floor panels independently to the channels 38, 40 and thus even if all the bolts securing one of the floor panels were to fail, the other floor panel will remain safe at least temporarily, and the upper wall section 30 also remains temporarily secured to the lower section.

The end walls 14, 16 are of the same construction as the wall 18, but of course have floor panels to one side only. Nevertheless, the same principle is employed to secure the wall sections 30, 31 of these walls together and to attach the floor panels to these walls.

A retaining plate (e.g., 59, FIG. 1) is provided on the exterior face of each of the walls 14, 16 to perform the function of the angle-section member 51 or 52 in FIG. 3. The retaining plates are drilled to receive the tie bolts 57, 58 which are then tightened to draw the floor panel 49 or 50 and the plate 59 tightly against the wall and simultaneously to secure the wall sections together thereby again providing a structure which encloses the abutting top and bottom edge frames of the wall sections. The retaining plates also are secured by a few of the shorter bolts mentioned above. Then if the longer bolts 57, 58 should fail in a fire the upper wall section is still secured (albeit temporarily) to the lower wall section. The retaining plates 59 are of course concealed by the cement rendering when the house is completed.

In each wall 14, 16, 18 the structural channels 46 at each side of the wall sections 30, 31 abut end to end and are rigidly connected together by short lengths of
channel section bolted inside the channels 46 and
bridging their abutting ends.

Vertical loads on the floor panels 49, 50 are trans-
mitted to the foundations via the bolts 57, 58 and the
frames of the lower wall sections 31 of the walls 14, 16,
18. It will be appreciated that because all vertical loads
are taken by walls 14, 16, 18, the internal layout of the
house is extremely flexible. Internal walling may conve-
niently be provided by partitioning extending between
tracks provided on the floor and ceiling.

When the distances between the walls 14, 16, 18 are
greater than normal, the floor panels may be inter-
mediately supported by stanchion-and-beam frames
disposed intermediate the walls 14, 16, 18 and parallel
thereto. The beams and stanchions conveniently are of
the same section as the columns 46.

The floor panels 49, 50 are clad on their top and bot-
tom surfaces respectively with a wooden floor 60 and
a plasterboard ceiling 62. Insulation is provided by
framed wood fibre slabs 64 supported on the lower
flanges of the joints 54 and the angle sections 51, 52
and on ledger angles 66 fixed to the back surfaces of the
joints.

The transverse walls 20, 22 also each are formed from
upper and lower sections which join below the
level of the floor decking.

The lower sections each comprise a wooden frame
with provision for windows as required. The edge mem-
bers 68, 70 of two adjacent frames are visible in FIG.
3. The lower section of the wall 22 is made up of three
timber sub-frames jointed together in order to accom-
modate the door recess.

The lower sections are finished externally with a ce-
cement rendering 72 or alternatively with metal cladding.
Internally, the panels are finished with plasterboard
74. A layer of expanded polystyrene 75 disposed adja-
cent the plasterboard provides thermal insulation.

The upper sections 78, 79 of the transverse walls 20, 22
are of metal-framed construction. A rectangular
horizontal frame 80 (FIG. 4) of deep cross-section ex-
tends across each section beneath the upper window or
windows 81 (FIG. 1). This frame constitutes a 'wind
girder' which transmits wind loads on the end walls 14
or 16 to the columns 46 of the other load bearing walls,
preventing significant deformation of the structure.

The frame 80 is made up of horizontal channel mem-
bers 82 and vertical channel members 83, framing
wood wool slabs 84. Adjacent vertical channel mem-
bers 83 abut each other back to back and are keyed
and welded together similarly to the abutting channels
42, 44 of the wall panels 32. Because the wood wool
slabs 84 are rigid, they strengthen the frame 80, partic-
ularly against parallelogram distortion, and diagonal
cross-bracing members need not be provided. Such
members also need not be provided in the panels 32, of
the wall sections 30, 31 the wood wool slabs 34, 36
again providing sufficient rigidity.

It will be appreciated that the wall section 79 is made
up of a number of panels consisting of the metal-
framed wood wool slabs 84. These panels are inter-
connected not only by the welded-together adjacent
channels 83, but also by the top and bottom channels
82 which extend completely across the section 79 and
are common to all of the panels, forming the top and
bottom edges of the frames enclosing the slabs 84.

Further channel section members 85, welded and
keyed together back-to-back, extend vertically up-
wards from the wind girder to support a channel-
section head beam 86 (FIG. 6) extending across the top
of the section 78, 79 above the window or windows 81.
The head beam braces the top of the sections 78, 79
and also supports the lower ends of rafters in the roof.
The spaces between the pairs of members 85 are filled
with wood wool slabs 88. The upper wall sections 78,
79 are faced externally with steel planking 92 sup-
ported on timber studning 94. The internal facing of
the sections is plasterboard 96.

At the edges of the sections 78, 79, removable min-
eral wool insulation 90 is provided in localised regions
to permit access to the side channel members of the
sections where necessary for fixing the sections 78, 79
to the columns 46.

The upper wall sections 78, 79 of the transverse walls
20, 22 are secured to the flanges of the columns 46 by
means of bolts passing through the edges of the panels.
As an example, the position of a typical bolt is indi-
cated at 98 in FIG. 4. In order to gain access to this and
other similar bolts, the mineral wool 90 is temporarily
removed. The wind girder 80 extends below the level
of the joint between the upper and lower load-bearing
sections 30, 31 and thus bridges the joint between
them. It is bolted to both the upper and lower sections
of the columns 46. This further strengthens the load-
bearing walls 14, 16, 18.

The timber framed lower sections of the transverse
walls do not carry either vertical or wind loads and are
fixed to the columns 46 by wood screws.

A strip of expanded polystyrene 99 is provided in the
columns 46 for thermal insulation, and the columns are
closed by means of rolled-section cover strips 100, 101
(FIGS. 3 & 4).

The houses stand upon a foundation consisting of in-
tegrally cast perimeter beams 102 (FIG. 5) beneath the
walls and floor slabs in the area enclosed by the perim-
eter beams. A dampcourse is provided by means of a
heavy gauge sheet of polythene extending beneath the
slabs and the perimeter beams. Further protection
against dampness is provided by a coating 103 of bitu-
menous paint on the slabs and beams.

The load-bearing walls 14, 16, 18 are located upon
studs projecting from the perimeter beams and re-
ceived in holes in the bottom channels 40 of the lower
wall sections 31. The walls are not bolted down to the
foundations, the weight of the structure being sufficient
to maintain it stable against wind loads. The location of
a typical stud is shown at 104 in FIG. 5. A mastic strip
106 and a flashing 108 are provided to prevent the in-
gress of moisture beneath the walls.

The non-sectional lower sections of the transverse
walls 20, 22 are fixed to the perimeter beams by lugs
and power driven nails. A bituminous seal, e.g., 'Tock-
strip,' and a flashing similar to flashing 108 are em-
ployed to keep out moisture.

The roof 26 comprises timber rafters 110 (FIG. 6)
supported on metal purlins of deep cross section. Two
alternative forms of purlin are shown in FIG. 6. A pur-
lin 112 is a lattice purlin consisting of spaced-apart
channel sections 114 joined by lacing bars, some of
which are shown at 115. A purlin 113 also employs the
channel sections 114 but these are joined by one or
more shear plates 116. The lower ends of rafters are
supported on the head beams 86 of the walls 20, 22.
which are strong enough to withstand this small load. Battens 117 are fixed over the rafters with an intervening layer of slaters felt 120. Tiles (122, FIG. 7) are fixed to the battens 117 in the normal manner.

The purlins 112, 113 are supported from the apex wall sections 24. Each apex wall section comprises a metal frame consisting of channel section outer members 124, 126, 128 welded together at their intersections. Wood wool slabs 130 extend between the members 124, 126, 128. These rigid slabs are framed in further channel section members 132, which interlock each other back-to-back and are welded between the members 124, 126 and the member 128 to act as struts in the same way as in the wall section 79. Thus the apex section 24 is made up of rigidly inter-connected panels stiffened by the slabs 130 in the same way as the slabs 34, 36, and 84.

Purlin support plates 134 are spot-welded at a number of points to the channel section members 132 to support the purlins 112, 113. The support plates are of sheet metal having a top edge 136 bent through 90° to form a flange. The ends of the purlins are bolted to these flanges. The purlin support plates spread the load from each purlin over several of the struts formed by the pairs of channel sections 132. As the flanges are continuous, the position of the purlins thereon is chosen solely with reference to the loads imparted by the roof. There is no need to align the purlins with the channel sections 132. A number of spot-welds are used for each joint between a plate 134 and a member 132 in order to increase the joint area and reduce stress levels. This permits thinner gauge metal to be used. Some of the slabs 130 are wholly or partially omitted from FIG. 6 to expose the purlin support plates.

The apex frames are located on top of the wall sections 32 of the walls 14, 16, 18 by means of short channels 138 welded to the channel members 38 of the sections 32 at 140.

The apex frames are retained in the short channels 138 by means of bolts located as indicated at 139. The bolts also serve to secure prefabricated timber framed ceiling panels 141 which are faced with plasterboard 142. A layer of mineral wool 144 provides insulation.

As an alternative to the pitched roof 26, a flat roof may be employed. Roof decks similar to the floor panels 49, 50 are fixed to the tops of the load-bearing walls 14, 16, 18 by bolts as described for the floor panels. Wood planking is fixed to the top surfaces of the roof decks to completely cover the top of the house. The planking is then coated with bitumen and covered with loosely fitted sheets of bituminous felt followed by a single prefabricated sheet of butyl rubber bonded to the house capping and to the bituminous felt. The rubber sheet is covered with bitumen and a final covering of washing gravel is applied to the still-wet bitumen.

Although the illustrated embodiment of the invention is a two-storey dwelling it will be appreciated that the invention is applicable to low-rise dwellings or other building structures of other than two storeys.

I claim:

1. A building structure, including: a load bearing wall comprising upper and lower wall sections formed of a plurality of generally channel shaped frames having vertical sides disposed edge-to-edge and parallel one above the other, each load bearing wall section comprising two parallel, horizontally spaced apart, vertical, substantially rigid shear layers within each frame, at least parts of the opposed webs of the channel shaped frames of the upper and lower wall section surrounding the vertical shear layers being in direct abutting contact with each other all along their lower and upper longitudinal extent respectively; said opposed webs having inwardly projecting U-shaped ridges formed centrally along the length thereof spacing said shear layers apart and providing outwardly facing opposed grooves, key means disposed in the grooves of the abutting webs directly keying together abutting frames and locating the upper and lower wall sections accurately upon one another; connector means; a floor panel connected to one side of the wall adjacent the neighboring edges of the wall sections at right angles thereto solely by the connector means, said floor panel comprising a frame of channel section with the web of the channel spanning the abutting joint between the upper and lower wall sections such that the floor panel does not underlie or overlie respectively either of the wall sections, and retaining means extending along the length of said wall on the other side thereof and spanning said abutting joint, said connector means passing at least partially through both the upper and lower wall section and through the web of said floor panel and said retaining means thereby also securing the upper and lower sections together.

2. A structure as claimed in claim 1 comprising a second load bearing wall spaced from and parallel with the first mentioned load bearing wall, said floor panel extending between the load bearing walls, second retaining means on the opposite side of the second load bearing wall from the floor panel, and connector means passing at least partially through the wall sections of the second load bearing wall and through the second retaining means.

3. A structure as claimed in claim 2 wherein the building structure has a pitched roof supported from roof frames mounted on the first-mentioned walls, each roof frame comprising a number of struts, the roof having purlins supported from vertical plates attached to the struts whereby load on each purlin is distributed between a plurality of the struts of each frame.

4. A structure as claimed in claim 3 wherein the purlins are lattice purlins.

5. A structure as claimed in claim 3 wherein the purlins comprise upper and lower longitudinal members joined together by shear plates.

6. A structure as claimed in claim 3 wherein the plates have flanges on which the purlins are supported.

7. A structure as claimed in claim 1 wherein the retaining means is constituted by a plate.

8. A structure as claimed in claim 1 wherein the retaining means is constituted by an edge of a further floor panel disposed on the opposite side of the wall from the first-mentioned floor panel.

9. A structure as claimed in claim 1 wherein the side edges of the wall sections each are provided with a column, the columns on corresponding sides of the upper and lower wall sections being connected together.

10. A structure as claimed in claim 1 including two said walls in parallel spaced apart relationship, the floor panel extending between the walls, a transverse wall also extending between the walls and being provided with a bracing structure which supports the first-
9 mentioned walls against deformation due to wind loads.

11. A structure as claimed in claim 10 wherein the side edges of the wall sections each are provided with a column, the columns on corresponding sides of the upper and lower wall sections being connected together, the transverse wall being connected to the first-mentioned walls by means of the said columns.

12. A structure as claimed in claim 10 wherein the said bracing structure comprises a frame of deep cross section extending horizontally between the first mentioned walls, its ends bridging the joints between the respective upper and lower sections of the first-mentioned walls.

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