

"BUILDING STRUCTURES AND COMPONENTS FOR USE THEREIN"

The present invention relates to building structures.

Once conventional technique for forming low rise building structures comprises casting, on site, reinforced concrete panels, with anchorage points being incorporated into the panels during casting. The cast panels are tilted up almost to a vertical position using a crane or hoist which hooks onto the anchorage points. The panel is then jacked into an exact vertical position using inclined jacks which remain in place in order to brace the panel, this process being repeated for several panels in the structure. The jacks remain in position until beams and fixing plates are secured in position to firmly anchor the panels within the structure, a process which may sometimes take several weeks. In addition, the necessity of having to brace each panel with a number of jacks (usually two or more jacks) possibly for several weeks is expensive as regards equipment costs and also tends to clutter the site. There is also a risk that a panel may topple prior to fixing.

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According to the present invention, there is provided a building structure comprising first and second building panels of reinforced cast material, each said panel including a tubular connector anchored to reinforcement within the panel and opening onto an edge or face of the panel, the said connectors of the two panels being aligned in the structure and being connected together by means of a bolt extending between the aligned connectors, the bolted connection including resilient means operative to allow contraction of the panels.

Embodiments of the invention will now be described, by way of example only, with reference to the accompanying drawings in which:

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Figure 1 is a perspective view of a corner portion of a building structure composed of several connected building panels;

Figure 2 shows, to an enlarged scale, a detail of a connection marked '2' in Figure 1;

Figure 3 shows, to an enlarged scale, a detail of a connection marked '3' in Figure 1;

Figure 4 is a side elevation of a resilient washer incorporated in the connections shown in Figures 2 and 3; and

Figure 5 is a perspective view of a connector reinforced to withstand a seismic loading.

With reference to Figures 1 to 4, a building structure comprises building panels 20 interconnected by connectors anchored to the panels. Preferably, the panels are reinforced concrete panels although they may be composed of other materials, particularly cast, water hardenable, materials. The form of connection between adjacent panels at right angles is shown in Figure 2, and that between adjacent panels in the same plane is shown in Figure 3. More particularly, each panel 20 incorporates tubular connectors 22 of square or other rectangular section, with the longitudinal axis of each tubular connector 22 being directed perpendicularly to the plane of the panel. The connectors are incorporated at the corner portions of each panel (as illustrated) and/or at other positions around the periphery of the panel so as to mate with correspondingly positioned connectors in adjacent panels or other structural member or to be directly connected thereto. Each wall of the

tubular connector is formed with a hole, slot or other aperture to receive the end portion of anchoring means which anchors the connector within the panel or to receive a bolt which acts to connect the adjacent
5 connectors of two adjacent panels. The illustrated configuration of the connectors enables each panel to be connected to a respective further panel at the side of the panel, above the panel, and below the panel, either in the same plane as the panel or at right angles
10 thereto.

As shown specifically in Figure 2, the connector 22 is anchored within the panel by anchoring means in the form of bolts or threaded reinforcing rods 24. When a bolt is used as the anchoring means, the bolt may carry
15 a transverse plate or bar at its end remote from the connector in order to provide for firm anchorage within the panel, and/or the bolt and the plate or bar (if provided) may be welded to the reinforcement. The anchoring means are preferably galvanised or otherwise
20 treated against corrosion.

The two adjacent connectors 22 of Figure 2 are fixed at right angles one to the other by means of a bolt 26 passing through the apertured wall of one connector 22 (the righthand connector, as shown) into
25 the interior of the other connector, the bolt 26 being anchored within this other connector by means of a tension plate 28 abutting against nuts 30 associated with the anchoring bolts or rods. The two adjacent connectors 22 of Figure 3 are fixed together by means of

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a bolt 32 passing through the adjacent apertured walls of the two connectors. As will be apparent, the connecting bolts are accessible for tightening through the open end of at least one of the connectors and preferably through the open ends of both connectors.

Although as described so far, connectors are anchored within a panel in order to align with correspondingly positioned connectors in adjacent panels whereby to connect the panels one to another, the connectors may also serve to attach other components (whether structural or otherwise) to the panel(s) by cooperation with like connectors in the other components; alternatively such other components may be directly attached to the connectors in the panel(s), for example by bolting through the component into a connector in the panel.

Reinforced concrete panels are normally erected while the concrete is still in a green state, with the result that the panels tend to contract during curing, while they are in situ within the structure. In addition, after curing the panels are subject to thermal expansion and contraction. To permit contraction upon curing, and subsequent thermal expansion and contraction, without the panels cracking within the structure, one or more resilient washers may be mounted on the connecting bolts which extend between adjacent connectors. Such a resilient washer is shown in Figure 4 and designated 38, and comprises a laminate consisting of an annular body 40 of rubber, plastics or other



resiliently compressible material, sandwiched between outer washers 42 of metal or plastics, the washers, when of metal, being galvanised or otherwise resistant to corrosion. Two such resilient washers 38 are shown in the connection of Figure 3, the washers 38 being mounted on the connecting bolt 32, with each washer lying against the inner face of a respective one of the two connectors. Only one such washer 38 is incorporated in the right angled connection of Figure 2.

In a modification of the right angled connection of Figure 2, the open inner-end face of the left hand connector shown in that figure may be closed by means of a plate welded into the connector so as to abut against the adjacent side wall of the right hand connector.

With this arrangement, the two connectors may be bolted directly together, as shown in Figure 3. It would alternatively be possible for the left hand connector of Figure 2 to be orientated so that it opens onto the edge of the panel and thereby lies with its axis parallel to that of the right hand connector. However, for ease of manufacture it is preferred for all of the connectors to be oriented in the same direction.

In a modification of the connection shown in Figure 3, an expansion gasket may be interposed between the adjacent side walls of the two connectors in order to take up excessive thermal expansion. When such a gasket is installed, the consequent gap between the adjacent edges of the panels is sealed with a memory caulk. Such a resilient gasket may also be incorporated between the

two connectors of a right angled connection, when using the modified construction discussed above.

In Figure 1, the connectors 22 are shown as mounted at the corner portions of the panels. However, the connectors may alternatively, or in addition, be mounted at other positions along the periphery of the panels. Also, the connectors may be mounted at any other required position within the panel in order to suspend one or more floor slabs or other components from the panel, as many connectors as required being mounted within the panel at appropriate positions. The floor slab(s) or other components may incorporate similar rectangular connectors and may be mounted from the connectors of the panels 20 using right angled type connections as shown in Figure 2, or modified as discussed above. In more general terms, however, slabs or other components may be suspended from the panels horizontally, vertically, or in an inclined manner, by means of the connectors.

The tubular connectors described hitherto have been of square or other rectangular cross-section. However, this is not essential and the connectors may be of other cross-section, for example triangular. Generally speaking, the triangular connectors may find application when it is desired to produce a different force distribution in the panel. In addition, the triangular connector has a smaller open cross-sectional area than the equivalent rectangular connector and may be easier to seal and to conceal. Also, the triangular connector

tends to be less expensive than an equivalent rectangular connector in that it consists of less material and, when made from steel, it may be easily and inexpensively fabricated by roll forming and welding.

5 Triangular connectors may also be used when it is required to connect two panels at an obtuse angle. A similar effect can be obtained by using a rectangular section connector with one or both end faces being cut at an angle of other than 90° to the longitudinal axis
10 of the connector.

 The tubular connectors of any desired cross-section can be fabricated from metal or plastics, according to requirements. For many applications the connectors will be of roll-formed steel, although they may alternatively
15 be of extruded aluminium or extruded plastics where strength considerations permit. As discussed earlier, the walls of the tubular connectors are apertured with holes, particularly circular holes, or elongate slots, to receive the end portions of the anchoring means by
20 which the connectors are anchored within the panels and to receive the connecting bolts by which two adjacent panels are secured. The slots, if present, permit a degree of adjustability.

 As will be apparent from the foregoing, tubular
25 connectors of any desired configuration may be anchored to the panels at any desired position either to provide a connection between adjacent panels, to connect a panel to another part of the building structure, or to attach



a component to the panel. The connectors may extend through the entire thickness of the panel or only through part of the thickness of the panel; in this latter regard, the connectors may be adjacent the inner or outer surface of the panel or they may be offset inwardly from both surfaces of the panel. The panels themselves may be of any required shape and configuration.

A connector capable of resisting seismic loading, may be produced by reinforcing a tubular rectangular or triangular connector with an internal plate which closes the cross-section of the connector in close proximity to the apertures in the connector walls. Such a connector is shown in Figure 5, the reinforcing plate being designated 48.

A structure composed of building panels incorporating tubular connectors as described above may be erected relatively quickly and with greater ease than conventional building panels. The panels may be erected using the following process which has particular benefit for low rise building structure.

A first panel for forming one side of a corner of the structure is lifted into position as previously described and is braced in that position by jacks, such jacks being illustrated at 50 in Figure 1. A second panel for forming the other side of the corner is then lifted into position, and, as soon as it is in position, is bolted to the first panel through the adjoining

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connectors. The two panels thus form a sub-structure which is self-supporting whereby the jacks can be immediately removed from the first panel. Further panels can then be attached in succession from the
5 second panel to provide a wall of required length. Temporary bracing in the form of jacks may be required for panels remote from the first corner, but this bracing may be removed as soon as the next corner is formed or as soon as permanent bracing constituted by
10 another part of the structure is in position. The process is repeated by adding further panels in succession until the basic structure is completed.

It has been determined that erection is facilitated if the further panels are always added sequentially in
15 the same direction around the structure.

It will be appreciated that this process permits erection using only a small number of jacks, these jacks being maintained in position for a minimum time only.

The various embodiments of the invention have been
20 described by way of example only, and modifications are possible within the scope of the appended claims.

**CLAIMS:**

1. A building structure comprising first and second building panels of reinforced cast material, each said panel including a tubular connector anchored to reinforcement within the panel and opening onto an edge or face of the panel, the said connectors of the two panels being aligned in the structure and being connected together by means of a bolt extending between the aligned connectors, the bolted connection including resilient means operative to allow contraction of the panels.
2. A structure according to Claim 1, wherein the panels are of rectangular form and a respective said connector is anchored in each corner portion of the panels.
3. A structure according to Claim 1 or Claim 2, wherein each connector has apertured side walls, and the connecting bolt extends through one apertured side wall of one of the connectors into the other connector, the connecting bolt being accessible through the open end of at least one of the connectors for tightening.
4. A structure according to Claim 3, wherein each connector is bolted to the reinforcement by bolt means extending through another apertured side wall of the connector.
5. A structure according to Claim 4, wherein the bolt means comprises a threaded end portion of a reinforcing rod.



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6. A structure according to any one of Claims 3 to 5, wherein the said connectors of the two panels are arranged with their axes substantially parallel and the bolt extends through adjacent apertured side walls of both connectors.

7. A structure according to any one of Claims 1 to 6, wherein the resilient means comprises a compressible annular body mounted on the connecting bolt and sandwiched between opposed washers.

8. A structure according to any one of Claims 3 to 7, wherein each connector is reinforced by means of an internal plate extending transversally of the connector in the vicinity of the apertures in the side walls.

9. A structure substantially as herein described with reference to the accompanying drawings.
