PRE-CAST CONCRETE PANELS


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10 Claims

ABSTRACT OF THE DISCLOSURE

Two similar, rectangular, pre-cast, concrete, vertical wall panels disposed one above the other are joined together by a joint including a horizontal plate and a vertical attachment bar. The plate is the bottom wall of a short tube extending widthwise of the lower horizontal edge of the upper panel and is anchored in this panel by means of two oblique anchoring members fixed to the plate and embedded in the panel. The bar is embedded in the lower panel and its upper end zone projects through a central aperture in the plate. A nut screwed on this zone bears downwardly on the plate via a radially slotted washer.

BACKGROUND OF THE INVENTION

(1) Field of the invention

This invention relates to a pre-cast concrete wall panel for use in the construction of buildings, particularly of tall buildings constructed from prefabricated parts. The invention also concerns a method of forming the panel, an apparatus for use in the method, a method of joining together two such panels superimposed one on the other, and the product of the latter method.

(2) Description of the prior art

There is disclosed in British Pat. No. 1,069,488 a rectangular, pre-cast, concrete, vertical wall panel for use in the construction of a tall building. The panel has been made by casting in a mould having two wide, opposite, lateral walls, two narrow, opposite, and walls, a narrow bottom wall, and an open top. The narrow bottom wall of the mould has an inside surface of shallow V-section and supports, within the mould space, two horizontal mould pieces each extending widthwise of the narrow bottom wall from one wide lateral wall to the other. These pieces form in the lower horizontal edge of the panel produced two openings each extending from one major face of the panel to the other major face thereof. Each recess has a short cylindrical extension leading vertically upwardly therefrom centrally of the thickness of the panel, the extension being lined by a short, vertical, metal bush partly closed at its lower end by a circular, centrally apertured washer which projects both radially inwardly of the bush and radially outwardly therefrom. The bushes and the washers are placed on the mould pieces prior to pouring of fresh concrete into the mould, and thus are pre-cast into the panel. Also pre-cast into the panel are two vertical attachment bolts co-axial with the respective bushes and projecting with their upper end zones from the upper horizontal edge of the panel. These zones are screw-threaded to receive nuts.

Two such panels are superimposed one on the other with the interposition of floor slabs and an in situ concrete stitch and a mortar bed carried by the floor slabs and the stitch. The upper panel is lowered towards the lower panel until the washers of the upper panel bear on the nuts on the attachment bars of the lower panel. Then, before the mortar bed sets, the nuts are adjusted, if necessary, to level the upper panel. After the mortar bed has set, the openings are filled with dry pack.

This known arrangement in a multi-storey building in which the wall panels are supported one upon another has the serious disadvantage that any one of the joints between the superimposed panels relies on the weight of the panel or panels above the joint and on the adhesion between the mortar bed and the panels. This has been found in practice to be insufficient in exceptional circumstances, for example in the case of an explosion inside or outside the panel immediately above the joint, or in the case of a very high wind, where very large upward forces or very large horizontal forces may occur. The failure of one joint in such a building often leads to progressive collapse of part or all of the building.

SUMMARY OF THE INVENTION

According to one aspect of the present invention, there is provided an apparatus for use in forming a pre-cast concrete wall panel, comprising mould wall means bounding a mould space and open at the top for receiving unset concrete therebetween, a narrow wall of said wall means, a projection extending widthwise of said narrow wall from a longitudinal edge of said narrow wall and disposed at the inside of said narrow wall within said space, a joint part included in said projection, anchoring means fixed to said joint part and extending within said space from said projection, displaceable mould portions intervening between the central part of said joint part and the region of said longitudinal edge, and surface portions of said joint part facing away from said joint part directly accessible from the region of said longitudinal edge following displacement of said mould portions.

According to another aspect of the present invention, there is provided a method of forming a pre-cast concrete wall panel, comprising providing within a mould space of a mould open at the top a projection which includes a joint part and which extends widthwise of a narrow wall bounding said space from a longitudinal edge of said narrow wall and is disposed at the inside of said narrow wall within said space, also providing within said mould space an attachment bar extending away from said member to that side of said mould opposite said narrow wall, and anchoring means fixed to said joint part and extending within said space from said projection, pouring
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unset concrete into said mould at the top thereof, the concrete flowing around said anchoring means, but not contacting a detrimental extent, and in after setting of the concrete, removing from the mould the concrete wall panel so formed having embedded therein said anchoring means, whereafter surface portions of said joint part facing inwardly of said panel are directly accessible from that side of said joint part nearer the centre of the panel by way of an opening formed in a major face of said panel and extending on said side of said joint part.

According to a further aspect of the present invention, there is provided a pre-cast, vertical, concrete, wall panel comprising a concrete main body having upper and lower horizontal edges and two vertical major faces, a joint part disposed in said body in the region of the lower horizontal edge of said body but projecting neither outwardly beyond said lower horizontal edge nor outwardly beyond said major faces, an attachment bar embedded in said body and extending, through the body, away from said joint part to the upper horizontal edge of said body, anchoring means embedded in said body and fixed to said joint part and extending within the body from said joint part, the concrete of said body not contacting said joint part to a detrimental extent, portions of said body defining an opening in one of said major faces extending above the level of said joint part, and uppermost surface portions of said joint part directly accessible by way of said opening from a location above the level of said joint part and at said one of said major faces.

According to yet a further aspect of the present invention, there is provided a method of joining together two pre-cast, vertical, concrete, wall panels, comprising providing a first pre-cast, vertical, concrete wall panel having a first concrete main body in which is embedded a first attachment bar projecting upwardly from an upper horizontal edge of the body, providing a second pre-cast, vertical, concrete, wall panel having a second concrete main body in which is disposed a joint part, a second attachment bar, and anchoring means, said joint part being disposed in the second body in the region of a lower horizontal edge of that body, but projecting neither outwardly beyond said lower horizontal edge nor outwardly beyond two opposite, vertical, major faces of said second body, said second attachment bar being embedded in said second body and extending therethrough away from said joint part to an upper horizontal edge of said second body, and said anchoring means being embedded in said second body and being fixed to said joint part and extending within said second body from said joint part, the concrete of said second body not contacting said joint part to a detrimental extent, applying a bed of unset setting material above the upper horizontal edge of the first body, lowering said second panel towards said first panel such that said bed therebetween is squeezed and that said joint part is displaced to a location below the upper end of said first attachment bar, and, by way of an opening in one of said major faces, fastening said first attachment bar to said joint part by fastening means applied between said first attachment bar and said joint part and above said joint part.

According to yet still further aspect of the present invention, there is provided a method of combining, a first pre-cast, vertical, concrete, wall panel, a first concrete, main body of said panel having an upper horizontal edge, a first attachment bar embedded in said body and projecting upwardly from said upper horizontal edge, a bed of set setting material above said upper horizontal edge, a second pre-cast, vertical, concrete wall panel, a second concrete, main body of the second panel having upper and lower horizontal edges and two vertical major faces and carried at its lower horizontal edge by said bed, a joint part disposed in the second body in the region of said lower horizontal edge and below the upper end of said first attachment bar, but projecting neither outwardly beyond said lower horizontal edge nor outwardly beyond said major faces, a second attachment bar embedded in said second body and extending therethrough away from said joint part to the upper horizontal edge of said second body, anchoring means embedded in said second body, fixed to said joint part and extending within said second body from said joint part, and means fastening said first attachment bar to said joint part and applied between said first attachment bar and said joint part and above said joint part.

By means of the present invention, upward and horizontal forces on one wall panel of a multi-story building in which the wall panels are supported one upon another are transmitted via the anchoring means to the joint part and thence via the fastening means to the attachment bar of the next panel below, and the likelihood of failure of the joint therebetween is reduced.

BRIEF DESCRIPTION OF THE DRAWING

In order that the invention may be clearly understood and readily carried into effect, reference will now be made, by way of example, to the accompanying drawings, in which:

FIG. 1 shows a perspective view from above of an apparatus for use in forming a pre-cast, vertical, rectangular, concrete, wall panel, but with a mould wall and mould pieces of the apparatus removed.

FIG. 2 shows a section through a detail of the apparatus.

FIG. 3 shows a partly-sectional perspective view from above of a joint between two floor slabs and two wall panels of a building.

FIG. 4 shows a fragmentary, vertical, longitudinal section through the joint, and

FIG. 5 shows a fragmentary section through the joint taken on the line V—V in FIG. 4, but with a nut and a washer displaced downwardly.

DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring to FIGS. 1 and 2, the apparatus includes particularly a mould 1 which is one of a battery of identical moulds producing rectangular, concrete, wall panels. The mould 1 comprises two wide walls 2 closed off, at the left, the right, and the bottom, by three narrow walls 3, 4 and 5, respectively, but is open at the top for receiving fresh, i.e. unset, concrete. The mould 1 is supported at the bottom by horizontal beams 6 and is movably carried at the top by rollers 7 running on horizontal beams 8. The wall 5 is of shallow V-section and carries two identical sets of mould pieces, the sets being spaced about one-quarter of the length of the mould from respective ends of the mould. Each set is shown in greater detail in FIG. 2 and consists of three pieces 9, 10 and 11, of which the pieces 9 and 10 are identical and are disposed flushly against the inside faces of the respective walls 2 and flushly against the inside faces of the wall 5. Each piece 11 extends the whole width of the gap between the pieces 9 and 10 and also abuts flushly on the inside faces of the wall 5. The upper surface of each mould piece 11 is shaped to fit against the underside of the assembly consisting of a short, horizontal, steel tube 12, an internally threaded metal sleeve 13 welded to the top of the tube 12, and a looped anchoring rod 14 welded to the bottom of the tube 12. Each tube 12 is arranged centrally of the width of the wall 5 and is coaxial with the associated sleeve 13 and the associated piece 11. As can be seen more clearly from FIG. 4, for example, each tube 12 consists of a thick, centrally apered, horizontal steel plate 12a which serves as a joint part and to which is welded an inverted U-shaped thin steel cover 12b. The length of each tube 12 extends widthwise of the wall 5, and the tube has a mouth at each
end which is closed by the piece 9 or 10. Each rod 14 is of butterfly shape, i.e. has respective wings which extend obliquely upwardly from the plate 12 on respective opposite sides of the tube 12. Screwed into the upper end of each sleeve 13 is the externally threaded lower end of an attachment bar or bolt 16 which is externally threaded also at its upper end. The upper end of each bolt 16 is positioned temporarily by a bracket 17. In FIG. 1, the piece 1 or one of the walls 2 have been removed for clarity of illustration.

When the apparatus has been arranged as shown in FIG. 1, fresh concrete is poured into the top of the mould 1 and flows about the tubes 12 and the anchoring rods 14 but does not penetrate to a detrimental extent into the interiors of the tubes 12, or between the tubes 12 and the wall 5, because of the provision of the mould pieces 9 to 11 closing the open mouths of the tubes and the gaps between the tubes 12 and the wall 5. After filling of the mould with concrete, the latter is caused or allowed to set. The wall panel 18 (see FIGS. 3 to 5) so formed thus has firmly embedded therein the tubes 12, the sleeves 13, the anchoring rods 14 and the attachment bolts 16. Following withdrawal of the walls 3 and 4, the wall panel can be lifted from the mould by a lifting device applied to the threaded upper ends of the bolts 16.

FIGS. 3 to 5 show a joint between two pre-cast, rectangular, floor slabs 19, and upper and lower vertical wall panels 18 and 18' each produced by the method just described. The panel 18' is identical to the panel 18 and thus has embedded therein two attachment bolts 16' identical to the bolts 16 and therefore having their upper ends threaded and projecting upwardly from the upper horizontal edge of the panel 18. On this edge are placed longitudinal edges of the floor slabs 19, and an in situ concrete stitch 20 is applied between the slabs 19 and the panel 18'. At its top, this stitch binds a recess 21 extending somewhat into the upper major faces of the slabs 19. Into this recess is laid a bed of wet mortar 22. Then, onto the upper ends of the bolts 16' are screwed respective nuts 23. The panel 18 is now lowered towards the panel 18' such that the shallow V-section rib forming the lower horizontal edge of the panel 18 squeezes the bed of mortar 22 and that the upper ends of the bolts 16' are received through the central apertures in the plates 12a, the threaded upper extremities of the bolts 16' penetrating through central holes in the U-shaped covers 12 into the interiors of the sleeves 13, but the nuts 23 remaining in the interiors of the tubes 12. Slotted washers 24 are then placed over the nuts 23 and the panel 18 lowered further. The covers 12b bear on the washers 24 (see FIG. 4). Before lowering of the panel 18 onto the bed 22, the nuts 23 have been adjusted to determine the position of the panel 18 when the panel has been lowered onto the bed, and now the nuts 23 can be adjusted to correct the position of the panel 18 if necessary. The squeezing of the mortar bed 22 causes the mortar to flow upwardly into the central apertures of the plates 12a and about the adjacent portions of the bolts 16'. Any excess mortar is later removed. When the bed 22 has set, the nuts 23 are slackened, and the slotted washers 24 are withdrawn from above the nuts 23 and then inserted immediately below the nuts 23, whereafter the nuts 23 are tightened downwardly to press the washers 24 hard against the plates 12a and those portions of the mortar bed 22 in the central apertures in the plates 12a (see FIG. 5). In order that the interiors of the tubes 12 may be directly accessible from a level above that of the plates 12a, the openings 25 formed by the mould pieces 9 and 10 in the opposite major faces of the panel 18 extend to above the level of the plates 12a. If required, the openings 25 and the interior of the tubes 12 may be subsequently filled with dry pack, i.e. mortar with a high water content. The joint shown is for an internal wall, with which it is preferable to have access to the joint from both major faces of the panel 18. However, with an external wall, it is preferred to have access to the joint from only the inside major face of the panel 18, in which case the tubes 12 are each produced closed at the respective opposite ends, by an integral metal wall, and either the pieces 9 or the pieces 10 are omitted, so that no openings 25 are formed in the outside major face of the panel 18.

The joint described has the particular advantage that it is capable of resisting upward forces on the panel 18 and also horizontal forces on that panel in any direction. Any such forces on the panel 18 are transmitted through the reinforcing rods 14 to the plates 12a and thence via the mortar bed 22, or the washers 24 and the nuts 23, to the bolts 16'. The bolts 16', through being embedded in the panel 18, transfer such forces to that panel. The arrangement shown, in which the mortar bed 22 extends up to the level at which forces on the panel 18 are applied to the bolts 16', has the advantage that the bolts 16' are thus supported as closely as possible to that level.

Although the tubes 12 could be arranged to extend to the major faces of the panel 18, and thus the mould pieces 9 and 10 be omitted, the arrangement shown is preferred. Similarly, it would be possible to omit the covers 12b, and to replace them by mould pieces during moulding, which mould pieces would be removed after forming of the panel, but, once again, the arrangement shown is preferred.

We claim:
1. In combination, a first pre-cast, vertical, concrete, wall panel, a first concrete, main body of said panel having an upper horizontal edge, a first attachment bar embedded in said body and projecting upwardly from said upper horizontal edge, a bed of hardened setting material above said upper horizontal edge, a second pre-cast, vertical, concrete, wall panel, a second concrete, main body of the second panel having upper and lower horizontal edges and two vertical major faces and carried at its lower horizontal edge by said bed, a joint part disposed in the second body in the region of said lower horizontal edge and below the upper end of said first attachment bar, but projecting neither outwardly beyond said lower horizontal edge nor outwardly beyond said major faces, a second attachment bar embedded in said second body and extending therethrough away from said joint part to the upper horizontal edge of said second body, anchoring means embedded in said second body, fixed to said joint part and extending within said second body from said joint part, and means fastening said joint attachment bar to said joint part and applied between said first attachment bar and said joint part and above said joint part.
2. A combination according to claim 1, wherein said joint part comprises a plate forming a bottom wall of a short, horizontal tube which extends widthwise of said lower horizontal edge and is open at one end whereby access may be had to said fastening means.
3. A combination according to claim 2, wherein said tube is open at both ends whereby access may be had to said fastening means.
4. A combination according to claim 2, and further comprising portions of said plate defining a central aperture through said plate, and portions of said bed extending to within said aperture and encircling said first attachment bar.
5. A combination according to claim 1, wherein said lower horizontal edge comprises a downwardly projecting rib of shallow V-section.
6. A combination according to claim 1, wherein said second attachment bar is fixed at its lower end by way of metal parts to said joint part.
7. A combination according to claim 1, wherein said anchoring means comprises first and second anchoring members extending divergently with respect to each other and obliquely upwardly from respective opposite sides of said joint part.
8. A combination according to claim 1, wherein said fastening means comprises a nut mounted on screw-threading formed on the upper end zone of said first attachment bar.

9. A combination according to claim 8, wherein said fastening means further comprises a radially slotted washer interposed between said nut and said joint part.

10. A combination according to claim 4, wherein said fastening means comprises a nut of a maximum external diameter less than the width of said aperture and mounted on screw-threading formed on the upper end zone of said first attachment bar, and a radially slotted washer interposed between said nut and said joint part and of an internal diameter less than said maximum external diameter and of an external diameter greater than said width of said aperture.