July 8, 1952 A. Y. PREBLE ET AL 2,602,322

METHOD OF WALL CONSTRUCTION AND SKELETON THEREFOR

Filed Aug. 2, 1946 2 SHEETS—SHEET 1

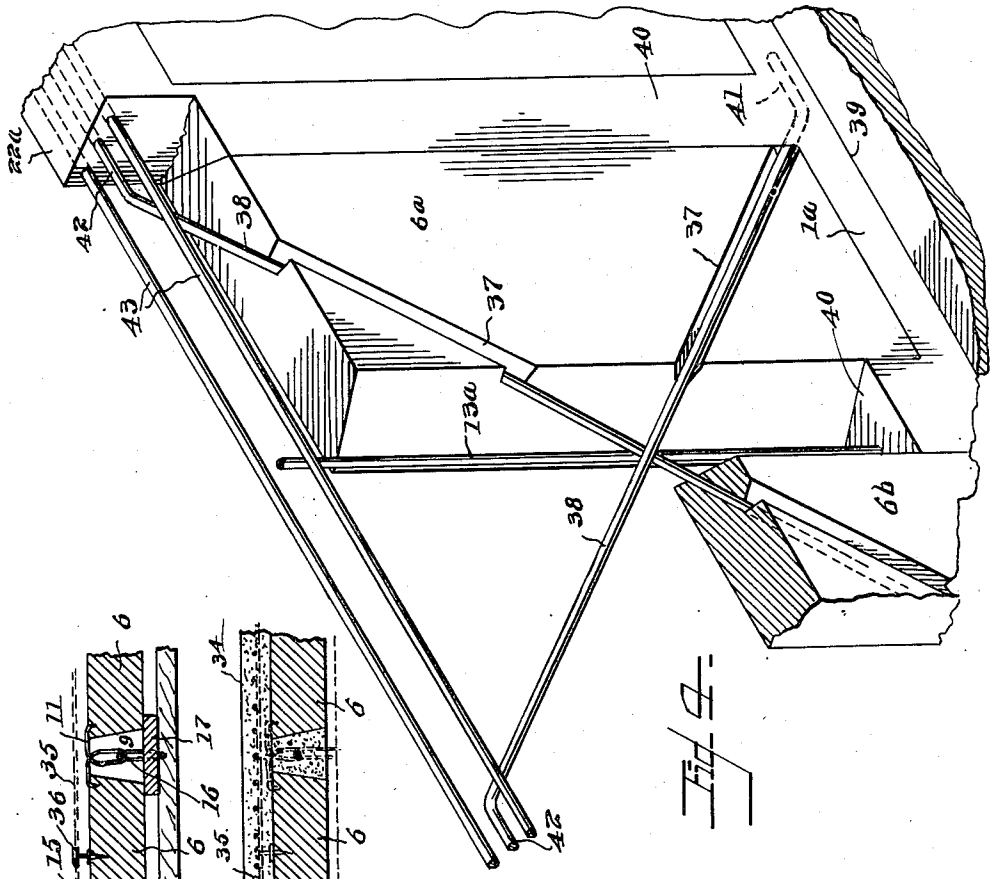


Fig. 4

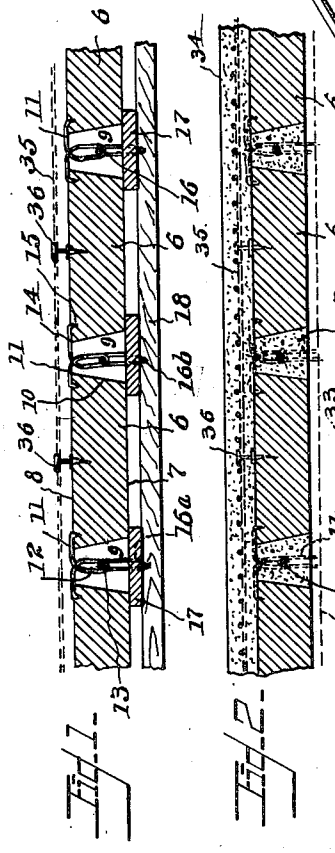


Fig. 1

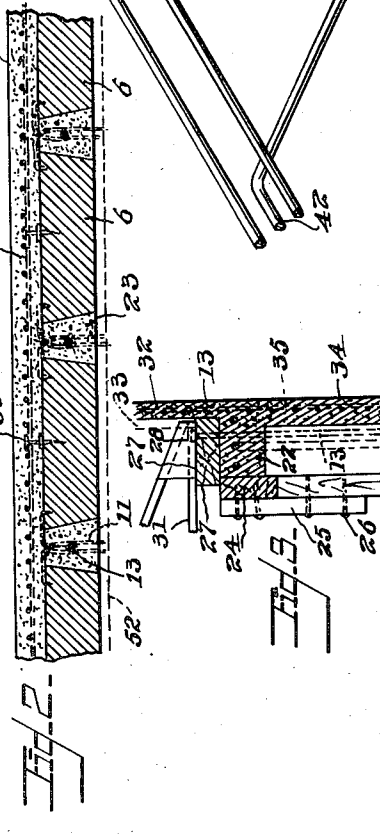


Fig. 2

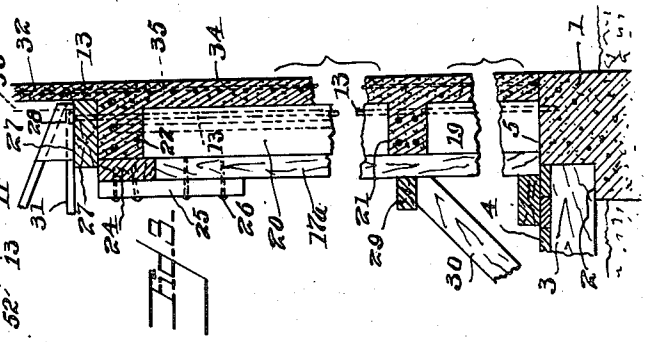


Fig. 3

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Fig. 6

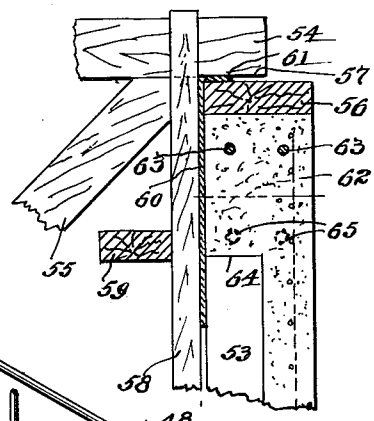


Fig. 5

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METHOD OF WALL CONSTRUCTION AND SKELETON THEREFOR

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This invention relates to wall construction, and particularly to walls which include a cementitious material such as a concrete mix, or the like.

In constructing a wall including concrete for buildings, or the like, it is the usual practice to construct and set up an outside form member which is a solid wall built of planks. A similarly formed wall is set up on the inside of the space in which the concrete wall is to be molded, and in some cases inside forms, or cores, are set in place so as to form a hollow wall of the concrete. The concrete is usually poured into the forms from above in a succession of operations, and when the concrete is sufficiently set, the internal cores are removed. In some instances, hollow, box-form cores have been employed, which are left in place in the wall when poured. The practice outlined above, requires a considerable amount of hand labor and a considerable quantity of lumber that is used in the inner and outer retaining walls for the poured concrete. The walls of the forms are usually built in sections, but these sections are relatively heavy and usually necessitate the employment of several men to handle them and set them up.

One of the objects of the present invention is to provide a simple wall construction and method of erecting the same, which will avoid the objections pointed out above, but which will result in producing a wall that requires a minimum amount of cementitious material to produce it; also, to provide a method which will require very simple labor operations to enable the placing of the cementitious material to be effected.

Another object of the invention is to provide a method for constructing a wall involving the placement of cementitious material which will result in producing a wall having high insulating characteristics, that is to say, which involves the employment of cores which may be, and preferably are, of insulating material, which remain embedded in the completed concrete wall, and which can be very readily set up in position preparatory to placing the cementitious material that separates them and preferably covers their superficial faces.

An ordinary concrete wall is ill-adapted for the attachment of built-in accessories such as cabinet work, book-shelves, or the like. One of the objects of this invention is to produce a wall, a considerable area of which is adapted to receive and retain fastening devices such as nails, screws, or the like.

Another object of the invention is to provide a composite wall which can be readily constructed

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by using simple operations, and which will produce a wall that has substantial sound-proof qualities.

In the practice of the method about to be described, we form a skeleton wall by setting up panels or core members that are spaced equidistant from each other so as to form molding spaces for stud material which is injected from one side of the skeleton wall into these vertical channel-form mold spaces between the upright core members. In building a wall, a cementitious material is applied at one side of the skeleton wall while upright mold members or boards are employed to close the stud spaces on the other side of the wall. One of the objects of the invention is to provide a method and means for not only effecting the placement of the cementitious material to form studs in the finished wall, but also to provide a method for forming a bonding beam at the upper ends of the studs integral and monolithic with the studs. In conducting these operations, the cementitious material is preferably placed by a pneumatic nozzle or "cement gun" such as is commonly used for placing concrete through the agency of compressed air.

Another object of the invention is to provide a wall construction employing spaced upright cores adapted to have concrete studs placed in the spaces between them, and to provide a method and means for facilitating the placing of reinforcements in the placed cementitious material, particularly diagonal reinforcing members for reinforcing the wall proper, and for anchorage into the footing of the wall and the bonding beam that connects the upper ends of the placed stud material.

Another object of the invention is to provide a tie of a form particularly adapting it for use in setting up a skeleton wall in accordance with my method.

Another object of the invention is to provide a skeleton wall particularly adapted to enable a cement gunning operation to form a concrete wall including concrete studs and bonding beams monolithic with the studs.

Further objects of the invention will appear hereinafter.

The invention consists in the novel method to be described hereinafter, and also resides in the novel features and combination of features that are embodied in the resulting wall construction.

A preferred embodiment of the invention is described in the following specification, while the broad scope of the invention is pointed out in the appended claims.

In the drawing:

Fig. 1 is a horizontal section through a typical section of skeleton wall, set up ready for application of the cementitious material, the ends of the section illustrated being merely broken away.

Fig. 2 is a view similar to Fig. 1, but illustrating a wall after the cementitious material has been placed at the studs and an outside diaphragm monolithic with the studs. In this view the simple form members that are illustrated in Fig. 1, are omitted.

Fig. 3 is a vertical section through a wall such as illustrated in Fig. 2, and illustrating the wall after the cementitious material has been placed, and before the backing forms, or backing members, have been removed from the side of the wall against which the concrete or other cementitious material is placed. This view illustrates the manner in which a mold is formed for the bonding beam located at the heads of the placed studs, and illustrates the manner in which a cap sill operates as a top side molding form for the bonding beam so that it will operate thereafter as a support for the ends of the roof girders.

Fig. 4 is an isometric view illustrating the manner in which diagonal reinforcing may be placed in the wall when the wall is being built.

Fig. 5 is also an isometric view representing a corner of a building with the cementitious material cut away and shown partially in section so as to disclose an arrangement of reinforcing that may be employed in practicing this invention.

Fig. 6 is a vertical section taken at the level where a bonding beam is formed, and illustrating means employed for enabling the depth of the molding space for the bond beam to be readily adjusted to facilitate forming a bonding beam of any desired depth.

Before proceeding to a detailed description of our method and the resulting wall, it should be stated that in practicing the invention in accordance with this method, we set up substantially equidistant upright core members or panels to form a skeleton wall. While these core panels may be made of any desired material, for this purpose we prefer to employ pre-formed material of light weight. In other words, this is preferably hardened plastic material which has incorporated in it a large proportion of light weight aggregate such as vermiculite, cinders, pumice, perlite, or other light weight insulating material. By reason of their composition, these panels give body to the wall and insulation characteristics. They carry no part of the load carried by the wall.

These panels are set up upright against backing means to close off one side of the skeleton wall so as to form vertical channel-shaped spaces or channel gaps located between the core members. In practice, instead of employing a heavy wall section for this purpose, we merely provide upright backing members in the form of boards placed in a vertical position with their side edges overlapping the adjacent edges of the cores. After this is accomplished, we inject moist cementitious material into the channel gaps from the side of the wall remote from the backing members. In doing this, we prefer to use a pneumatic nozzle or similar means for delivering the cementitious material with a high velocity and under pressure. In this way, the cementitious material is placed in a workmanlike manner, to fill the entire channel molding spaces formed between the cores.

The core members that we employ are preferably of a composition which renders them pervious to fastening means which can be driven into them. This facilitates the use of ties to connect the adjacent edges of the core members, and has other advantages that will be described more in detail hereinafter. These cores have solid bodies.

Referring to the drawing and particularly to Figs. 1 to 3, in building a wall in accordance with our method, we erect it upon a footing 1 of concrete or other suitable material which, if desired, may be formed with a shelf 2 for the ends of floor beams 3 on which a floor 4 may be secured, the level of which is substantially the same as that of the upper face 5 of the footing.

On the upper face 5 of the footing, we set up the backing or "picket fence" for holding upright a plurality of core members or core panels 6 formed of any suitable pre-molded material such as those suggested above, and preferably having insulating and sound-proofing qualities, in addition to having a bonding property for plaster. These cores are preferably in the form of panels having a width corresponding to the desired spacing for the studs that are to be formed in the wall. As illustrated in Figs. 1 and 2, these cores are preferably of cuneiform cross-section, and present superficial inside faces 7 and superficial outside faces 8. In this way, a skeleton wall is formed with cuneiform vertical channel-shaped gaps 9 between the adjacent inclined faces or edges 10 of the core members. At the outer side of this skeleton wall, we prefer to employ small ties 11 of metal (see Figs. 1 and 2), which may be of bent wire, that is, wire that is bent to form an elongated eye 12 at about the middle point of the tie, which eye may be bent around or slipped onto vertical reinforcing rods 13 as shown. Each tie includes two arms 14 extending in opposite directions and formed with integral pointed spurs 15 at their ends, that can be forced, or driven, into the outer faces 8 of the cores. If desired, the reinforcing rods 13 may be anchored in position by employing wire "hairpin" ties 16, the bights of which form sockets for the reinforcing rods 13 on their outer side; the inner ends of the wire ties 16 are inserted through small holes 16a drilled into the backing members 17 and twisted into a knot 16b on the outer side of the board. These backing members are preferably boards (2" x 6") of sufficient width to enable their side edges to overlap the adjacent edges of the cores, after the cores have been set up against them. These backing members 17 may be secured together at their lower ends and at higher levels also, if desired, by means of horizontal stringers 18 which may be secured to them by nails, or other means not illustrated. This forms the "picket fence" referred to above, and which operates as the backing for the gunnite operations.

After setting up a skeleton wall as shown in Fig. 1, cementitious material is then applied preferably from a cement gun, from the outer side of the wall, and this cement is shot into place in the cuneiform channel gaps 9. In this way, the studs are built up from the upper face of the sill 1, up to the upper ends of the cores.

In Fig. 3 we illustrate a construction in which the wall has a height necessitating the use of two tiers of core members 19 and 20, the cores 19 being in the lower tier, and the upper core members 20 being supported so that a horizontal molding space is formed into which cementitious material is placed by the "gun," to form a stringer 21 monolithic with the cementitious material that is placed between the lower core members 19; and

after placing material for this beam 21, the gunning operation is continued upwardly in the channel gaps between the core members 20 up to their upper ends. If it is desired to form a bonding beam 22 of the cementitious material monolithic with the studs 23, we provide a horizontal backing stringer 24 (see Fig. 3) that is supported on the upper ends of the backing members 17a (see Fig. 3) and the inner face of which laps the upper ends of the core members 20. This stringer member 24 should be thick so as to give it considerable rigidity, and if desired, the backing members 17a also may be made of the same thickness. If this is done, it facilitates the application of short cleats 25 that are secured to the core members 17a and the stringers 24, by fastening devices such as the nails 26.

In completing the molding space for the bonding beam 22, we prefer to employ a cap sill 27, the inner edge of which is supported on the upper edge of the stringer 24. This cap sill may support upright reinforcing members 13. If desired, the upper ends of these reinforcing members 13 may carry heads such as the head 28, that seat on the upper faces of the cap sill 27, when the rods 13 are dropped down through openings in the cap sill to receive them. If necessary, any suitable means may be employed between the upper ends of the core members 20 and the under face of the cap sill 27 to prevent any possibility of its outer edge sagging down. Such means are not illustrated.

After completing the placing of the studs, up to the upper ends of the core members 20, the concrete is shot into the beam mold space between their upper ends and the under face of the cap sill 27, so as to make the beam monolithic with the studs, and the intercostal sections of the beam between the studs are then shot with the gunite above the upper ends of the core members 20.

The cap sill 27 is left in place, although after the concrete sets, the stringer 24 is removed together with all of the backing members 17a; and any stringers, such as the stringer 29 and shores 30, are removed.

The cap sill 27 is adapted to support the end of a roof truss 31, but if it is desired to form a fire wall 32, this should be formed before the roof truss is put in place and would be accomplished by placing a continuous backing or form 33 in position as indicated by the dotted lines in Fig. 3, against which the cementitious material may be shot to form a fire wall 32 which would operate as an extension to the diaphragm or outer slab 34 of the cementitious material, which can be shot after the studs and the bonding beam 22 are formed; or if desired, this diaphragm can be shot continuously with the shooting of the studs' faces, and the level of the diaphragm 34 carried on up as the height of the studs increases.

Such a diaphragm or outer slab 34 can be reinforced if desired, by means of reticulated reinforcing material indicated by dotted lines 35 in Fig. 1. This may be in the form of wire mesh held in position by furring nails 36 driven into the outer faces 8 of the core members 6.

In Fig. 4 we illustrate the manner in which diagonal reinforcing can be incorporated in a wall built in accordance with our method. In order to accomplish this, one of the superficial faces of certain of the core members 6, such as the core members 6a and 6b shown in Fig. 4, are provided with diagonally extending channels or grooves 37 to receive diagonal reinforcing rods 38 disposed in them as shown. If the footing 1 is already in place, and such diagonal reinforcing is to be em-

ployed, and it is desired to secure a good anchor for the lower end of each rod, it is preferable to support the core members 6a so that their lower ends are disposed slightly above the floor line indicated at 36 in Fig. 4. This enables a super sill 1a to be formed in a space between the floor level and the lower edges of the core members 6a which would be monolithic with the studs 40. The lower ends of the diagonal reinforcing rods 38 would have bent ends forming anchor shanks 41 extending in the direction of the super sill 1a and embedded in the same when the cementitious material is shot in to form it. When constructing a partition wall, or a light wall without a diaphragm or slab 34, the grooves 37 would be used and made deep enough to place the rods 38 down below the surface of the panels; so as not to interfere with surfacing the wall with wall board, or plaster.

If it is not desired to form a super sill 1a, then the lower end of the reinforcing rod can be bent upwardly into a channel gap that is to receive stud material.

At their upper ends the diagonal reinforcing bars 38 would have horizontal anchor shanks 42 that would run intermediately between horizontal reinforcing bars 43 that would be placed in the bonding beam 22a.

Fig. 4 also indicates the position of a vertical reinforcing rod 13a. These would be embedded on the medial plane of the studs 40.

In Fig. 5 I illustrate a corner of a building, the wall of which is constructed in accordance with the invention. This view illustrates a wall construction in which diagonal reinforceing rods 44 are provided near the outer face of the wall embedded in the diaphragm or outer slab 45. This location for the diagonal reinforcing can be used where the diaphragm 41 has sufficient depth to embed the reinforcing satisfactorily.

In this embodiment of the invention, at a corner 46 of a building, the upper end of reinforcing going to the corner, would be bent to form a shank 47 extending longitudinally with the meeting wall of the building and preferably lying alongside of longitudinal reinforcing bars 48 that run along in the bonding beam 49. In this view, the reinforcing at the corner 46 is illustrated as consisting of two parallel vertical rods 50 embedded in the corner or key stud 51 at which the two walls unite that form the corner.

The dotted line 52 in Fig. 2 indicates the depth of plaster that can be applied to the inner face of the wall. If desired, the ends of the wire ties 16 (that will be left projecting out after the form boards 17 have been removed) can be used as ties for fastening plaster reinforcing.

Before plastering the inside of the wall, the location of the faces of the panels 6 can be noted so as to facilitate properly locating built-in fixtures.

The pre-molded core panels should have a surface that is rough and pitted with small holes. This makes an admirable surface for receiving and holding of the plaster.

In Fig. 6 we illustrate simple means that we may employ where it is desired to facilitate adapting the depth of the bonding beam to special requirements. For example, if the beam has an abnormal span, the means illustrated enables the depth of the beam to be made greater. Referring to this figure, 53 indicates the upper portion of a core member, or panel, above which the upper end of a rafter 54 may be located and

supported on an X-frame including a diagonal brace **55** constituting one of the bars of the X-frame supporting the rafter. In this case, the cap sill **56** can be secured by driven fasteners or nails applied at the line **57**, to support the cap sill on the projecting end of the rafter, that is to say, the portion of the rafter that projects over the wall. The rafter **54** of course would be located in a space between an upright or backing board **58** of the "picket fence" which would include a waler or stringer **59**. Instead of employing a backing stringer such as the stringer **24** illustrated in Fig. 3, we may provide a sheet metal backing apron **60** having a flange **61** at its upper edge, that hangs on the rear edge of the cap sill **56**, the body of the apron hanging down so that its lower edge laps the upper ends of the core panels **53**, and being located between the core panels and the backing boards **58**. If a bonding beam is not to have great depth, the upper tips of the core panels **53** may be located at a relatively high elevation indicated by the dotted line at **62**, in which case it would only be necessary to employ a pair of reinforcing bars such as the bars **63**.

If, however, a beam of greater depth were required, the upper end face **64** of the panel members could be located at a lower level, giving the beam almost double the depth that it would have had if the bottom of the beam were to be located at the level of the line **62**. In this case, additional reinforcing members **65** could be employed as indicated by dotted lines in this figure. These aprons would be made of thin sheet metal, and when a number of them are used, they would be used in any convenient lengths with their ends overlapping each other. They would of course be removed after the cement **66** has been shot into the channel spaces and into the molding space for the beam that is formed under the cap sill and above the upper ends of the core panels **53**. In Fig. 6, this cement is illustrated as being monolithic with the diaphragm slab **67** that forms the outer face of the wall.

It is obvious that if desired, the wall can be "shot" with a cement gun from the inside of the wall instead of from the outside. And the panels **6** may be set up with their wider faces at either side of the wall.

Many other embodiments of the invention may be resorted to without departing from the spirit of the invention.

We claim as our invention:

1. A method of constructing a wall structure, which includes setting up upright backing members spaced apart from each other, setting up substantially equidistant upright core panels composed of pre-formed material having a composition that is pervious to inserted fasteners, and in capable of supporting wall load, and disposed so that their side edges overlap the adjacent edges of the backing members to form channel gaps between the panels opening toward one side thereof, and having sufficient horizontal cross-section to mold studs capable of supporting all the load on the wall, placing reinforcing rods in the said channel gaps, applying wire ties to the reinforcing rods with their ends engaging the faces of the panels; and injecting a moist cementitious material into the open sides of said channel gaps to fill the same and form reinforced studs capable of supporting all the wall load, and

continuing the injection of moist cementitious material above the upper ends of the panels and onto the faces of the panels to unite the said studs and to embed said ties; and removing the backing members thereafter.

2. A skeleton wall operating as a form, ready to receive an injected cementitious material, comprising the combination of a plurality of premolded equidistantly spaced non-load bearing core panels, an upright backing for the core panels overlapping the adjacent edges of the core panels so as to co-operate with the core panels to form a plurality of substantially vertical channel-form spaces to receive the cementitious material forming studs capable of carrying all the load of the finished wall, a cap sill, means for supporting the cap sill spaced above the ends of the panels, an apron of sheet material backed up by the backing, and bridging the space at one side between the upper ends of the core panels and the cap sill, and cooperating therewith to form a molding space for injection of cementitious material to form a bonding beam.

3. A skeleton wall according to claim 2, in which the upper edge of the apron is formed with a flange projecting over the upper face of the cap sill to support the apron.

4. A method of constructing a wall structure which includes setting up panels spaced apart at their side edges to form upright stud-molding gaps between them, closing said gaps at one side of said panels, and leaving their other sides open, said gaps having sufficient horizontal cross-sections to mold studs of cementitious material therein capable of supporting all the wall load; placing substantially vertical reinforcing rods in the said stud molding gaps; supporting a backing stringer on the side of the panels where said stud molding gaps are closed; supporting a cap sill above the upper ends of the panels and forming with the stringer and panels a bonding beam molding space open on the same side as the stud molding gaps between the panels are open; suspending the reinforcing rods in said stud molding gaps from the cap sill; and injecting cementitious material into the upright molding gaps to embed the reinforcing rods, and into the bonding beam molding space to form a bonding beam embedding the upper ends of the suspended reinforcing rods and monolithic with the cementitious material placed in the stud molding spaces between the said panels.

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