

PATENT SPECIFICATION (11)

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DRAWINGS ATTACHED

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- (21) Application No. 15821/71 (22) Filed 19 May 1971 (19)
(31) Convention Application Nos. 084 014 (32) Filed 28 May 1970
107 895 16 March 1971 in
(33) Canada (CA)
(44) Complete Specification published 3 Oct. 1973
(51) International Classification E04G 17/14 E04C 3/09
(52) Index at acceptance
E1S 4A1B 4A6C 4A6E 4G2 4G3A1 4G3CX
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(54) SHUTTERING

(71) We, HAMBRO STRUCTURAL SYSTEMS LIMITED, a Canadian Company of P.O. Box 5170, Postal Station F, Ottawa, Ontario K2C 344, Canada, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

The present application relates to shuttering for use in supporting cast concrete and in particular shuttering in which a combination of joists, interconnecting bars and rigid panels are utilised to support a poured concrete floor. In accordance with one form of the invention, the interconnecting bars and rigid panels may be removed after the concrete has set and reutilised. In accordance with a further preferred form of the invention the joist may also be removed after the concrete has set so that they can be reused.

According to the present invention there is provided shuttering for use in supporting cast concrete, comprising metal joists which in use are supported in parallel spaced apart relationship, interconnecting bars for extending between adjacent joists and rigid panels which can be supported on the bars so as to extend between and fill the space between adjacent joists, each joist having a top chord, a bottom chord and a web extending between said chords, the top chord or the web being provided with an elongated longitudinally extending slot or the top chord being provided with a longitudinally extending channel, each bar being of substantially rectangular cross-section with a notch provided near each end in the narrower face thereof to enable each end portion of the bar to be initially inserted into the slot or placed above the channel with its broadest face parallel to the plane of the top surface of a joist and the bar then rotated to place the broadest face at right angles to the plane of the top surface of a joist thereby to engage the bar with the joist.

Some embodiments of the present invention will now be described with reference to the accompanying drawings, in which:—

Figure 1 is a vertical section through shuttering according to the present invention;

Figure 2 is a perspective view partly broken away illustrating formwork pursuant to the present invention;

Figure 3 is a perspective view similar to Figure 2 illustrating a slightly modified embodiment of the invention;

Figure 4 is a perspective view of yet another form of shuttering according to the present invention;

Figure 5 is a perspective view with the panels removed of yet another embodiment of the invention;

Figure 6 illustrates a preferred form of elongated slot provided for receiving the end of an interconnecting bar;

Figure 7 illustrates an interconnecting bar adapted for utilization with the elongated slot of Figure 6;

Figure 8 illustrates an alternative embodiment of elongated slot;

Figure 9 illustrates another form of interconnecting bar;

Figure 10 illustrates an alternative form of elongated slot intended for utilization with an interconnecting bar as illustrated in Figure 9;

Figures 11 and 12 illustrate alternative forms of top chord for the open web steel joist for utilization with the interconnecting bar illustrated in Figure 13;

Figure 13 illustrates an interconnecting bar adapted for utilization with the top chords of Figures 11 and 12;

Figure 14 is a vertical section through a wall form constructed pursuant to the present invention;

Figure 15 is a perspective view of one face of a wall form pursuant to the present invention;

Figure 16 is a perspective view of a cold rolled sheet steel joist which can be used

with shuttering according to the present invention;

Figure 17 is a vertical section through a cast concrete floor system using the cold rolled steel joist as disclosed in Figure 16;

Figure 18 is a vertical section illustrating the shuttering system utilizing the cold rolled sheet steel joist of Figure 16; and,

Figure 19 is a plan view of an interconnecting bar for use with the sheet steel joist of Figure 16.

Referring to Figure 1 there is shown a vertical section through a building construction utilizing the shuttering of the present invention. As illustrated, there is shown a support 10 which may be either a poured concrete wall, a masonry or block wall or could alternatively be a column placed beneath the floor system. On either side of the support 10 are placed temporary scaffolds 11 and 12, on the top ends of which are supported open web steel joists or bar joists 13 and 14. Supported between successive open web joists 13, 14 are rigid panels 15 and 16, for example of plywood. These panels 15 and 16 are supported by a plurality of interconnecting bars 17 positioned transversely of the joists 13 and 14, the ends of the interconnecting bars 17 being received in openings 18 formed in the lower edge of the top chord or in the upper part of the web of the open web joists 14 and 15.

The steps in the process of erecting a building utilizing the shuttering of the present invention typically would consist of pouring a floor or foundation, erecting vertical walls or columns, positioning temporary scaffolding 11 and 12 to support the open web joists 13, 14 inserting interconnecting bars 17 and plywood panels 15, 16 between the joists 13, 14, and pouring the successive concrete floor of the building. After an appropriate period of time, for example seven days, the interconnecting bars 17 and panels 15, 16 would be stripped from the open web joists 13, 14, and after a further period of time, for example 28 days, the open web joists 13, 14 would be removed, together with the temporary scaffolding 11, 12. This material could then be raised to a higher floor of the building and reused to make formwork for pouring a succeeding upper floor of the building.

It should be noted that no requirement for reshoring of the poured concrete floors is raised by the system of the present invention. By allowing the open web joists 13, 14 to remain in place, the necessity for reshoring is avoided, and thus the construction of the building can be accelerated since mechanical trades can have access to the floor at an earlier date than would be required if reshoring were utilized.

As an alternative form of construction

it is within the scope of the present invention to support the open web joists 13, 14 on permanent supports in the building structure, and to incorporate the open web joists 13, 14 as permanent portions of the building. Such open web joists 13, 14 may either have a conventional top chord having a flat upper surface, or may utilize a form of top chord provided with shear connection to the concrete to give a composite action which results in a significant decrease in the cost of building construction. It will be appreciated that any poured concrete structure will of course have to include reinforcing elements to strengthen the concrete at critical locations, but for the sake of simplicity such reinforcement has not been illustrated in the drawings of the present invention.

With the system of the present invention it is possible to utilize standard material sizes to form the plywood panels 15, 16 and the spacing of the open web joists 13, 14 may for example be advantageously fixed at approximately four foot centers, thereby enabling the use of standard 4ft x 8ft sheets of plywood which are the most inexpensive size commercially available. It should also be recognized that in accordance with contemporary construction practice, such plywood panels would be treated with a release coating, such as oil, to avoid adherence of the concrete to the panel. Such a release coating enables the ready stripping of the forms from beneath the poured concrete floor with a minimum loss of formwork due to accidental destruction.

As illustrated in Figure 1, and in other figures of the drawings, the interconnecting bars 17 may be equipped with permanent handles 19, or alternatively such interconnecting bars 17 may be utilized together with removable handles resembling spanner wrenches which are utilized to grasp the interconnecting bar 17 for rotation during insertion and removal. As will be discussed hereinbelow, the interconnecting bars 17 are formed of a material of a substantially rectangular cross section and are suitably notched at the ends to stabilize the positioning of the open web joists 13, 14 during construction. Additionally, the plywood panels 15, 16 utilized together with the interconnecting bars 17 serve to give a diaphragm action to reinforce the formwork against horizontal loads during pouring of the concrete floors.

In Figure 2 there is illustrated in perspective a section of shuttering pursuant to the present invention as illustrated in Figure 1. The open web joist 13 supports an interconnecting bar 17 on which a rigid plywood panel 15 is positioned. A like panel 15A is positioned on the opposite side of the open web joist 13 from the panel 15 and is supported by an interconnecting bar (not illus-

trated). The form of open web joist 13 shown in Figure 2 utilizes a "hat" section top chord which has a substantially flat upper surface 20 and horizontally extending flanges 21 and 22 to support the edges of the plywood panels 15A and 15 respectively. A portion of an elongated opening 18 is also illustrated in the drawing.

Figure 3 illustrates an alternative form of top chord which is provided with a flat upper surface 23 with one long vertical leg 24 and a short vertical leg 25. As before, the long vertical leg 24 is provided with elongated openings 18 for cooperation with the interconnecting bars 17.

Figure 4 illustrates an alternative embodiment of the invention utilizing an alternative form of top chord for each of the open web joists 13 and in which a second interconnecting bar 17 is utilized to connect the bottom chords of the open web joists 13 to provide bridging where necessary for strengthening the formwork. As before, the plywood panel 15 is supported by the upper interconnecting bars 17 and fits between the joists 13 and has its upper surface substantially flush with the tops of the top chords of the joists 13. It will be noted that the form of top chord illustrated in Figure 4 includes an upwardly extending channel positioned at either side of the joist into which the ends of the upper interconnecting bars 17 are fitted. This channel is provided with notches at appropriate locations so that the interconnecting bars 17 may be removed after pouring of the concrete floor.

Figure 5 illustrates another alternative embodiment of the invention in which the top chord is formed in the shape of an inverted channel with elongated openings for cooperation with the ends of the interconnecting bars 17, and a bridging bar 25 is provided connecting the bottom chord of the open web joist which bottom chord is formed by a pair of angles with a space therebetween.

Figure 6 illustrates one form of elongated opening 18 formed in the side of the joist for supporting of the interconnecting bar 17.

Figure 7 illustrates a preferred form of interconnecting bar 17 formed of rectangular cross section material with a notch 26 in each end of the bar 17. In use the bar 17 is turned so that the flat side of the material extends in the long direction of the opening 18 so that the bar 17 may then be inserted in the opening 18 and rotated so that the sides of the notch 26 engage the short edges of the opening 18 to fix the bar 17 in relation to the opening 18.

While Figure 6 illustrates a preferred form of elongated opening 18, in many cases an opening 18 as illustrated in Figure 8 would be suitable for use within the pre-

sent invention. In such case an interconnecting bar 17 as illustrated in Figure 9 may be utilized for supporting the rigid panels.

Figure 10 illustrates yet another form of elongated opening 18 which might be utilized with the present invention in which a portion of the material 27 adjacent the opening 18 may be formed so as to be removed by being knocked out to assist in removal of the interconnecting bar 17 during stripping of the formwork.

Figure 11 illustrates a form of top chord which might be utilized with interconnecting bars 17 of a shape illustrated in Figure 13. In this case the notches 26 are formed in the lower edge of the interconnecting bar and sit on the upturned lips 28 of the top chord of the open web joist.

Figure 12 illustrates a shape of top chord shown in Figure 4 which is also provided with upturned lips 28 to cooperate with an interconnecting bar 17 such as that illustrated in Figure 13.

Figure 14 illustrates the application of the present invention to the erection of formwork for vertical constructions such as the pouring of concrete walls. Figure 15 is a perspective of one side of the formwork illustrated in Figure 14, and the two figures of drawings will be described together for simplicity. A vertically extending member 50 which resembles an open web joist of tapering depth is positioned vertically and provided with a channel 51 with a plurality of elongated openings 52. Interconnecting bars 53 are inserted in the openings 52 in the channel 51 and serve to support vertical rigid panels 54 from outward motion. A bottom tie consisting of a tubular spacer 56 is provided at the base of the wallform and a top tie 56 is positioned at the top of the wallform. As before the concrete wall is poured the shape being retained by the shuttering and after the concrete has set the shuttering is stripped by removal of the interconnecting bars 53 and the panels 54 and subsequently by removal of the vertical reinforcing members 50.

Referring to Figure 16, there is shown in perspective a cold rolled sheet steel joist which can be used with the present invention, such a joist is described and claimed in our co-pending United Kingdom Patent Application No. 2438/73 (Serial No. 1,332,372). The joist is indicated generally at 110 and consists of a bottom chord 111 in a generally hollow rectangular shape, a vertical flange 112 and a generally Z-shaped top chord 113. In erecting the composite floor system described in Figures 17 and 18, cold rolled sheet joists 110, in properly spaced-apart parallel relationship, are supported at opposite ends upon any usual and conventional supports.

Positioned between two such joists 110 130

are interconnecting bars 114 which have tapered and notched ends 115. The ends 115 cooperate with the joists 110 and are wedged into openings 116 in the vertical flanges 112 during erection. The plurality of openings 116 are generally rectangular in shape with one side inclined so that the opening 116 is tapered from one end to the other so that when interconnecting bar end 115 is inserted and hammered into the opening 116 interconnecting bar 114 becomes wedged securely. Supported on the interconnecting bar 114 is the reusable panel formwork 119. Wet concrete is prevented from spilling off the panels 119 by the Z-shaped top chord 113 and by the vertical face 112 of each joist 110.

In accordance with a further feature of the invention, such a shaped interconnecting bar as seen in Figure 19 permits the easy installation and removal of interconnecting bars 114 so that they may be re-used. Once the interconnecting bars are removed the openings 116 serve as pass-ways for electrical and mechanical conduits thereby permitting a saving in the height required between floors.

The top chords 113 of this joist 110 may be embedded in the concrete floor 117 and the reinforcing mesh 118 hangs in a catenary shape between the joists 110 to provide a proper reinforcement for the concrete floor 117. Thus the top chord 113 becomes part of the concrete floor.

WHAT WE CLAIM IS:—

1. Shuttering for use in supporting cast concrete, comprising metal joists which in use are supported in parallel spaced apart relationship, interconnecting bars for extending between adjacent joists and rigid panels which can be supported on the bars so as to extend between and fill the space between adjacent joists, each joist having a top chord, a bottom chord and a web extending between said chords, the top chord or the web being provided with an elongated longitudinally extending slot or the top chord being provided with a longitudinally extending channel, each bar being of substantially

rectangular cross-section with a notch provided near each end in the narrower face thereof to enable each end portion of the bar to be initially inserted into the slot or placed above the channel with its broadest face parallel to the plane of the top surface of a joist and the bar then rotated to place the broadest face at right angles to the plane of the top surface of a joist thereby to engage the bar with the joist.

2. Shuttering as claimed in claim 1, in which the top chord of each joist has a substantially flat upper surface which lies in substantially the same plane as the top surface of said rigid panels.

3. Shuttering as claimed in claim 1 or claim 2, in which each joist consists of a top chord formed by a hat or channel section member having a flange in which a plurality of said elongated slots are provided, a web formed as an open framework and a bottom chord.

4. Shuttering as claimed in claim 1 or claim 2, in which each joist consists of a top chord having at each side a longitudinally extending channel with the opening of the channel parallel to the top surface of the top chord, a web formed as an open framework and a bottom chord.

5. Shuttering as claimed in claim 1 or claim 2, in which each joist consists of a cold rolled sheet steel joist having a top chord which is Z-shaped in cross-section, a substantially flat web and a bottom chord which is of hollow rectangular shape in cross-section.

6. Shuttering as claimed in any preceding claim, in which the notch provided in each end of each bar is rectangular or V-shaped.

7. Shuttering for use in supporting cast concrete, substantially as hereinbefore described with reference to and as illustrated in the accompanying drawings.

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are interconnecting bars 114 which have tapered and notched ends 115. The ends 115 cooperate with the joists 110 and are wedged into openings 116 in the vertical flanges 112 during erection. The plurality of openings 116 are generally rectangular in shape with one side inclined so that the opening 116 is tapered from one end to the other so that when interconnecting bar end 115 is inserted and hammered into the opening 116 interconnecting bar 114 becomes wedged securely. Supported on the interconnecting bar 114 is the reusable panel formwork 119. Wet concrete is prevented from spilling off the panels 119 by the Z-shaped top chord 113 and by the vertical face 112 of each joist 110.

In accordance with a further feature of the invention, such a shaped interconnecting bar as seen in Figure 19 permits the easy installation and removal of interconnecting bars 114 so that they may be re-used. Once the interconnecting bars are removed the openings 116 serve as pass-ways for electrical and mechanical conduits thereby permitting a saving in the height required between floors.

The top chords 113 of this joist 110 may be embedded in the concrete floor 117 and the reinforcing mesh 118 hangs in a catenary shape between the joists 110 to provide a proper reinforcement for the concrete floor 117. Thus the top chord 113 becomes part of the concrete floor.

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rectangular cross-section with a notch provided near each end in the narrower face thereof to enable each end portion of the bar to be initially inserted into the slot or placed above the channel with its broadest face parallel to the plane of the top surface of a joist and the bar then rotated to place the broadest face at right angles to the plane of the top surface of a joist thereby to engage the bar with the joist.

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5. Shuttering as claimed in claim 1 or claim 2, in which each joist consists of a cold rolled sheet steel joist having a top chord which is Z-shaped in cross-section, a substantially flat web and a bottom chord which is of hollow rectangular shape in cross-section.

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