May 24, 1966 F. F. SOUKUP 3,252,682

PREFABRICATED CONCRETE WALL AND ROOF FORM STRUCTURE

Filed Aug. 17, 1960 4 Sheets-Sheet 1

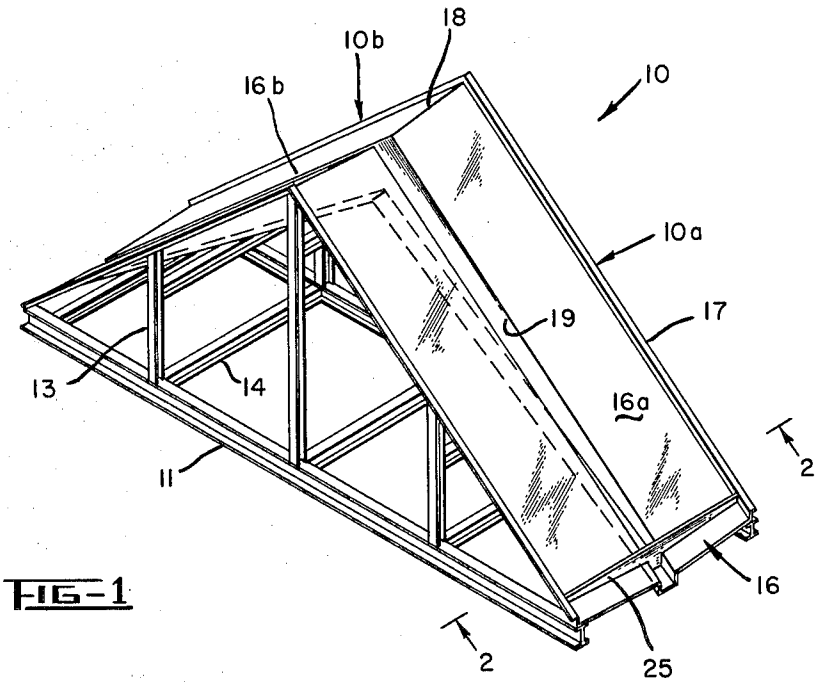

FIG-1

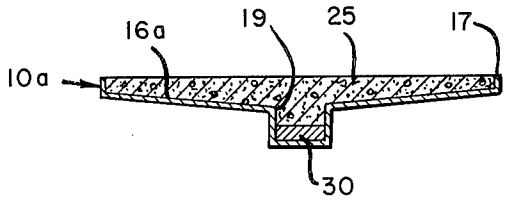

FIG-2

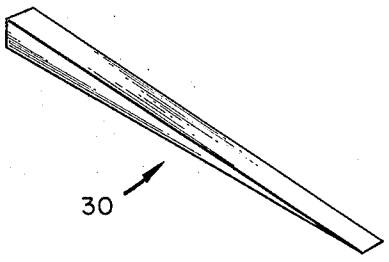

FIG-3

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PREFABRICATED CONCRETE WALL AND ROOF FORM STRUCTURE

Filed Aug. 17, 1960 4 Sheets-Sheet 2

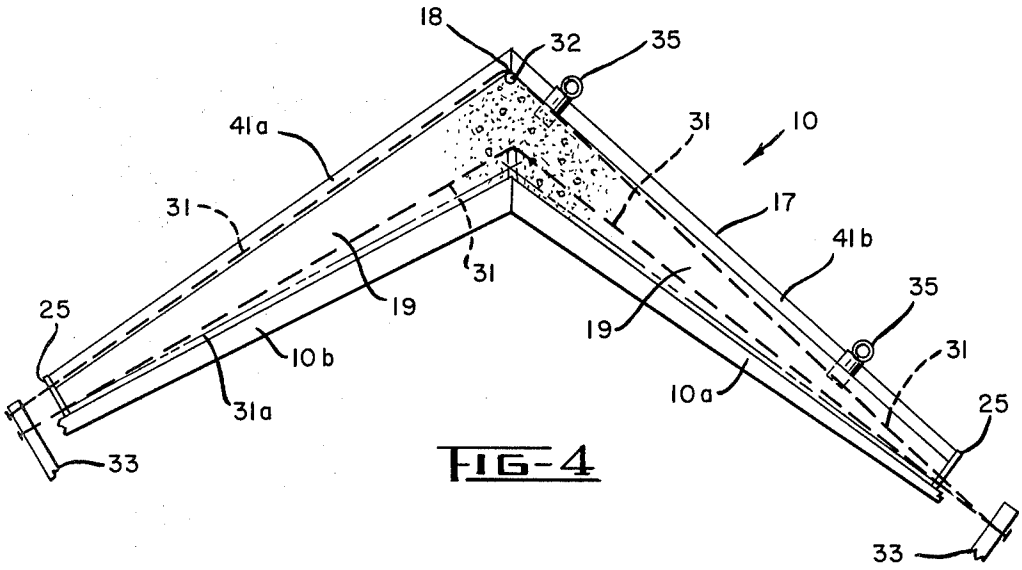

FIG-4

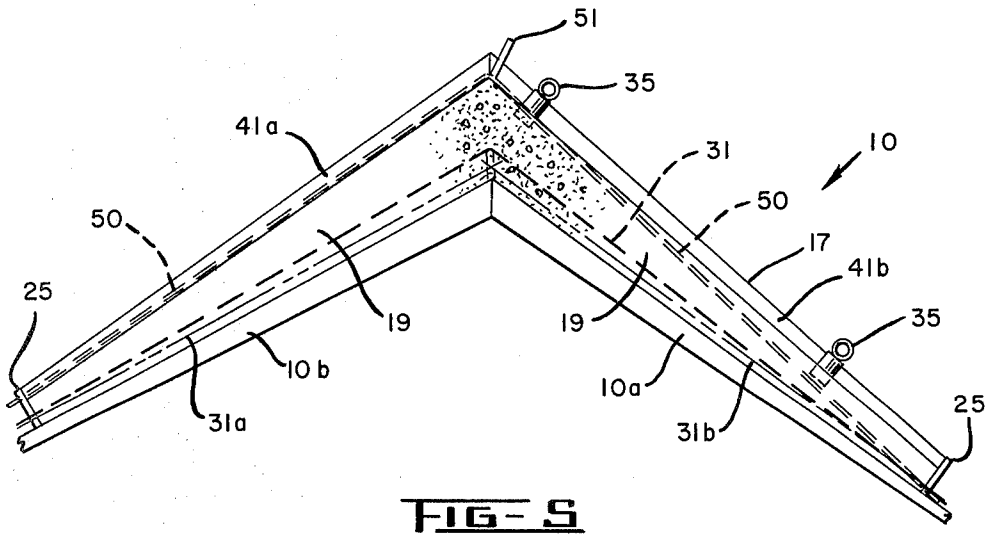

FIG-5

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PREFABRICATED CONCRETE WALL AND ROOF FORM STRUCTURE

Filed Aug. 17, 1960 4 Sheets-Sheet 3

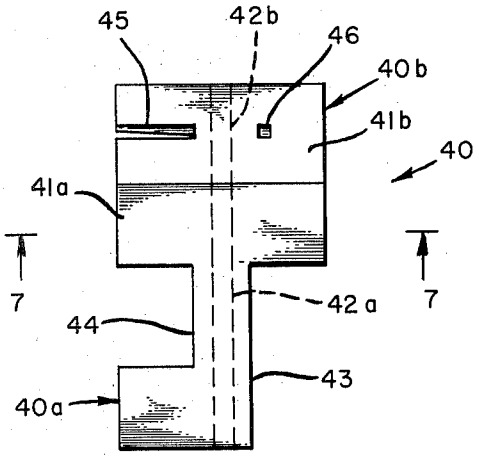

FIG-6

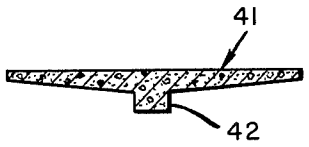

FIG-7

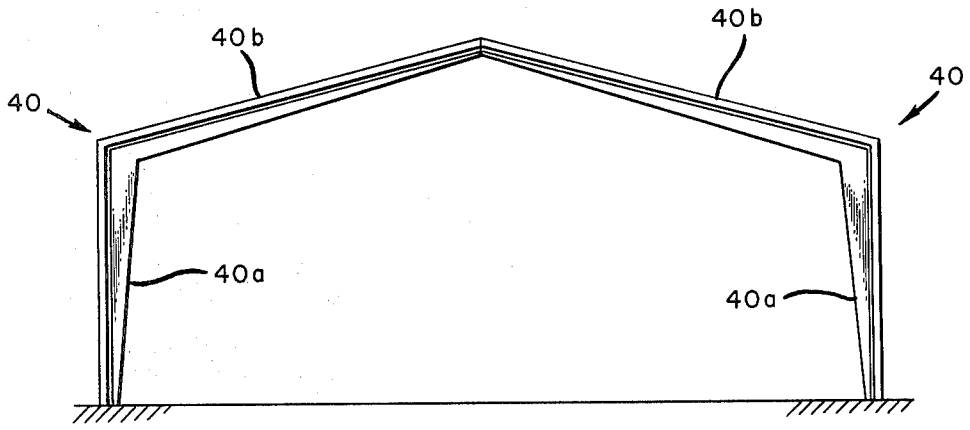

FIG-8

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PREFABRICATED CONCRETE WALL AND ROOF FORM STRUCTURE

Filed Aug. 17, 1960 4 Sheets-Sheet 4

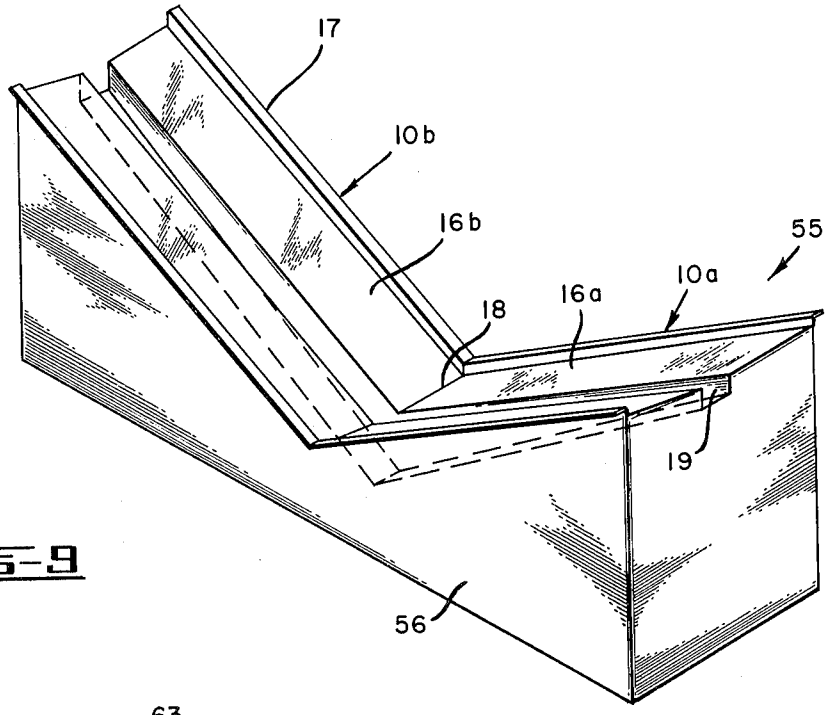

FIG-9

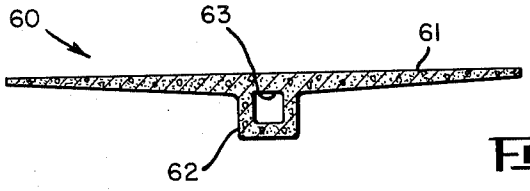

FIG-10

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United States Patent Office 3,252,682 Patented May 24, 1966

3,252,682

PREFABRICATED CONCRETE WALL AND ROOF FORM STRUCTURE

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Filed Aug. 17, 1960, Ser. No. 50,222
7 Claims. (Cl. 249—158)

This invention relates to prefabricated concrete wall and roof forms. More particularly the present invention relates to structures of this character wherein the concrete units are reinforced by prestressed steel members.

Prefabricated wall slabs or sections have been used widely for a number of years in building construction. By "prefabricated wall slab or section" is meant a wall slab or section made of concrete in a horizontal form and then tilted up, after removal of the form, to vertical position.

There is an advantage in applying such technique to wall and roof units but extension of the technique to include a roof section integral with a wall section is difficult. A three dimensional structure of this character, that is, a structure which is not flat and which has a third dimension of large magnitude, is not easy to construct as one integral unit, and the structure is difficult to manipulate.

It is another particular object of the invention to provide a facile, dependable means of prefabricating integral wall and roof units of concrete.

The above and other objects of the invention will be apparent from the ensuing description and the appended claims.

Inasmuch as the terms "prestressing," "pre-tensioning" and "post-tensioning" are used herein, it is appropriate to define them.

Prestressing, as used herein, refers to the practice of applying tension to reinforcement members in concrete before a load is applied to the concrete. Prestressing can be carried out by pre-tensioning or by post-tensioning. In the former case (pre-tensioning) reinforcement cables or the like embedded in concrete are pulled or tensioned before the concrete has set and hardened. In the latter case (post-tensioning) the reinforcement cables or the like are pulled or tensioned after the concrete has set and hardened sufficiently to take compression, and it is accomplished by laying the cables in tubes which are embedded in the concrete, pulling the cables after the concrete has set and hardened, then filling the tubes with a concrete or grout mix and allowing it to harden. These are known techniques with which those skilled in the art are well acquainted.

Certain forms of the invention are illustrated by way of example in the accompanying drawings, in which:

FIGURE 1 is a perspective view of a form used in accordance with the invention to construct a concrete wall and roof unit.

FIGURE 2 is a transverse section taken through the form of FIGURE 1 shown filled with concrete.

FIGURE 3 is a perspective view of a filler strip employed with the form of FIGURE 1 to control the depth of the column and of the beam or rafter portions of the end product.

FIGURE 4 is a view in vertical midsection of the form of FIGURE 1 with concrete cast in place and with pre-tensioned reinforcement members also in place.

FIGURE 5 is a view similar to FIGURE 4 but wherein the reinforcement members are post-tensioned.

FIGURE 6 is a view in side elevation of a wall and roof unit constructed in accordance with the invention.

FIGURE 7 is a section taken along the line 7—7 of FIGURE 6.

FIGURE 8 is a view in end elevation of a building structure showing two wall and roof units (such as that shown in FIGURES 6 and 7) in erect, abutting relation.

FIGURE 9 is a perspective view of a modified type of form wherein the column and rafter elements of the wall and roof sections are intended to be on the exterior surface.

FIGURE 10 is a view in end elevation of a modified form of roof and wall unit in accordance with the invention.

Referring now to the drawings and more particularly to FIGURE 1, a form is shown at **10** comprising a framework made up of base members **11**, vertical members **13**, and cross members **14**. The framework **11** may be of wood, steel, aluminum or any other desirable type of construction. It serves to support a form or mold surface **16** and side strips **17**. It will be seen that the form surface **16** is in two sections, **16***a* and **16***b*, which adjoin one another at a peak **18** and which slope outwardly and downwardly therefrom to form an inverted V. Each of the sections **16***a* and **16***b* is formed with a channel **19** which tapers in depth from the peak **18** to the bottom edge of the respective surface, so that the channel is deepest at the junction of the surface **16***a* or **16***b* and diminishes progressively in depth therefrom.

In effect a double form **10***a* and **10***b* is thereby provided. The form **10***a*, as explained hereinafter, is employed to produce a wall section and the form **10***b* is employed to produce a roof section. Each form section **10***a* or **10***b* is channel-shaped in cross section as shown in FIGURE 2 and it tapers in cross section so that it is deeper near the center line. As there shown a bulkhead **25** is provided. The bulkhead **25** conforms to the cross sectional shape of the mold, it is movable to adjust the height of the wall section and the span of the roof section, and it is removable. It is held in place during use by any suitable means (not shown) such as wedges or nails. There is, of course, one bulkhead for each mold section **10***a* and **10***b*, and preferably an assortment of bulkheads is provided to conform to the carrying depth of the channels **19**.

Referring to FIGURE 3 a filler strip is shown which is designated by the reference numeral **30** and which is tapered as shown. A number of such filler strips are provided for each mold section **10***a* and **10***b* and each of them fits into its respective channel **19**. Its purpose is to adjust the depth of the respective channel **19**. The filler strips **30** are of different thickness so that the channels **19** can be adjusted for a particular design. For example, if a shorter length of wall or a roof of shorter span is to be made, the channels **19** will be made shallower by selecting thicker filler strips.

Referring now to FIGURE 4, the form **10** is there shown in vertical midsection. The bulkheads **25** are shown in place. Also shown are steel cables **31** extending over the peak **18** and supported by members such as shown at **32** which serve to space the cables from the bottom of the form. (Conventional steel reinforcement rods are shown at **31***a* which are not prestressed and which serve to provide strength for handling and compression purposes.) The ends of the cables **31** are shown secured to anchor members **33**. Each cable will be pulled by a suitable means (not shown) such as jacks to apply a suitable tension and thereby prestress the cable. All inner surfaces of the form in contact with the concrete may be coated with a suitable release agent. Concrete is then poured into the form starting at the bottom of each section **10***a* and **10***b* adjacent the respective bulkhead **25** and progressing upwardly to the peak **18**. The concrete mix, after having been poured, is screeded and leveled off flush with the side rails **17** and the bulkheads **25**. Two or more hooks **35** will be embedded in the concrete before it hardens, such hooks being employed to hoist and manipulate the precast concrete unit when it is ready for removal from the form. The concrete is allowed to set and harden sufficiently to withstand the strain of lifting

and removal from the form **10**. Suitable lift means (not shown) such as a crane is used to hoist the concrete unit, employing the hook or hooks **35** to assist in this operation.

Referring now to FIGURES 6 and 7, the resulting precast, prestressed, concrete roof and wall unit is there shown at **40**. It is T-shaped in cross section as shown in FIGURE 7, comprising a body portion **41** and a column element **42***a* (or a rafter element **42***b*). The body portion **41** as shown in FIGURE 6 comprises a wall section **41***a* and a roof section **41***b*. Shown in the wall section **41***a* are a door opening **43** and a window opening **44**. Shown in the roof section **41***b* are roof openings **45** and **46**, for example, for vents, pipes, chimneys, etc. Openings such as those shown at **43**, **44**, **45** and **46** are very easily provided, whenever they are needed, by blocking off parts of the form **10** and then removing the blocking members after the concrete has hardened, thereby leaving openings such as those shown at **43**, **44**, **45** and **46** in FIGURE 5.

Referring to FIGURE 8, two roof and wall units **40** are there shown in erect position, each comprising a wall section **40***a* and a roof section **40***b*. These are shown with the wall sections **40***a* upright and the roof sections **40***b* abutting to form a peak.

It will be understood that the roof sections **40***b* can be tied together at the peaks by any suitable means well-known in the art and that the wall sections **40***a* can be seated upon and tied to a foundation by any suitable means (not shown). By repeating this operation a building of any desired length can be erected very rapidly.

The structural shape shown at **40** in FIGURES 6, 7 and 8 is advantageous. It provides both a wall section and a roof section. By using prestressed and pre-tensioned reinforcement members and by using the tapered column and rafter elements shown, a very strong structure is provided. The forms shown are very advantageous because they facilitate casting the structures and they also facilitate storage and transport. For example, a large number of forms can be used and the concrete structures left on the forms and/or transported while still on the forms. Alternatively only one or a few forms can be employed.

Among other advantages the following may be mentioned: The units **40** lend themselves to transportation by rail and by truck or highways. For example, a roof and wall unit **40** for a building having a fifty foot span can be laid on the bed of a truck or trailer and fall within the tolerance limits on height which are specified in many of the States. The system is flexible because it offers a choice of making the units at a central plant and transporting the finished unit to the construction site, or making the units at the site. Also, the units are easily lifted, e.g., by a single crane.

The technique described with reference to FIGURE 4 comprises pre-tensioning the cables **31**. FIGURE 5 illustrates how post-tensioning can be carried out in accordance with the invention. The form **10** is the same as that shown in FIGURE 4, and similar parts are similarly numbered. However, tubes **50** are supported in the form by any suitable means and reinforcement cables **31** are passed through these tubes. (Conventional, non-prestressed steel rods are provided at **31***a* as in FIGURE 4.) Concrete is poured, screeded and levelled as described above in connection with FIGURE 4, and it is allowed to set and harden enough to resist compression. Then the steel cables **31** are tensioned. This post-tensioning can be accomplished by fastening keeper members (not shown) to one end of each cable, and applying a jack to the other end of each cable, the jack reacting against the concrete structure. Then each tube **50** is filled with a grout or concrete mix, which is allowed to set and harden. Then the protruding ends of the cables are cut off. The order of post-tensioning and filling the tubes **50** with grout or concrete may be reversed. The tubes **50** can be filled with grout or concrete by forcing the wet mix into one end of each tube **50** until it comes out the other end. Alternatively, a filler tube **51** may connect to each tube

50 at its peak and the met mix filled through this tube, which will be cut off after the tubes **50** have been filled.

This technique of post-tensioning is advantageous for on-site jobs, where units **40** are made at the construction site and where the extra equipment used in the pre-tensioning technique is not available. Thus, all that is needed is a means of anchoring the form **10** and cast unit **40**, and a means such as a winch and pulleys, or a jack to post-tension the cables **31**.

Referring now to FIGURE 9, an inverted form is there shown which is generally designated by the reference number **55**. It comprises two sections **10***a* and **10***b* as in the case of the form **10** shown in FIGURE 1. However, the sections **10***a* and **10***b* form a valley with its low point at **18**. The numeral **56** indicates generally a framework or support for this form which may be a solid block or a wooden or steel framework such as that shown in FIGURE 1, suitably modified.

Bulkheads, filler strips and blocking members will be employed as in the case of form **10** in FIGURE 1. Also, cables will be located within the form as described above in connection with FIGURE 4 or FIGURE 5 and will be pre- or post-tensioned cables. Concrete will be poured commencing at the low point **18** and moving upwardly along each section **10***a* and **10***b*. The concrete will be screeded, levelled, allowed to set and harden and then removed from the mold. The resulting precast, prestressed concrete roof and wall unit will be identical with that shown in FIGURES 6, 7 and 8 except that the column and rafter elements will be on the outside of the unit rather than on the inside.

Referring now to FIGURE 10, an end elevational view of a prestressed, precast concrete unit **60** is there shown having a body portion **61** and a portion **62** constituting the column element of a wall section or the rafter element of a roof section. As will be seen, the portion **62** is formed with a longitudinal passage **63**. This structure will be made in the same way as the structure **40** shown in FIGURES 6, 7 and 8 except that the channel **19** of the form **10** will have a suitable blocking member located within it to block out a portion of the channel, such blocking member being removable when the concrete has set and hardened. Alternatively if the blocking member is hollow, it may remain in the finished concrete structure. The passageway **63** has the advantage that it lightens the weight of the finished product. Also, these passageways serve as ducts to carry piping, for flow of a heating or cooling fluid and for other purposes.

It will, therefore, be apparent that a novel and very useful structural shape has been provided consisting of an integral, precast and preferably prestressed concrete wall and roof section, and that a very novel and advantageous means of prefabricating such an article has been provided. The invention has been described in relation to wall and roof sections wherein the roof forms an obtuse angle with the wall. However, the invention can be applied to sections with a flat roof (90° to the wall) and it can also be applied to inverted V-shaped structures wherein the sloping wall sections are formed which come together at an acute angle. The technique has desirable features of adjustability. For example, a single form such as shown at **10** in FIGURE 1 can be adjusted for thicker and thinner slabs by adjusting the side walls **17**, for shorter or longer slabs by adjusting the bulkheads **25** and for deeper or shallower ribs by selection of filler strips **30**.

I claim:

1. A form for producing a monolithic precast concrete structure comprising

a pair of form sections,

each of said sections including a bottom surface sufficiently wide to form a building wall or roof section, upright walls secured along the sides of said surface to confine fluid concrete to the desired thickness of side wall or roof section, and a unitary channel

member depending from and opening into said bottom surface for formation of an integral reinforcing column or beam,

said sections being joined at adjacent ends with the bottom surfaces and the channels thereof disposed at relatively fixed angles to each other and to the horizontal for formation of a continuous wall and roof section with integral column and beams.

2. The form defined in claim 1 wherein

the channel depending from the bottom surfaces of each section is progressively deeper toward said adjacent ends.

3. In combination with the form defined in claim 1

spacer members insertable in said sections and adapted to support metal reinforcement members along the lengths of said sections.

4. The form defined in claim 1 including

members insertable in said sections to blank out wall or roof openings.

5. The open form defined by claim 1 including

a bulkhead for each section which is removable from and insertable in its respective section at a selected distance from said joint adjacent ends to conform generally to the cross section of said section at said elected distance.

6. The form of claim 1 wherein said sections diverge downwardly from said apex.

7. The form of claim 1 wherein said sections diverge upwardly from said apex.

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