

March 5, 1946.

A. HENDERSON

2,396,045

PRECAST REINFORCED CONCRETE MEMBER

Filed May 11, 1945

2 Sheets-Sheet 1

Fig. 1

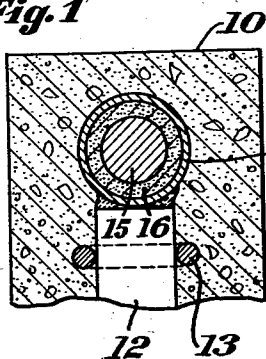


Fig. 2

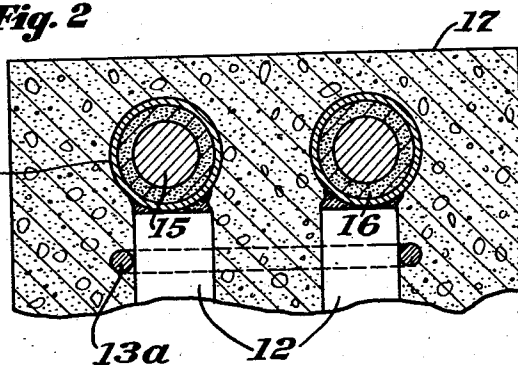


Fig. 3

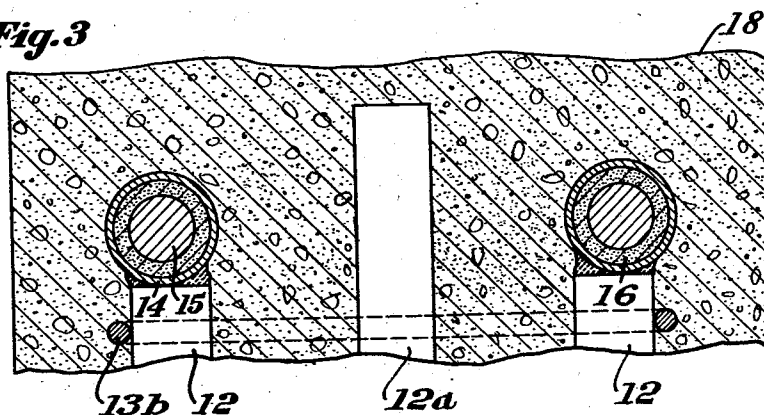
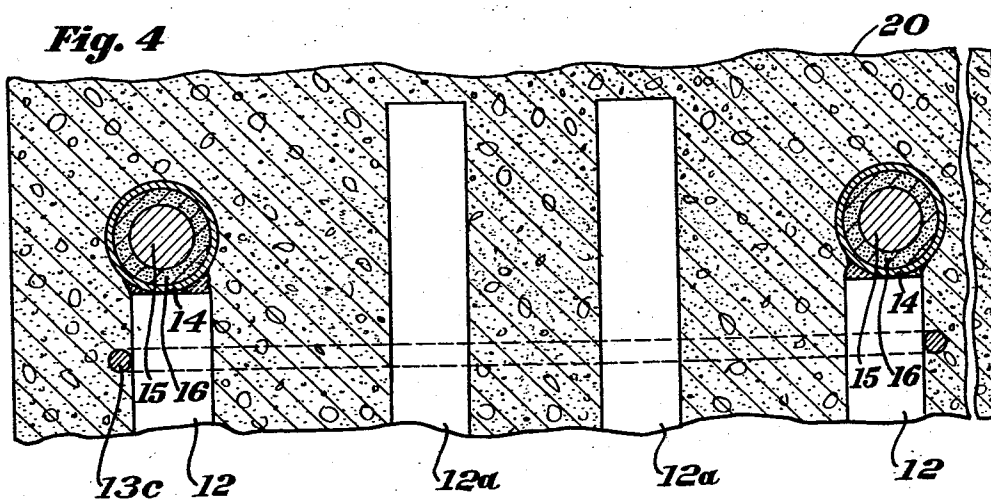


Fig. 4



INVENTOR

Albert Henderson

BY

Stebbins, Blanko & Webb

ATTORNEYS

March 5, 1946.

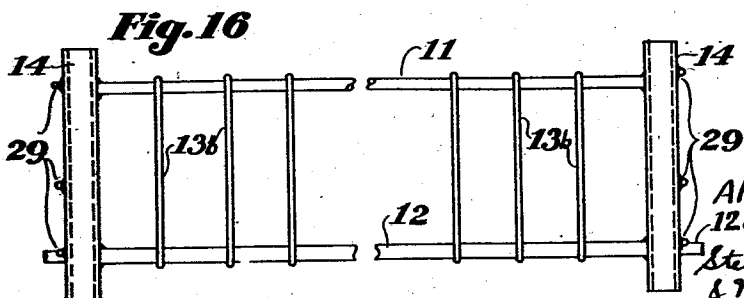
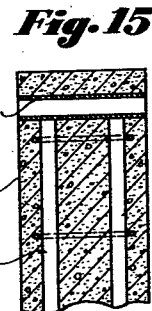
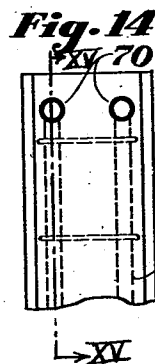
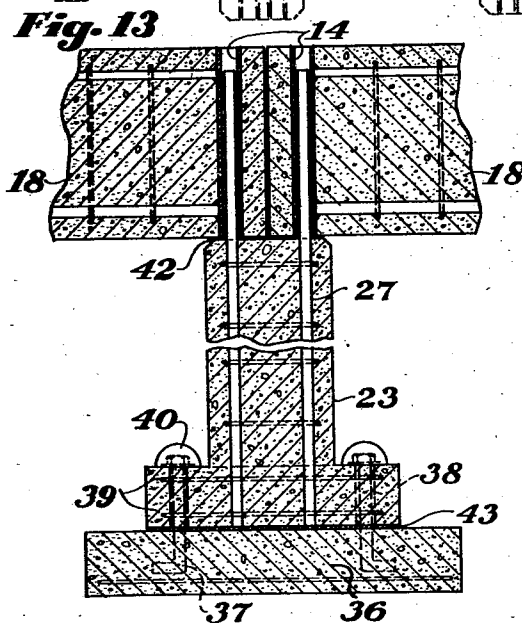
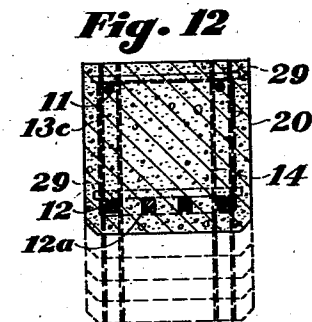
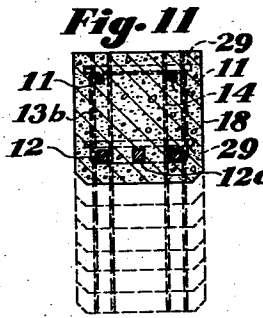
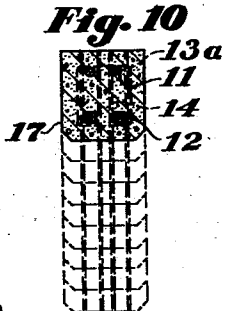
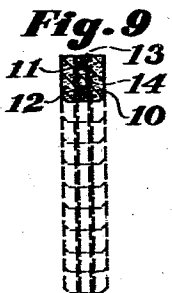
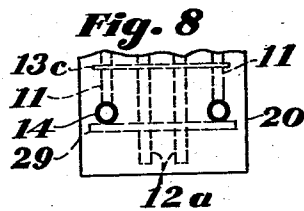
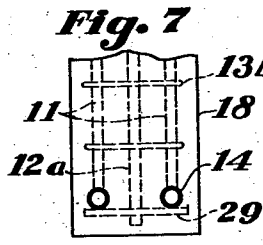
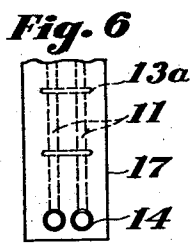
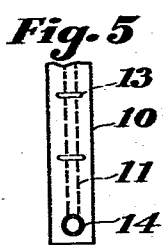
A. HENDERSON

2,396,045

PRECAST REINFORCED CONCRETE MEMBER

Filed May 11, 1945

2 Sheets-Sheet 2



INVENTOR

Albert Henderson

12a BY
Stebbins, Blenko
& Webb ATTORNEYS

UNITED STATES PATENT OFFICE

2,396,045

PRECAST REINFORCED CONCRETE MEMBER

Albert Henderson, Edgewood, Pa., assignor to
William P. Witherow, Pittsburgh, Pa.

Application May 11, 1945, Serial No. 593,220

9 Claims. (Cl. 72—71)

This invention relates to precast structural members of reinforced concrete and, in particular, to a simplified system of such members whereby many types of structures may be erected using a relatively small number of standard shapes.

This is in part a continuation of my application Serial No. 480,620 filed March 26, 1943, for Precast concrete building connections, which is a continuation-in-part of my prior applications Serial No. 432,209, filed February 25, 1942, for Precast concrete building and Serial No. 313,067, filed January 9, 1940, for Concrete building.

In order to make a system of precast structural members practical, satisfactory forms of connections between the various members are necessary. The lack of such connections is probably the reason for the relatively limited use of precast structural members heretofore. To meet this requirement, I embed lengths of metal pipe in certain of the members such as girders, beams, joists, and the like. The pipe lengths are welded to reinforcing rods embedded in the members, thus imparting the necessary rigidity to the connections. The pipe lengths may also have relatively short metal anchor rods welded thereto for embedding in the members, extending parallel to the longitudinal reinforcing rods therein. By thus welding the reinforcing rods and anchor rods to the pipe lengths, instead of relying on some other form of tie, such as looping the rods around the pipe lengths, I obtain an extremely rigid bond between the pipe lengths and the concrete and avoid any danger of cracking of the concrete adjacent the pipe lengths which would result in breaking the bond therebetween.

The importance of this feature is readily observed from the table of allowable stresses in concrete under shear in terms of percentages of the ultimate compressive strength (Building Regulations for Reinforced Concrete, American Concrete Institute, Detroit, Michigan, 1941) as follows:

	Per cent
1. Beams with no web reinforcement and without special anchorage of longitudinal steel.....	2
2. Beams with no web reinforcement but with special anchorage of longitudinal steel....	3
3. Beams with properly designed web reinforcement but without special anchorage of longitudinal steel.....	6
4. Beams with properly designed web reinforcement and with special anchorage of longitudinal steel.....	12

Members embodying my invention are in the last of the above groupings and thus have an allowable shear stress several times that of mem-

bers without anchorage of the longitudinal reinforcing rods.

The pipe lengths to which the rods are welded also afford means to position the rods accurately in the forms and maintain them rigidly in position while pouring concrete.

I preferably employ pipe of a convenient size, such as 1½", for embedding in the members to provide the necessary connections. The pipe lengths are preferably positioned in the members so that their centers are substantially 2½" from the nearest surface of the member, thus providing an adequate thickness of concrete to protect the pipe lengths from fire and corrosion.

The various types of members are made in several widths, each of which is an integral multiple of the width of the narrowest size. The member of the narrowest width has connections composed of one pipe length embedded therein. The members of greater widths have two pipe lengths embedded therein for each connection. The center-to-center spacing between the pipe lengths of the members other than the smallest, increases by a distance equal to the width of the latter. For example, if the width of the narrowest member of one type is 4", the next larger sizes are 8", 12" and 16". The 4" wide member has one pipe length embedded therein for each connection. The remaining members have two pipe lengths embedded therein for each connection. The center-to-center spacing of the pipe lengths in the 8" wide member is 3", in the 12" wide member 7" and in the 16" wide member 11".

The embedded pipe lengths permit adjacent members to be secured together by means of dowels embedded in one member and extending through a pipe length in the other. In some cases pipe lengths embedded in two or more members are disposed in alinement and a common bolt therethrough secures them together. In columns, the longitudinal reinforcing rods thereof project above the top of the column and pass through pipe lengths embedded in girders or beams supported thereon. The space between the rods and the interior of the pipe lengths is then filled with grout. It is important that the embedded pipe lengths have definite positions in the members with respect to the reinforcing rods thereof. The outermost longitudinal reinforcing rods in the girders and beams are substantially in alinement with the pipe lengths and the column-reinforcing rods are substantially in line with the voids left by the pipe lengths in the girders and beams. The spacing of the longitudinal reinforcing rods of the various members is also such as to permit a pipe length of the desired size, e. g., 1½" inside diameter and substantially 2" outside diameter to pass between them. This is particularly important when a column 8" wide supports a girder or beam 12"

wide, or a column 12" wide supports a girder or beam 16" wide. It is also important when brackets and splice plates are used. Furthermore, the spacing between the longitudinal rods should allow a 1½" nut to be welded to two parallel longitudinal reinforcing rods.

The various precast concrete members (i. e., columns, girders, beams, etc.) having widths of 4", 8", 12" and 16" are made in various depths differing by 2". This applies to all the various shapes and permits the use of metal stirrups of the same width for a given width of column, girder, beam, or the like. The stirrups used for the size of members next larger than the minimum width can be also applied to members of larger widths. For example, two stirrups may be used in the member 12" wide and three in the members 16" wide. I also use the stirrups to tie together the spaced pipe lengths in some shapes, such as brackets, splice plates, etc.

The member of minimum width 4", has one lower and one upper primary longitudinal reinforcing rod. The member of the next larger width, 8", has two similar rods, the 12" wide member three, and the 16" wide member four. This arrangement permits the rods nearest the side faces of the members substantially to abut the embedded pipe lengths and permits them to be welded thereto.

The widths of the various members (4", 8", 12" and 16") are integral multiples of the width of the smallest similar member and the widths and depths of the various members are appropriately related. Similarly, the depths of the various members vary by a predetermined increment.

The 4", 8", 12" and 16" wide members have 1, 2, 3 and 4 longitudinal reinforcing rods, respectively, embedded adjacent a face. These rods are so located that the rods of any member are substantially in line with the centers of the spaces between adjacent longitudinal reinforcing rods embedded in the next wider member. Furthermore, other spaced longitudinal reinforcing rods embedded adjacent a face opposite to that mentioned have their center to center spacing differing between successive sizes of members by an amount which is an integral multiple of the increment of the widths of said sizes. Also the longitudinal reinforcing rods adjacent the four corners of the members have their center to center spacing on the four sides of the members, differing by an integral multiple of the increment in the widths or depths of the members. That is, the reinforcing members in an opposite face have a difference in the center to center spacing from the other rod members which is an integral multiple of the difference in the widths or depths of the members.

The columns may have bases cast integral therewith, the width of the bases having a certain relation to the widths of the members. Similarly, the height of the bases is related to the height of some of the members. Anchor bolt holes are located in the bases on center-to-center spacings related to the spacing of the reinforcing rods of the members. Steel base plates may also be provided on concrete column shafts, their widths being related to the widths of the members and the anchor bolt holes being spaced in relation to the spacing of the longitudinal reinforcing rods of the members.

In all the members, the centers of the longitudinal reinforcing rods nearest the surfaces of the members are spaced substantially the same

distance therefrom, 2½". Where the connections involve bolts, the heads thereof or the nuts threaded thereon may be embedded below the surface of the members and then mortared over for protection against fire and corrosion. As an alternative, a precast concrete cover may be applied to the nut or bolt heads for protection. This is desirable when erection proceeds during cold weather to eliminate the freezing of mortar applied in the field.

Nuts or pipes embedded in some of the members for securing tie means have anchors also embedded in the members and welded to the nuts and pipes. The concrete bond to the anchors is strong enough to substantially resist the shear stresses of the tie means.

Further details, novel features and advantages of my invention will become apparent during the following complete description which refers to the accompanying drawings. In the drawings,

Figures 1 through 4 are partial sections taken longitudinally through the ends of members such as beams or girders of the several widths, normal to their depth and at the level of one of the reinforcing rods;

Figures 5 through 8 are partial plan views of the ends of members such as joists or beams;

Figures 9 through 12 are transverse sections therethrough;

Figure 13 is a sectional view showing a column supporting the ends of a pair of girders;

Figure 14 is an elevation of one end of a member;

Figure 15 is a section therethrough along the plane of line XV—XV of Figure 14; and

Figure 16 is an elevation of the assembly of reinforcing rods, stirrups and pipe lengths adapted to be embedded in a precast member.

Referring now in detail to the drawings, Figure 1 shows a precast concrete member 10, preferably 4" wide, which may be a post, girder, beam, joist or the like. If a beam, the member has upper and lower longitudinal reinforcing bars or rods 11 and 12 embedded therein with stirrups 13 extending around the rods, as shown in Figures 5 and 9. A pipe length 14 is embedded vertically in the member adjacent each end and is welded to the rods 11 and 12. The member 10 may conveniently be of any desired length and depth. The pipe length 14 preferably has an inside diameter of 1½" but in some cases smaller diameter pipe is used. The vertical hole through the member at each end provided by the embedded pipe length is adapted to receive a dowel 15 extending from another member, such as a column supporting the beam 10. The space between the dowel and the interior of the pipe is filled with grout or other bonding material 16, and a rigid permanent connection therebetween is thus obtained.

Figure 2 shows a member 17 similar to that of Figure 1 except that it is twice as wide, e. g., 8", and has two upper and two lower reinforcing rods around which stirrups 13a extend, and two pipe lengths embedded in each end. Corresponding parts are designated by the same numeral as in Figure 1. The pipe lengths are preferably positioned on centers 2½" inwardly from the side faces of the member and substantially 3" apart. The spacing of the reinforcing rods is preferably such as to permit a 1½" pipe to pass therebetween. Figures 6 and 10 further show the details of the member 17 when in the form of a beam.

Figure 3 shows the arrangement of the reinforcing rods and pipe lengths in a member 18,

three times as wide as the member 10 and having two or three upper and three lower reinforcing rods around which stirrups 13b extend. The pipe lengths 14 are positioned on centers $2\frac{1}{2}$ " from the side faces of the member as in the member 17 and substantially 7" apart. The middle rod 12a, as shown, projects beyond the pipe lengths 14.

Figure 4 shows a member 20 four times the width of the member 10, having two or more upper and four lower reinforcing rods around which stirrups 13c extend, and pipe lengths embedded therein. The pipe lengths, as in the members 10 and 17, have their centers spaced $2\frac{1}{2}$ " inwardly from the side faces of the member and 11" apart. They are welded to the outer reinforcing rods. It will be apparent from Figures 9 through 12 that the beams 10, 17, 18 and 20 may be of various depths, increasing by increments of 2", e. g., 4" x 4", 4" x 6", 4" x 8"; 8" x 8"; 8" x 10", 8" x 12"; 12" x 12", 12" x 14", 12" x 16"; 16" x 16", 16" x 18", 16" x 20" and so on. Crossbars 29 are embedded in the ends of beams 18 and 20 and are welded to the pipe lengths 14 and to the reinforcing rods between those adjacent the side faces. This firmly bonds the concrete at the end of the beam to the pipe lengths. The difference between the vertical spacing of the rods in successive sizes of members is a multiple of the difference between the depths of such sizes.

Figure 13 illustrates a column-and-girder connection and shows the column construction in somewhat greater detail. A column shown at 23 is secured to a field-cast footing 36. Anchor bolts 37 embedded therein project upwardly through the holes 26 in the column base which are formed by lengths 38 of 2" pipe embedded therein. The pipe lengths 38 are welded to stirrups 39 embedded in the column base. Protective covers 40 of reinforced concrete are applied to the nuts screwed onto the bolts 37.

As clearly shown in Figure 12, the pipe lengths 14 embedded in the ends of the beams 18 and welded to the upper and lower reinforcing rods 11 and 12 thereof are adapted to receive the ends of the reinforcing rods 27 projecting above the upper end of the column 23. A mat of asbestos 42 impregnated with cement in powder form when made, is wetted and disposed on top of the column before the beams 18 are placed thereon. The cement sets and forms a gasket with the asbestos mat insuring a good bearing for the beams on the column. Mats 42 are made in various sizes and punched with holes for the rods 27 to match the different sizes of columns. A layer of grout 43 is applied to the footing 36 before the column is set thereon.

Figures 14 and 15 show a column 69 similar to the column 23 except that the reinforcing rods 27 thereof terminate short of the upper end of the column and have transverse pipe lengths 70 welded thereto and embedded in the column. These pipe lengths are adapted to receive bolts for securing brackets coacting with members supported by the column. This form of connection is particularly suited for transmitting high compression loads to the column. A $1\frac{1}{2}$ " bolt extending through the pipe length 70, for example, would have a safe working load of 40,000 pounds in double shear. If the rods 27 are 1" square in section and the bond between them and the concrete has a working value of 250 pounds per square inch, each linear inch of reinforcing rod 27 would have a bond strength of 1,000 pounds

requiring 40" of length of reinforcing bars to transmit to the concrete forming the column the load imposed thereon. This type of connection is of advantage where the relatively low bearing value of the concrete itself would be a limitation. The bearing value of the embedded pipe lengths on the concrete is not considered.

Figure 16 shows the assembled pipe lengths, reinforcing rods and stirrups embedded in various types of members, ready to be disposed in the mold in which such members are cast. As there illustrated, the pipe lengths 14 welded to the upper and lower reinforcing rods 11 and 12 constitute a rigid truss, the reinforcing rods being stayed intermediate their ends by the stirrups 13. As previously mentioned, short crossbars 29 are welded to the pipe lengths to increase the bond with the concrete at the extreme ends of the members.

It will be apparent from the foregoing description and explanation that my invention provides a complete system of integrated reinforced concrete structural members of various dimensions, the several types of units having their reinforcing rods similarly disposed, in corresponding sizes, whereby connections between adjacent members may readily be established by means of the embedded pipe lengths welded to the reinforcing rods and dowels or bolts extending therethrough and into other members. I thus provide a system embodying a relatively few standard units, such as columns, girders, beams, and the like, which can be made in various sizes differing from each other by standard increments of width, thickness and depth. All these members may accordingly be cast in the same molds and stirrups of the same dimensions may be used with the reinforcing rods of various types of members in corresponding sizes.

The connections provided for securing adjacent members together may be easily made and provide a rigid anchorage of each member to the others. This results from the welding of the pipe lengths to the reinforcing rods and the filling of the space between the interior of the pipe lengths and dowels or bolts extending therethrough with grout, thereby preventing any looseness of shifting of the members. The connections between beams or girders and columns, furthermore, are adapted particularly for transmitting shear load directly to the column reinforcing rods.

The asbestos gasket disposed on top of the column or bracket before placing girders or beams thereon insures full bearing and uniform distribution of the load despite slight imperfections in the adjacent surfaces. The nut covers provide ample protection against fire and corrosion for the nuts and heads of the bolts used in the connection.

The spacing between centers of the reinforcing rods and also the embedded pipe lengths varies between the members of different widths by the same increments as the widths themselves. In all the members, the reinforcing rods and embedded pipe lengths have their centers spaced the same distances substantially from the adjacent surfaces of the members. This brings the reinforcing rods and embedded pipe lengths of meeting members in the same plane and makes for simplicity in the connections therebetween.

The total section of the reinforcing rods embedded in members of various widths also varies

as the widths themselves, i. e., a member 4" wide will have one tension reinforcing rod, a member 8" wide will have two, a member 12" wide will have three and a member 16" wide will have four. In the case of columns, only the outside rods would be used in most cases.

The use of 1½" pipe for the embedded pipe lengths permits the accommodation therein of rods of square section up to a maximum size of 1⅞" on a side. The actual inside diameter of 1½" pipe is practically 1⅝" and its outside diameter approximately 2". This permits 1½" bolts to be inserted through the pipe lengths for making connections although smaller bolts and pipes may be used where they have sufficient section to support the load applied. Smaller pipe may also be used in order to maintain the desired thickness of concrete around them in all directions. The space between the bolts and inside of the pipes may be filled with grout or the bolts may have a snug fit in the pipes. Other filling material may be used, such as sulphur or other molten material.

Although I have illustrated several preferred embodiments with modifications, it will be apparent that changes in the details disclosed herein may be made without departing from the spirit of the invention or the scope of the appended claims.

I claim:

1. A building construction comprising a plurality of precast reinforced concrete members including a first member having a tie means extending therefrom, a second member having embedded in the concrete thereof a frame comprising a longitudinally extending primary reinforcing bar substantially straight throughout its entire length and a transversely extending metal member welded to said reinforcing bar substantially at the end of said bar, the end face of said bar substantially abutting said metal member, said metal member having a bore therein receiving the said tie means from said first member when said members are in assembled positions.

2. A building construction comprising a plurality of precast reinforced concrete members including two spaced members each having tie means extending therefrom, and a third member having embedded in the concrete thereof a frame comprising a longitudinally extending reinforcing bar substantially straight throughout its entire length and spaced, transversely extending metal members, the extreme ends of said reinforcing bar abutting the opposed faces of said spaced metal members, said metal members each having a bore therein receiving the said tie means extending from said two spaced members when said members are in assembled positions.

3. A building construction as defined by claim 2 characterized by said frame including a second

longitudinally extending bar spaced from said first mentioned bar and secured to said spaced metal members.

4. A building construction comprising a plurality of precast reinforced concrete members including two spaced support members each having a tie means extending therefrom, and a beam member having embedded in the concrete thereof a rigid truss comprising at least two lower spaced longitudinally extending reinforcing bars, at least two upper spaced longitudinally extending reinforcing bars substantially in vertical alignment with said lower bars, a pair of transversely-extending, spaced metal members at each end of said truss welded to the ends of pairs of vertically aligned bars, crossbars welded to each pair of said metal members, each of said metal members having a bore therein receiving the tie means extending from one of the spaced support members when the members are in assembled positions.

5. A building construction as defined by claim 4 characterized by an additional reinforcing bar projecting beyond said metal member and welded to one of said crossbars.

6. A building construction as defined by claim 2 characterized by the ends of the reinforcing bar abutting said metal members being welded thereto.

7. A reinforced precast concrete structural unit adapted to serve as a beam or the like, comprising an elongated mass of concrete polygonal in cross-section, at least one metal member having a bore therein embedded in said mass adjacent each end thereof but spaced inwardly from the ends, and at least one longitudinal reinforcing bar embedded in said mass adjacent to but spaced inwardly from a side face thereof, said metal members being substantially in alignment with said bar and at right angles thereto, and the ends of said bar abutting said metal members and being welded thereto.

8. A reinforced precast concrete structural unit adapted to serve as a beam or the like, comprising an elongated mass of concrete polygonal in cross-section, and a frame embedded therein including spaced parallel longitudinal upper and lower reinforcing bars for said unit and pipe lengths normal to said bars, in alignment therewith and welded to the ends of said bars, said bars being sufficiently shorter than the unit so that said pipe lengths may be located adjacent the ends of the unit but spaced inwardly of the ends of the unit.

9. A structural unit as defined by claim 8 characterized by said frame including at least two pipe lengths at each end of the unit, and cross bars normal to the pipe lengths and welded thereto.

ALBERT HENDERSON.