PRESTRESSED CONCRETE FLOOR, ROOF AND LIKE STRUCTURES

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PRESTRESSED CONCRETE FLOOR, ROOF AND LIKE STRUCTURES


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This invention relates to concrete floor, roof and like structures of the kind comprising an assembly of intersecting primary and secondary concrete beams and has for its object to provide an improved floor or roof structure of this kind which employs prestressed primary and secondary beams which are assembled in such a manner that the beams covering any particular area must act and deflect in conjunction with each other so as to increase the bearing capacity, or alternatively, enable the primary beams to be made of lighter construction by reason of the load bearing contributions made by the secondary beams.

Broadly, according to the present invention, there is provided a method of assembling or constructing a floor roof or the like structure which consists firstly in erecting prestressed primary beams in position and thereafter fitting between the primary beams elements which co-act with parts of the primary beams to form secondary beams which are prestressed after they have been placed in position between the primary beams.

The primary beams provided by this invention for carrying the foregoing method into effect each comprise upper and lower beams which are spaced apart and located in the same vertical plane and which are bridged by vertically disposed members spaced apart along the length of the primary beam which also form parts of the secondary beams which are disposed at right angles to the primary beams.

The rectangular spaces or panels defined by the top and bottom beams and the vertical members are each divided into two triangles by a diagonal member which is directed so as to act in conjunction with the vertical members of that panel to withstand the shear forces set up by the loads, the bending moment imposed by the load borne by the beam being counteracted by changes in the longitudinal forces acting along the top and bottom beams.

The primary beams consist of a number of pre-cast concrete units and channels or holes are provided in the bottom beams for the reception of high tensile wires which extend from end to end of each beam. Each top and bottom beam comprises a number of sections arranged in line. When the units forming each primary beam are assembled and the wires have been inserted, the latter are stretched and anchored at their ends and a prestressed concrete lattice girder is formed.

The primary prestressed concrete beams of the floor, roof or like structure are first of all erected in position parallel one to another and spaced at predetermined distances apart and spanning the breadth of the structure, and after this has been done elements are assembled between and in the same plane as the primary beams which extend at right angles to the primary beams and which co-act with the vertical members of the primary beams to form secondary beams.

Each secondary beam comprises between each of two primary beams an upper boom section and a lower boom section and a diagonal member and the ends of the top and bottom boom sections abut against the upper and lower ends of the vertical members, it being understood that said sections between the primary beams are arranged in line for each secondary beam.

High tensile wires are then introduced through or along the bottom boom sections of the secondary beams and also through the lower ends of the vertical members and the wires are stretched and anchored at their ends when the secondary beams are then actually brought into being.

Preferably the bottom boom sections of the secondary beams are provided with channels for the reception of high tensile prestressing wires which after tensioning remain in contact with the side of the channels. The said channels may be provided in the bottom face of the lower boom sections of the secondary beam in which case threading of the prestressing wires through holes in the primary beam will be avoided and such channels may thereafter be filled with protective material.

By this means a range of floors, roofs and like structures of widely differing shapes, lengths, and breadths may be constructed from a series of standard elements.

If, however, the wires in the secondary beams are tensioned in the normal manner after the secondary beams have been fully constituted, the effective line of thrust will not coincide with the line of the wires unless these wires lie along the neutral axis of the secondary beams. This is for the following reason. If the wires are eccentric they will tend to bend the secondary beams. The secondary beams, however, are restrained from bending by the effect of the primary beams and are not able to take up the profile which they would if they were freely supported; in consequence, the tension in the wires sets up hyperstatic reactions between the primary and secondary beams which modified the statical equilibrium of each. The magnitude of these reactions varies for different proportions of floor, roofs and like structures and they are only rarely advantageous to the load-bearing capacity of the structure.

There are several solutions to this problem. In the first place, the wires may be so arranged that the resultant of the force they exert passes along the neutral axis of the secondary beams. This is wasteful in steel. In the second place, they may be arranged to be curved in elevation following a profile calculated to avoid producing hyperstatic reactions between primary and secondary beams. This solution is avoided because it leads to different cable curves for every secondary beam in any one floor and completely different sets of curves for different arrangements of spans. In the third place, this is the method proposed here, the secondary beams may be so constituted that the force of the wires acts on the lower beam only, thus avoiding any bending effects and producing simple compression on these members.

This is done in the following manner. Either the lower beam alone is fitted between the primary beams or the complete secondary beam element is fitted and only the joint between the lower beam is filled. Thus when the wires are tensioned they produce simple compression of the lower beam and no bending at all. The primary beams are sufficiently flexible transversely to allow this compression to take place. The lower beams having been stressed the remainder of the beam is duly constituted either by placing and jointing the remaining members or by placing the top joint of the one-piece secondary beam element. The deck elements are then placed in position. Alternatively, the joints in the upper beam may be left open until the deck elements are placed in which case the whole of the weight of the structure is carried on the primary beams acting in a simply-supported manner,
and the primary and secondary beams act together as a monolithic whole only under live loads.

Thus, the finishing supporting framework for the floor, roof or like structure can be said to comprise primary and secondary beams which are generally similar in construction, with the vertical members or pillars at the points of intersection constituting parts of both beams.

Assuming, for the purpose of explanation, that each primary beam of a structure is intersected along its length by say seven secondary beams and that a primary beam is subjected to load, then the deflection of the primary beam would be resisted at five points (excluding those at the abutments, e.g. walls or stanchions, at the two ends of the beam) and the primary beam is therefore reinforced by these resistances and its bearing capacity thereby increased.

Thus, both primary and secondary beams deflect together and in so deflecting set up bending moments in themselves. Because of this, the primary beams may, if desired, be made of tighter construction for a specified load by reason of the contributions made by the secondary beams.

The pre-cast concrete pieces which are assembled together to form both the primary and secondary beams may, if desired, be made to interlock or interengage with one another to facilitate assembly.

End sections of the lower booms of both primary and secondary beams may be inclined upwardly towards the end sections of the top beams and the prestressing wires extending through these inclined sections are preferably chamfered to correspond with the chamfered upper boom member of the primary beam. This slab is preferably chamfered to correspond with the chamfered upper boom member of the primary beam. This slab is preferably chamfered at the chamfered upper boom member of the primary beam to provide an extra reserve of strength against isolated point loads.

The invention will be further described with reference to the accompanying drawings which are included merely by way of example and in which Figure 1 is a perspective view showing an assembly of intersecting primary and secondary beams. Figures 2, 3 and 4 are a side view and an end elevation and section respectively of a primary beam element. Figures 5 and 6 are respectively a side view and a section of a secondary beam element, and Figures 7 and 8 are respectively an inverted plan view and a section of a deck element according to the invention.

Referring now to the drawings, but first more particularly to Figure 1.

1 designates generally a primary beam element and 2 designates generally a secondary beam element, 3 being a primary beam end unit and 4 a secondary beam end unit.

Each primary beam element is preferably precast concrete structure and, as more clearly shown in Figures 2, 3 and 4, comprises an upper beam member 5 and a lower beam member 6 spaced apart by vertical members 7 and 8 defining a rectangular space which is divided into two by a diagonal member 9. Advantageously the lower beam member is provided with channels 10 and 11 for the reception of high tensile wires 24 the arrangement being such that after assembly of the primary beam which is made up from a number of elements arranged end to end the high tensile wires after insertion in the channels provided for the purpose are stretched and anchored at their ends to form a prestressed lattice girder.

Each secondary beam element as more clearly shown in Figures 5 and 6 comprises an upper beam section 12 and a lower beam section 13 spaced apart by vertical members 14 and 15 defining a rectangular space which is divided into two by a diagonal member 16 the lower beam member 13 being provided with channels 17 and 18 for the reception of high tensile wires which are introduced into the channels after the secondary beams, which are assembled from a number of secondary beam elements, are placed in position at right angles to and co-acting with the primary beams, such high tensile wires being stretched and anchored at their ends.

The deck elements as illustrated in Figures 7 and 8 consist of a thin square slab 20 of plane upper surface but thinner in the middle 21 than at the edges 22 and 23 thus constituting a shallow dome. The edges of the said slab are preferably chamfered to correspond with the chamfered upper boom member 5 of the primary beam. This slab provides on all sides on the upper booms of the primary and secondary beams, grout to render them monolithic. Thus slab and compression beams work together. A slab applied to the floor, bending in both primary and secondary beams is created, leading compression in the top members of both and causing in its turn compression in two directions in the slab. Now compression in the slab in the direction of the primary beams will bind the slab more tightly to the top boom of the secondary beam and therefore provide the support basis as in the manner of jack arch, but also creates a two way compression in the slab by the overall two way bending of the beam assembly. A certain compression of this type is created by the load of the finishing surface of the floor which applies a permanent two-way compression in the slabs and provides with them an extra reserve of strength against isolated point loads.

What we claim is:

1. The method of constructing a prestressed concrete giraffe which comprises placing a series of primary beams in spaced parallel relationship, placing a series of secondary beams at right angles to the primary beams and in spaced parallel relationship with each other and with the secondary beams in abutting relationship with portions of the primary beams, joining by grouting the abutting portions of the primary and secondary beams, providing a series of secondary beams along the lower portions thereof, and then joining by grouting the upper portions of the primary and secondary beams.

2. The method of constructing a prestressed concrete giraffe which comprises joining a plurality of elongate members and prestressing the same in lowermost regions thereof to form a series of primary beams placing such primary beams in spaced parallel relationship, placing a series of secondary beams at right angles and in abutting relationship with said primary beams and with the secondary beams being disposed in spaced parallel relationship, joining by grouting the uppermost portions of the secondary beams with the abutting portions of the primary beams, prestressing the secondary beams longitudinally thereof and in the lowermost regions thereof, and then joining by grouting the uppermost portions of the secondary beams with the primary beams.

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