Paper Tube Assembly for Concrete Construction

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This invention relates to concrete construction and to means for forming concrete structures.

A characteristic feature of structural concrete work is the various forming means which are used essentially as a mold to receive poured concrete and contain it in a desired shape until it has set. Form work is not only arranged exteriorly for this purpose, but interior forming is also frequently employed; in some cases to form functional internal cavities, such as the conduit ways in concrete sewer pipe and the like, and in others to form spaced voids in order to lighten the structure and use the concrete with economy.

In prior concrete constructions, hollow terra cotta tile has frequently been used for producing voids in the poured concrete. Another well known method of construction involves the use of metal pans which are arranged to support the poured concrete and then removed after the concrete is set. These and other forming means heretofore employed have the objection of being relatively expensive and involving substantial labor costs incident to their use.

To overcome these objections it has been proposed to employ paper tubes or parts of tubes as forming means. The buoyancy of these light paper tubes causes them to "float" or move around during the pouring of the concrete and the important commercial problem of holding these tubes in place, so as to make practical their intended use, has arisen.

In accordance with my present invention, I have discovered and developed an arrangement for positioning the paper tubes and holding them in the desired location or locations while the concrete structure is being formed. My arrangement comprises end plates or other similar terminal members adapted to prevent endwise movement of the paper tubes, transverse spacing members arranged to position the paper tubes laterally, and a plurality of rods or similar elongated members for connecting and aligning the end plates and spacer plates and housing therebetween the paper tube or tubes. The end plates and spacer plates, and the connecting rod members, may be made of paper if desired, or they may be made of other suitable materials, such as wood or metal.

One of the features of my invention is the provision of the housing arrangement above described for holding the paper tubes in place and for providing at the same time steel reinforcement for reinforcing the concrete construction. This reinforcement may consist wholly or in part of the end plates, spacer plates, and connecting rod members mentioned above made of steel or other suitable metal. Thus, in this instance, my arrangement would perform the dual function of holding the tubes in place and providing some or all of the required steel reinforcement for the concrete construction. Where long lengths of tubes are used additional spacer plates may also be provided to support the tubes as required.

Further details of the assembly characteristic of my invention are described in conjunction with the illustrations of the accompanying drawing, in which:

Fig. 1 is a side elevation of a paper tube assembly arranged according to my invention;

Fig. 2 is a corresponding section on the line 2—2 of Fig. 1;

Fig. 3 is a fragmentary view in perspective illustrating a method of grouping the tube assemblies;

Fig. 4 is an illustration in section of the application of my invention in the construction of reinforced concrete floors;

Figs. 5, 6, 7 and 8 are plan views showing various alternative forms of end plates and spacer plates; and,

Fig. 9 is an illustration in section of the application of my invention in the construction of sewer pipes and the like.

As illustrated in Figs. 1 and 2 of the drawing, my paper tube assembly comprises a cylindrical paper tube 10 which is fitted with end caps 11, and is supported by transverse spacing members or spacer plates 12 and contained against endwise movement by terminal members or end plates 13, both the spacer plates 12 and end plates 13 being aligned on rod members 14.

The paper tube 10 may be made up from various types of paper, such as 0.010" kraft paper plies; and it may be of either spiral or convolute construction, or it might be formed in some other manner such as by extrusion. Particular features such as length, diameter, wall thickness, water resistance, etc., may be varied over a wide range to adapt the tube assemblies for use in a variety of concrete structures, as will appear more fully below.

The end caps 11 are preferably of a one-piece drawn body type and they may be made from grades of paper similar to those employed for the paper tube 10, although usually the construction need not be as sturdy as that of the tube. These end caps are designed as end closures to prevent the concrete from entering the tubes and to supplement the forming function performed by the tube. They will be protected from excessive loads in most instances by the end plates 13.
The spacer plates are essentially annular in form, the inner diameter being selected to fit easily over the tube and the outer profile being formed with projecting flanges in which suitable openings are provided for receiving the rods. The end plates are conveniently made in a corresponding form but without a central opening, the body of the end plates being designed to prevent endwise movement of the tube, as heretofore mentioned.

For certain applications, the spacer plate, the end plate, and the rods may also be made up from paper stock, it being understood of course that the common rod may be sufficiently body to provide adequate functional strength. Tube assemblies made entirely of paper may be used to good advantage, for instance, where it is desired to form a system of interior voids in structures of relatively light construction, such as prefabricated concrete slabs and the like. For this purpose, the tube assemblies may be readily arranged inside the exterior form work, according to the system of voids desired, either individually or in interlocked groups as described below. By proporcioning the spacer plates and end plates so as to position the tubes in proper relation to the outer surfaces of the structure to be formed, it is possible to dispose the assemblies properly by merely laying them inside the exterior form work provided for the structure. This is particularly true of heavier constructions in which metal spacer plates and end plates, and rods of standard reinforcing steel are employed, as mentioned below, to meet increased strength requirements. For constructions of intermediate weight, the spacer plates and end plates, and especially the rods may be satisfactorily formed of other materials, such as wood.

As illustrated in the drawing, the spacer plates and end plates are arranged for association with four rods. Although it will be apparent that a lesser or greater number of rods might otherwise be used under particular circumstances, a specific advantage of the arrangement employing four rods is the ease with which such an assembly adapts itself for grouping in the manner illustrated in Fig. 3. According to the arrangement in Fig. 3, the respective spacer plates and end plates of adjacent tube assemblies are aligned on common rods so that the spacer plates and end plates of each assembly are interlocked with those of each adjacent assembly, and the individual assemblies may thus be integrated in groups of varying size.

A particular application to which the grouping of tube assemblies in this manner readily lends itself is in the construction of reinforced concrete floors as illustrated in Fig. 4. It will be recognized that the arrangement shown in Fig. 4 is effectively similar to the widely used type of reinforced concrete floor construction mentioned above in which terra cotta tile or the like is arranged in spaced rows with reinforcing steel disposed in the intervening spaces so that when the concrete is poured it will form around the terra cotta tile in what amounts to a series of reinforced T-beams.

The paper tube assemblies of my invention provide substantial advantages when employed in construction of this type. A principal advantage is the ease and facility with which the assemblies may be positioned to serve as forming. Also, the manner in which the assemblies are constituted affords a practical and simple means for utilizing conventional steel reinforcing as a part of the assembly, and thus considerably simplifies the problem of locating the reinforcing and holding it in place while the concrete is poured.

The sectional view of Fig. 4 illustrates the disposition of the tube assemblies in the finished structure of a reinforced concrete floor. As shown, concrete is poured around the form work provided by tube assemblies aligned in interlocking relation according to the arrangement described in connection with Fig. 3. In this manner, the concrete between the tubes to form the usual joint-like structure reinforced as heretofore mentioned with standard reinforcing steel included in the tube assemblies as rods. The proportions for the tube assembly, that is, the diameter of the tubes, the spacing between tubes and so forth, will of course depend on the design characteristics of the particular floor construction desired, but it is apparent that such proportions may be readily selected in accordance with considerations which are well known and need not be applied in the design of concrete structures.

An important feature of my tube assemblies is the cylindrical form of the tubes, which takes advantage of the familiar strength increments of layers obtainable with round or spherical objects. This feature renders the strength factor of tubes having wall thicknesses, adequate to withstand the pressures encountered in forming concrete. The tubes should also possess sufficient water resistance, either inherently or by virtue of supplementary treatment, to obviate softening through absorption of moisture from the concrete.

Where, as in the instance just described, the rods consist of standard reinforcing steel, it will usually be more satisfactory to employ metal spacer plates and end plates. And when this is so, it may also be desirable, in order to obtain more uniform weight distribution, to form the end plates so that their weight substantially corresponds with that of the spacer plates. Two arrangements are shown in Fig. 5 and Fig. 6, respectively, by which this result may be accomplished. In Fig. 5 the end plate is formed with a plurality of perforations arranged throughout the body of the end plate to reduce its weight accordingly. Such a design has the advantage of maintaining a substantial outline for the spacer plates and end plates. The alternative design of end plate shown in Fig. 6 employs an arrangement of substantially larger projecting portions surrounding a relatively small central portion, which may also have a small central opening. The advantage of a design of this sort is that it would allow manufacture with a greater economy of material.

A further modification which may be employed advantageously when rods of standard reinforcing steel are used is a system of open-ended slots arranged to facilitate the assembly of the rods with metal spacer plates and end plates. Two arrangements of this sort are illustrated in Fig. 6 and Fig. 7. The open-ended slots in Fig. 6 are formed so as to be at angles to the diagonal axes of the end plate (or spacer plates 2—not illustrated). The bottom portion 23 of the slots 22 occupies the same relative position as the previously mentioned openings 19 which are otherwise used to receive the
rods 14. The advantage of a slot arrangement such as is shown in Fig. 6 is that it eliminates the necessity of threading the rods 14, so to speak, through the end plates 12 and end plates 13. The slots 22 make it possible to position the rods 14 by merely laying them in place. Moreover, the particular construction of the slots 22 forms an outer lip 24 which may be easily bent over with a hammer or other convenient tool to clinch the rods 14 securely. The alternative arrangement shown in Fig. 7 in relation to a spacer plate 12, differs mainly in that the slots 25 in this case open outwardly on the diagonal side of the spacer plate 12 (or end plate 13—not illustrated). This construction forms two lips 25 for each slot 25 so that a double clinch may be made on the rods 14. The added strength of an arrangement of this sort is desirable in heavy construction when reinforcing steel of relatively large diameter is used.

An additional feature of my paper tube assemblies is the transverse reinforcing effect that may be obtained when the assemblies are arranged in interlocked relation as described in connection with the paper tube in a concrete pipe (indicated at 22 and end plates 13 used in such an arrangement, they form effective transverse reinforcement which may be readily employed according to the requirements for such reinforcement in concrete floor slab construction. The reinforcing effect of the spacer plates 12 and end plates 13 may be further enhanced when desired by providing them with surface corrugations or extrusions, or the like (not shown).

The manner of utilizing the rods 14 and the spacer plates 12 and end plates 13 for reinforcing as well as for positioning the paper tube assemblies of my invention as forming means will of course require some adaptation in relation to the reinforcement requirements of various types of construction. And in this connection it will be noted that the amount of transverse reinforcement can be adjusted within wide limits by varying the number of spacer plates 12 used for each tube 10. The transverse reinforcing effect can also be adjusted by varying the weight of stock from which the spacer plates 12 and end plates 13 are made up, or by forming the plates with an irregular surface configuration as suggested above. Likewise, the amount of longitudinal reinforcing may be similarly adjusted by varying the size of reinforcing steel used, or by increasing the number of openings 16 in the spacer plates 12 and end plates 13 so that additional reinforcing steel can be accommodated.

One arrangement for accommodating an increased amount of longitudinal reinforcing steel is illustrated in Fig. 8, which shows an annular-shaped spacer plate 27 having a series of openings 28 spaced around the annular body of the plate 27. Spacer plates of this sort are particularly adapted for use in the construction of hollow concrete columns. For this purpose an assembly of the general type illustrated in Fig. 1, but equipped with spacer plates 27 and end plates (not shown) of corresponding form, is disposed vertically as an interior form for the hollow core of the column. The openings 28 in the spacer plates 27 and corresponding end plates (not shown) allow the requisite amount of reinforcing steel to be employed as a part of the forming assembly. It will also be apparent that spacer plates of the type shown in Fig. 8 might at times be used to advantage in construction such as is illustrated in Fig. 9.

Fig. 9 shows the manner in which my paper tube assemblies may be employed in the construction of concrete sewer pipe. The arrangement in this instance differs mainly in that the tubes 10 are joined in endwise relation by end closures consisting of connector sleeves 25 so as to provide the forming means for a continuous conduit way. The assembly is completed by spacer plates 12 and rods 14. The application of my invention has several distinct advantages. It is possible, for instance, to form sewer pipe by merely placing my tube assemblies in an appropriately prepared ditch and then filling the ditch with concrete (indicated at 30) to a satisfactory level. Also, my tube assemblies are well adapted, as previously noted, for utilizing reinforcing steel as rods 14 when reinforcement is required. A further feature of this application of my invention is the manner in which advantage is taken of the strengthening effect of a cradling bed of concrete. It is known that the strength of the usual type of sewer pipe in withstanding the load imposed by the covering fill (indicated in Fig. 9 at $1$) is substantially increased by supporting the pipe in a cradle. By positioning my tube assemblies to space them according to the bottom of the ditch in which the pipe is to be formed an effective cradle is provided as the concrete is poured around the tube assemblies to form the sewer conduit way.

I claim:

1. A forming means for concrete structures comprising a cylindrical paper tube adapted to support freshly poured concrete, end closures on said paper tube, transverse spacing members fitted externally and at intervals longitudinally of said paper tube to prevent lateral displacement of said tube, terminal spacing members disposed across the ends of said paper tube to contain said paper tube against endwise movement, and rod members disposed in spaced parallel and longitudinal relation to said paper tube in aligning engagement with said spacing members and said terminal members, said aligned rod members and spacing members forming a housing adapted to position said paper tube during a forming operation.

2. The forming means defined in claim 1 further characterized in that the rod members are steel reinforcing rods.

3. A forming means for concrete structures comprising a plurality of cylindrical paper tubes arranged in spaced side-by-side relation and adapted to support freshly poured concrete, end closures on said paper tubes, transverse spacing members fitted externally on each of said paper tubes to prevent lateral displacement of said tubes, terminal members disposed across the ends of said paper tubes to contain said paper tubes against endwise movement, and rod members disposed in spaced parallel and longitudinal relation to said paper tubes in aligning engagement with said spacing members and terminal members, the spacing members and terminal members being aligned between adjacent paper tubes on common rod members in interlocked relation.

4. The forming means defined in claim 3 further characterized in that the rod members are steel reinforcing rods.

5. In form work for concrete structures, the combination which comprises a plurality of cylindrical paper tubes adapted to support freshly poured concrete, end closures on said paper tubes, transverse spacing members fitted externally on
said paper tubes to prevent lateral displacement of said tubes, terminal members disposed across the ends of said paper tubes to contain said paper tubes against endwise movement, and rod members disposed in spaced parallel and longitudinal relation to said paper tubes in aligning engagement with said spacing members and terminal members, said paper tubes being arranged in spaced side-by-side relation by aligning the spacing members of adjacent paper tubes on common rod members in interlocked relation.

6. The combination defined in claim 5 further characterized in that the rod members are steel reinforcing rods.

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