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PROCESS OF MAKING ELONGATED STRESSED CONCRETE STRUCTURES

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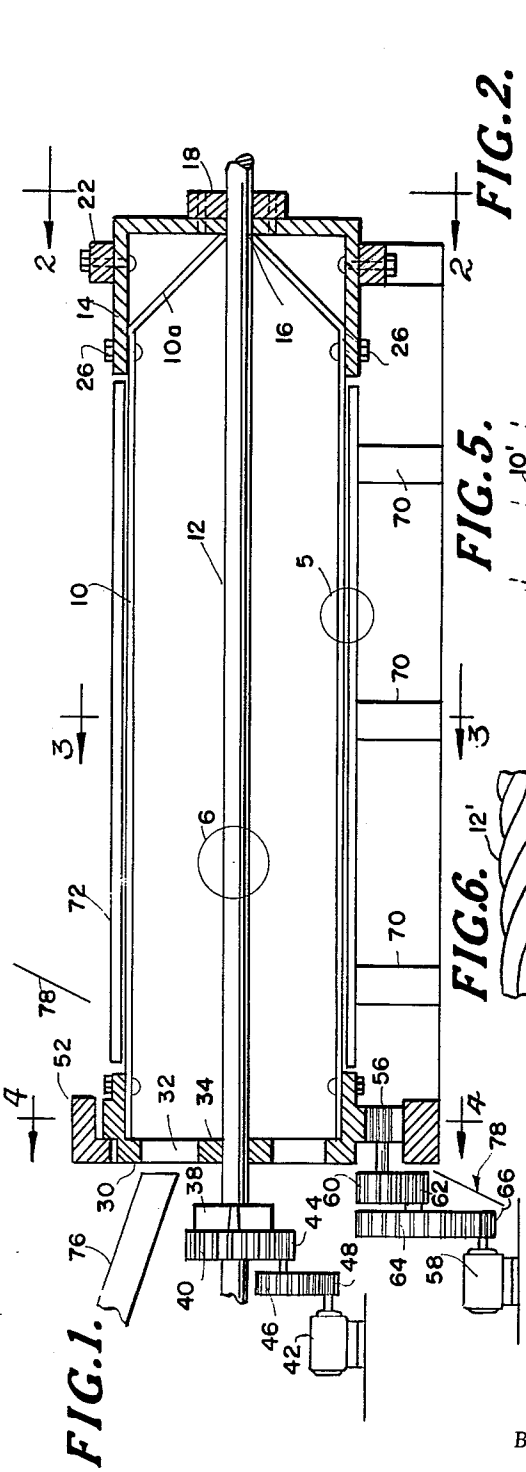


FIG. 1.

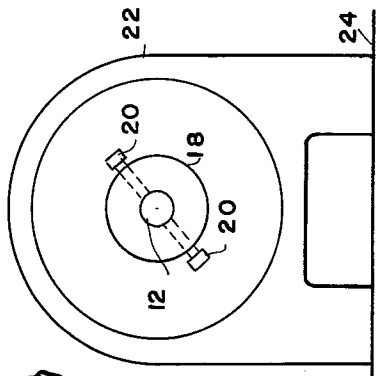


FIG. 2.

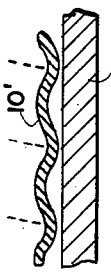


FIG. 5.

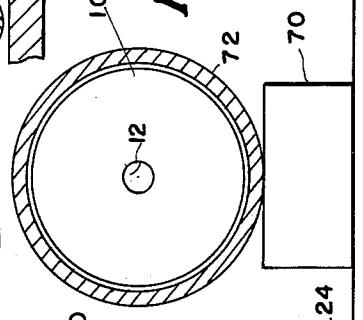


FIG. 3.



FIG. 6.

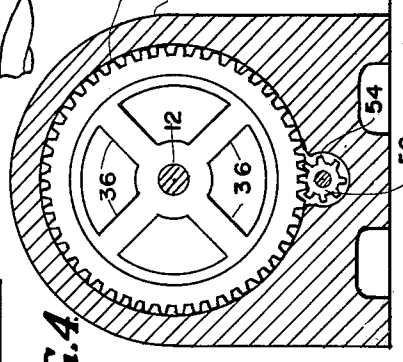


FIG. 4.

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PROCESS OF MAKING ELONGATED STRESSED CONCRETE STRUCTURES

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This invention pertains to structures such as beams or piles made of concrete in which certain stresses are established apart from the stresses incident to use. In common parlance, the invention relates to "pre-stressing" concrete structures.

In accordance with the invention it is contemplated to pour concrete within the confines of a surrounding shell member such as an elongated cylinder, and with a strand member running lengthwise through the shell member and therefore embedded in the concrete, this combination characterized by imparting compressional forces in a radial direction between the shell on the outside, and the strand member on the inside. This establishment of radial stress contributes to the strength of the resulting concrete structure, whether it be used as a beam, or as a pile, or some other purpose. For convenience, but without limitation, this description will proceed with the invention applied to a cylindrical concrete pile, for driving into the ground for the usual purposes of supporting buildings and other structures.

In accordance with the invention, rotational or torsional force or twist is imparted to the central strand, or to the shell, or to both, so as to contract the cross-sectional area of the strand, or expand the cross-sectional area of the shell, prior to the hardening of concrete poured into the shell. At a predetermined point in the hardening process, which may include the time when the concrete has set to its ultimate limit, the torsional force is relieved. The result is that the strand member will tend to increase the cross-sectional area, or, if acted upon, the shell will tend to decrease in cross-sectional area, with the result that compressional forces are established in the intervening concrete. The invention thus states a method of forming concrete structures, as well as the product of the method.

Further objects and the entire scope of the invention may be best understood with the aid of illustrative embodiments, now to be described.

The illustrative embodiments may be best understood with reference to the accompanying drawings, wherein:

FIGURE 1 shows a diagrammatic side elevational view partly in section of respective equipment for carrying out the method and producing the structures.

FIGURE 2 is an end view taken substantially along the line 2—2 of FIGURE 1.

FIGURE 3 is an elevational cross-sectional view taken substantially along the line 3—3 of FIGURE 1.

FIGURE 4 is an elevational cross-sectional view taken substantially along the line 4—4 of FIGURE 1.

FIGURE 5 is a fragmentary cross-sectional view of a modification of structure which may be used in FIGURE 1, and the location of FIGURE 5 may be within the circle designated 5 in FIGURE 1, and

FIGURE 6 shows a modification of the central strand member, and may be considered an equivalent to the central strand member as shown within the circle designated in FIGURE 1.

In the respective figures reference character 10 designates a cylindrical metallic shell inside into which concrete is to be poured and permitted to harden. The shell member 10 being intended for a pile, it terminates at its right-hand end as viewed in FIGURE 1 in a conical

or pointed portion 10*a*. Extending centrally and coincident with the axis of shell member 10, is a strand member 6, which may also be of metal, and therefore have some resiliency. In the general case this may be of any cross-sectional configuration, and in one case, to be mentioned more fully hereinbelow, it may be a multiple strand 12, twisted cable.

Removably affixed to shell member 10 near its right-hand pointed end as shown in FIGURE 1, is a first torsion cap member 14, this member having a central opening 16 through which strand member 12 may pass. Member 14 has affixed thereto a clamping device of any suitable form designated 18 for the purpose of fixing the strand member 12 to the cap member 14 so that one will not rotate with respect to the other. For this purpose, as best shown in FIGURE 2, some convenient means, such as set screws 20, may be employed for fixing strand member 12 to the cap member 14.

Cap member 14 is furthermore fixed to a cylinder support member 22 in such fashion that the cap will not rotate within the support member. The support member 22 is to be otherwise firmly fixed to some reference, such as the ground, designated 24.

The apex of the conical portion 10*a* of the shell member 10 is provided with an opening sufficient to pass the strand member 12.

It will be desired in practice to remove the cap member 14 from the shell member 10 subsequent to completion of the structure. Any suitable means may be employed, and for convenience, bolts 26 are illustrated.

At the left-hand end of shell member 10 as viewed in FIGURE 1 there is a second torsional cap member 30, also affixed by any convenient removable means, to the shell member 10. Cap member 30 has openings therethrough, such as openings 32. These may be created by having the central hub 34 of the cap member, through which freely pass the strand member 12, supported in spider fashion by arms 36 from the outer rim of cap 30. As will be more fully explained hereinafter, it is one function of the apparatus shown in FIGURE 1 to impart twisting or torsional forces to the strand member 12. For this purpose there is diagrammatically illustrated in FIGURE 1, left-hand end, a chucking or clamping device of any convenient type, designated by reference character 38 for being affixed to the strand member 12. Attached to chuck 38 is a gear 40 driven by a suitable hydraulic or electric motor 42 through a chain of reducing gears 44, 46 and 48.

It is also a function of the apparatus, as will be described more fully hereinbelow, to impart a torsional or twisting force on the shell member 10. For this purpose, the previously mentioned torsion cap 30 is provided with gear teeth 50 about its periphery (FIG. 4). Cap member 30 with its gear teeth as just stated, is rotatably captive within a surrounding support member 52, this also affixed to a firm base such as ground 24. Operating in a suitable well 54 in frame member 52, is a pinion gear 56 meshing with the teeth 50 on the cap 30. A suitable hydraulic or electric motor 58 is provided to rotate gear 56 through a chain of reducing gears 60, 62, 64 and 66.

Where the concrete structure and therefore the shell member 10 is to be quite long, and might sag between the support members 22 and 52, a plurality of piers 70 may be provided to support same. Also, where it is desired to have the shell member of fairly thin material, which might bulge under heavy forces imparted thereto, the entire shell member 10 may be surrounded by a heavier wall retaining member 72. When used, the latter will rest upon the piers 70, and in this particular case as shown in the drawings.

No limitation is necessary or intended as to the manner

of pouring liquid concrete into the shell member 10. However, as an example, a flexible delivery chute 76 may be employed, which may be actually inserted through one of the spider holes 32. Moreover, the entire structure may be slanted, as upon a hillside, so that the ground level might be as shown by the "level" line otherwise designated by reference character 78. Of course, the entire structure may, in fact, be entirely vertical so that the last few cubic inches of the shell 10 could be filled with concrete without any difficulty. It would be also possible, of course, under known practices to force concrete into the shell member 10 even though same is horizontal, this contemplating suitable locking of spider holes 32 or the like as the pouring process might be carried out.

Now referring to the method or operation according to the invention, a first embodiment is that with the strand member 12 anchored at its right-hand end as shown in FIGURE 1, twisting movement would be imparted to the strand member at its left-hand end, such as by operating the motor 42 until a predetermined amount of twisting movement had been imparted to the strand member 12 at the chucking device 38. For example, there might be one revolution of twist for every foot of length of the strand member 12, which would cause cross-sectional contraction of the strand member. This twisting movement upon strand member 12 would be accomplished before any concrete in the mold would have hardened. It will be apparent that the entire twisting motion could terminate before the concrete is poured, but there would be no difference if concrete still in substantially liquid form were within the shell member 10 as the twisting motion proceeded. The torsional force would be maintained upon strand member 12, as by any suitable locking of the motor 12 and the gear chain, until the concrete has come to a predetermined degree of hardness, in one example, complete hardening of the concrete. When this predetermined degree of hardness is reached, then the torsional force upon the cable is to be released as by an unchucking at either or both of chuck members 18 and 38. When released, the strand member 12 will tend to resume its original configuration, and in doing so it will expand, and create compressional forces in the concrete in radial directions, acting between the strand member on the inside, and the shell member 10 on the outside.

Where the shell member 10 is characterized by being corrugated in a helical fashion, as shown by FIGURE 5, if twisted in a direction to "tighten the corrugations" in the sense that if the corrugations were a strand wound about a mandrel, that would tighten, the cross-sectional area of the shell member, now designated 10' would reduce. Conversely, if twisted in the opposite direction, the shell member 10' would increase in cross-sectional dimension. Accordingly, another embodiment of the basic method invention, is to operate the motor 58 so as to impart twisting to the torsion cap 30 through movement of the gear 56, to apply an "untwisted" motion to the helically contoured shell member 10, to increase its cross-sectional area. In this state of affairs, after concrete has been permitted to reach its predetermined degree of hardness, release of torsional force on the shell member 10 will result in the latter contracting upon the concrete therewithin. Therefore, again there is established the desired radial compressional stress in the concrete.

It is furthermore possible to operate both the means for imparting torsional movement to the strand to contract same, and to the shell to expand same, whereupon, after hardening of the concrete, contracting of shell member plus expansion of the strand member will augment the radial compressional stress.

It will be apparent that the means for imparting the respective rotational forces can, in fact, act against one another, where both the strand and the shell are to be rotated in opposite directions.

An excellent type of strand member 12 is a multiple strand twisted cable, shown in FIGURE 6 and there designated 12'. This type of strand member will contract in cross-sectional configuration when torsional force is imparted thereto, tending to "tighten" the twisting. Such tightening also tends to shorten the pitch of the twist of the individual strands making up the complete strand member 12'. After concrete has hardened, and has formed intimately with the individual strands and fills the valleys between the strands, the untwisting action will also tend to cam the concrete up out of these valleys, to augment the radial compressional stressed in the concrete.

It will be apparent, in regard to the torsional imparting means for both the shell and the strand, that if these are constructed ruggedly enough to not yield to a tendency of the members under torsion to shorten (or elongate) as they are twisted, additional torsion of the shell and strand may occur, which will upon release, further augment the compressional stresses in the resulting concrete structure.

Inasmuch as any number of suitable arrangements can be created for imparting the various rotational forces and for performing other functions, it is to be emphasized that no limitation is to be placed upon the invention, and that the above described illustrative embodiments have been presented only as examples. The true scope of the invention is to be determined from the appended claims.

What is claimed is:

1. A method of making an elongated concrete structure within a cylindrical shell member which comprises: increasing the diameter of the shell member by imparting torsional force thereto; placing a strand member to extend longitudinally within said shell member; reducing the diameter of said strand member by applying torsional force thereto; pouring concrete within said shell member; permitting said concrete to set to a predetermined degree of hardness; and thereafter releasing said torsional forces on said shell member and on said strand member.

2. A method as in claim 1 wherein a torsional force is applied in a first direction to the strand member, and in the opposite direction to the shell member.

3. A method as in claim 1 wherein said shell member is helically corrugated, wherein the torsional force is applied to said shell member in a direction tending to unwind the helical corrugations, wherein said strand member is a multiple strand twisted cable and wherein the torsional force is applied to said strand member in a direction tending to tighten the twist.

References Cited in the file of this patent

UNITED STATES PATENTS

2,080,074	Freyssinet	May 11, 1937
2,303,394	Schorer	Dec. 1, 1942
2,319,105	Billner	May 11, 1943
2,582,751	Fitzpatrick	Jan. 15, 1952
2,590,478	Weinberg	Mar. 25, 1952
2,655,708	Eschenbrenner	Oct. 20, 1953
2,674,115	Chalos	Apr. 6, 1954
2,677,957	Upson	May 11, 1954
2,781,658	Dobell	Feb. 19, 1957

FOREIGN PATENTS

162,184	Austria	Jan. 25, 1949
676,533	Great Britain	July 30, 1952
692,408	Great Britain	June 3, 1953
1,115,054	France	Dec. 26, 1955

OTHER REFERENCES

Fully and Partly Reinforced Concrete, Journal of American Concrete Institute, January 1945, pp. 186 to 192, copy in div. 15.

Prestressed Concrete Design Overseas, Engineering News-Record, Apr. 5, 1945, pp. 97–100 (page 98 hereinafter noted).