ANCHORS FOR STRESSED CABLES
William F. Kelly, 100 Bellevue Drive, New Orleans, La. 70124
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ABSTRACT OF THE DISCLOSURE

A process and apparatus for post-tensioning prestressed concrete including placing opposed forms in the area to be concreted, securing a dead end anchor to one form and a live end anchor to the opposite form, securing a terminal of a tensioning member in the dead end anchor, passing the other end of the member through the live end anchor and through the form, exerting a pulling pressure on the member to lightly pretension the latter for holding the same in proper position when concrete is poured, and pouring concrete into the area between the forms to embed the anchors and members therein, the anchors including a tapered case, a complementary tensioning jaw assembly slidably mounted in the case, the inner wall of the jaw assembly being toothed for surface engagement with a tensioning member passing therebetween, and spaced reaction plates secured to the outer periphery of the tapered case, the dead end anchor further including a closure cap frictionally engaged in the tapered case and having a window therein for viewing the position of the tensioning member inserted into the case, and a helical spring positioned between the jaw assembly and closure cap, the live end anchor additionally including a compressible seal engaged with the outer end of the tapered case to prevent concrete from coming in contact with the jaw segments, the seal being readily removed to permit the tensioning member to be jacked through the cavity thus formed by the seal.

This invention is a process and apparatus for post-tensioning of prestressed concrete, which is especially adapted for use in the construction of poured-on-grade concrete slabs used in building structures, but susceptible of a variety of other uses.

An object of this invention is to provide a series of spaced assemblies, each assembly including a dead end anchor unit, secured to one end of a concrete form, and a live end anchor unit secured to an opposed form, the anchors being equipped with appurtenances for supporting and holding the terminals of a high-strength tensioning member, such as a cable or rod, which is stressed to a predetermined tautness before pouring the concrete, for post-tensioning the prestressed concrete, the appurtenances also including means positioned near each anchor and adaptably connected to the opposite ends of the member, the means including, inter alia, reaction plates embedded in the earth and supported by reaction stakes to complete the force couple through the earth.

Other objects are to provide a versatile anchor adaptably for use either as a dead end or live end anchor, the anchor having movable components which are positively retained within an exterior casing when transported to the place of use, the anchor in this form being employed as a dead end anchor; to provide an anchor of the character described, wherein the anchor is adapted for use as a live end anchor by the facile removal in situ, of a few inexpensive parts; and to provide a live end anchor wherein a sponge rubber seal is positioned between the outer end of the anchor and the form to prevent the flow of concrete into the interior of the anchor, thereby insuring free passage of the tensioning member through the live anchor, its seal, and the wood form, the sponge seal being readily removed after the concrete has set to permit caulking compound to be inserted into the outer end of the anchor casing and a concrete plug placed in the cavity from which the seal has been removed.

Additional objects are to provide a process of the character described for prestressing tensioning members to a predetermined tautness before placement of concrete within the forms, the members being readily adaptable for the application of conventional jacking equipment to effect post-tensioning of the concrete, and to provide a system of the character described, wherein the anchors are disposed between the forms, thereby wholly embedding the anchors in the poured concrete and obviating removal of any portion of the anchors after the concrete has set and the forms removed.

Other objects of the invention will be manifest from the following description of the present preferred forms of the invention, taken in connection with the accompanying drawings, wherein:

FIG. 1A is a side elevational view of a dead end anchor engaged with one end of a stressing cable mounted in a concrete slab on grade between wooden forms and illustrating the adjustable assembly connected to an auxiliary anchor just outside the form;

FIG. 1B is a similar view of an anchor constructed in accordance with this invention and comprising the live anchor through which the tension cable is jacked and secured to the adjustable assembly that coats with the adjustable assembly of the dead end anchor;

FIG. 2 is a longitudinal sectional view taken through the dead end anchor showing to advantage the manner of mounting one end of a prestressing cable therein;

FIG. 3 is a similar view taken through the live end anchor illustrating the manner of mounting the other end of the prestressing cable therein;

FIG. 4 is a vertical sectional view taken along the lines 4—4 of FIG. 2, looking in the direction of the arrows;

FIG. 5 is a perspective view of the sponge rubber seal used between the outer end of the live anchor and the concrete form;

FIG. 6 is a longitudinal sectional view taken through the live end anchor after the concrete has set;

FIG. 7 is a detail fragmentary sectional view of the dead end anchor illustrating the manner of initiating movement of one terminal of the tensioning member therein;

FIG. 8 is a vertical sectional view taken along the lines 8—8 of FIG. 2, looking in the direction of the arrows and showing one end of the dead end anchor in elevation;

FIG. 9 is a cross sectional view taken along the lines 9—9 of FIG. 8, looking in the direction of the arrows, showing a reinforcing flue of the reaction plate;

FIG. 10 is an elevational view of a modified form of an anchor reaction plate;

FIG. 11 is a cross sectional view taken along the lines 11—11 of FIG. 10, looking in the direction of the arrows;

FIG. 12 is a fragmentary vertical sectional view of the adjustable tensioning means engaged with the live anchor;

FIG. 13 is a vertical sectional view taken along the lines 13—13 of FIG. 12;

FIG. 14 is a vertical sectional view taken along the lines 14—14 of FIG. 2, looking in the direction of the arrows;

FIG. 15 is a similar view taken along the lines 15—15 of FIG. 2;

FIG. 16 is also a vertical sectional view taken along the lines 16—16 of FIG. 2, looking in the direction of the arrows; and

FIG. 17 is a similar view taken along the lines 17—17 of FIG. 2, looking in the direction of the arrows.

The process and apparatus of this invention is here shown reduced to practice for post-tensioning a prestressed, poured-on-grade concrete slab, but is susceptible
of use for any purpose to which an anchor for post-tensioning prestressed concrete can be applied. In FIGS. 1A and 1B, a pair of anchors are illustrated. The dead end anchor assembly, generally designated 20, is shown in FIGS. 1A and 2, and the live anchor assembly, generally designated 21, is shown in FIGS. 1B and 3. In accordance with the present invention, the dead end and live end anchors are of the same basic manufacture, including a tapering case 22 of generally frustr-conical shape, preferably of coldpressed extruded steel, having a flange 23 on the larger end. A jaw assembly 24 complements and is slidably mounted in each case 22 and is preferably composed of three arcuate elongated tapering segments 25. The inner wall of each jaw segment is toothed, as shown at 26. The extreme inner ends of the walls of each segment terminates in a smooth flared mouth for facile introduction of a cable or other suitable tensioning member 27 thereto into the latter has passed through the inner, reduced end of the case 22. A movable thimble-like finder 28 at the smaller terminal of tapered case 22 is adapted to receive an end of cable 27 and is movable therewith, to insure passage thereof completely through jaw assembly 24. Jaw segments 25 are retained together by a resilient band 29.

Dead end anchor 20, in addition to including case 22 and jaw assembly 24, also comprises a closure and jaw-retention assembly 30, shown to advantage in FIG. 2. This assembly is secured in the outer end of case 22, and embodies a helical spring 31 mounted between a closure cap 32 and a cup 33, the latter being contiguous with the outer ends of the jaw segments to exert continuous pressure thereon. Cap 32 is preferably of cup-shaped, the flanged edges of which are adapted for frictional engagement with the inner peripheral wall of case 22. Cap 32 is further provided with a central opening 34 which is covered by a translucent window 35 of clear plastic or like material inside the cap, an annular seal 36 being interposed between the cap and window. This arrangement permits visual inspection to determine that tensioning member 27 has been properly inserted into the anchor, as shown in FIG. 2. Cap 32 additionally prevents the passage of concrete interiorly of the anchor.

The apparatus of the present invention is further provided with means for permitting free movement of the tensioning member within the concrete after it has hardened. For this purpose, the surface of the member may be greased and encased in a vinyl jacket 37, the extremity of the jacket overlapped by a sleeve 38 of masking tape or the like, which also overlaps the inner end of tapering case 22, as advantageously shown in FIGS. 2 and 3. This prevents passage of concrete into the case.

For carrying out the objects of the present invention, a reaction plate 39, which may be of square configuration, is centrally press fitted or secured in any other suitable fashion in the periphery of case 22 adjacent flange 23. A plurality of radial flutes on the plate are indicated at 40. Case 22 is held in spaced connection with concrete form F through the medium of nails 41 which extend through openings in plate 39. Case 22 is also provided with a hoop stress restraining washer 42, which is fixed to the outer periphery of the case at a point intermediate its length. This washer obviates the need for using a larger and heavier steel case on jobs requiring a tensioning member of larger diameter, and also serves as an additional reaction plate.

The salient feature of the present invention to construct the space S in such a manner that none of teeth 26 will engage tensioning member 27 with sufficient pressure to cut the same or, in the case of cable, to sever a strand or strands. For carrying out this purpose, case 22 and jaw assembly 24 are so constructed that a space S is provided between the lower outer periphery of jaw segment 25 and the adjacent inner periphery of case 22. Therefore, when a tensioning force is exerted on member 27, the forward portions of segments 25 are flexed outwardly in space S so that forward teeth 26 neither do engage, or engage lightly, the tensioning member. (See FIG. 2.) This results in a more uniform application of pressure by the remainder of teeth 26 on member 27 without damage to the latter and makes the theoretical triangular stress take-up distribution an actuality rather than purely theoretical. The angle through which the forward portion of the jaw assembly moves will vary from one application to another.

The manufactured anchors above-described may be transported to a building site or other locale where the anchors are to be used, and a plurality thereof secured in spaced relationship to concrete form F to serve as dead end anchors, as shown in FIG. 2.

To adapt the anchor for use as a live end anchor, cap 32, spring 31 and cup 33 are removed, removal being readily effected by forcing tensioning member 27 through jaw assembly 24 against cap 32. The live end anchor, shown to advantage in FIG. 3, therefore, omits structure in the outer end of case 22 beyond the jaw assembly, leaving member 27 free to pass through and beyond said assembly, case 22 and form F. To prevent concrete from flowing through the open end of the case to the jaw assembly, a seal 43, preferably of sponge rubber, is compressed between flange 23 at the outer end of case 22 and form F. It will be noted upon reference to FIG. 3, that a portion of seal 43 extends into the open outer end of case 22 and has a cable-access opening 44 extending axially therethrough.

As shown in FIGS. 1A and 1B, forms F are held in place by anchoring stakes 45 which are driven into the ground. It will also be noted from these figures that member 27 spans the distance between opposed forms F, said member being secured in dead end anchor 20. Anchor 20 is also adjustably connected to reaction means 46 comprising a steel reaction stake 47 and a steel reaction plate 48, the latter being completely embedded in the ground G and secured to stake 47 which is driven into the ground at an angle, as shown in FIG. 1A. Adjustment of tension on dead end anchor 20 is effected by a turnbuckle 49 threadedly connected to rods 50 and 51. The free terminal of rod 50 is secured to a hook 52 fixed to stake 47 and the free terminal of rod 51 is engaged with a bent portion of a nail 41 connected to dead end anchor 20.

The form holding the live end anchor is in turn supported by a stake 53 driven into the ground G, to which reaction means 54 are connected. Reaction means 54 includes a steel stake 55 engaged with a reaction plate 56 which is completely embedded in the ground. Adjustment of tension is effected by a turnbuckle 57 threadedly connected to rods 58 and 59. The free terminal of rod 58 is secured to a hook 60 fixed to stake 53 and the free terminal of rod 59 is engaged with a hook 61 carried by stake 55.

In connection with stake 55, there is provided means for pretensioning tensioning member 27 in accordance with one of the objects of the present invention. This means includes a pretension anchor 62 of conventional type which is initially engaged with tensioning member 27 at the locus of stake 49 and the cable has been drawn tight, manually. A pretensioning wedge 64 is permanently connected to stake hook 61 by a chain 63. As shown in FIGS. 12 and 13, pretensioning wedge 64 is preferably of longitudinally dished formation and includes a top wall 65, tapering side walls 66 and a sloping end wall 67. End wall 67 is provided with a center longitudinal recess 68 extending from the terminal thereof to a point proximate the upper limit of the wedge, which recess is adapted for the reception of member 27 in the manner shown in FIGS. 12 and 13. By insertling wedge 64 stationary stake 55 and pretension anchor 62, thereby forcing member 27 into longitudinal recess 68, movement of the member occurs in a direction to effect tightening of the latter until the desired tautness or pre-stressing is obtained. Stake 47 and its reaction plate 48...
is the final terminal point of the pretensioning forces which is put on the tensioning member prior to its encase-
ment in the concrete slab. The dead end anchor and its appurtenances, which have been generally designated 20, 5
fixes the static or non-jacking end of the post tensioning cable and transmits the post tensioning stress to the concrete, after final tensioning, converting the structure to a post tensioned, prestressed concrete structure. The glued, tensioning member and vinyl covering permits the member to, in effect, float free in the concrete, after it has hardened, to successfully post-tension the prestressed concrete slab. The excess cable or rod projecting beyond the live anchor is relieved of its vinyl jacket and grease, as their functions have been accomplished.

In use, one end of member 27 is inserted into dead end anchor 20 and pushed therethrough until finder 28 engages cap 32. Upon exerting pull on tensioning member 27, teeth 26 of each segment of jaw assembly 24 engages member 227 and uniform pressure is applied to a substantial portion of the outer periphery of member 27. Dead end anchor 20 is then secured to form F by nail members 39. Reaction means 46 is then connected to one of nail members 41, as illustrated in FIG. 1A. Intermediate portions of the cable are then engaged with conventional chairs 69 positioned subjacent the cable on a Visqueen membrane or the like 70, spread over compounded fill 71. This controls the loop effect of member 27 between the form F.

The free terminal of tensioning member 27 is then trained through live anchor 21, sponge rubber seal 43 and form F, the anchor being secured in spaced relation to form F by nails 41. After the member is manually drawn tight, it is released and held in place by virtue of the engagement of teeth 26 of jaw segments 25 with the outer periphery of the cable in the same manner as at the dead end anchor. Member 27, beyond form F is drawn through stake 53 which is, in turn, connected to form F as shown in FIG. 1B. Pretension anchor 62 is next applied to member 27, at the point where it passes through stake 55. Initial pretensioning of cable 27 between the forms is then effected by driving wedge 64 between anchor 62 and stake 55, thereby taking up any slack in cable 27 between the forms and assuring proper positioning and tightening of the member. It has been found that by driving wedge 64 between anchor 62 and stake 55, that a pull on tensioning member 27 of approximately 500 to 750 pounds is developed, which is sufficient for the purposes of the present invention.

After the cable has been initially pretensioned, concrete 72 is poured and permitted to harden. Before post-tensioning, forms F and sponge rubber seal 43 are removed and after post-tensioning of the member with jacking equipment, terminals of nails 41 and end portion of member 27 beyond live end anchor 21 are removed. A caulking compound 73 is then inserted into case 22 between jaw assembly 24 and the terminal of the casing. Concrete 74 is next placed in the cavity from which seal 43 has been removed to form a concrete plug extending to the limit of concrete 72. It will be noted from FIG. 6, that by virtue of the conformation of the cavity and of plug 74, accidental displacement of the plug is obviated.

In FIGS. 10 and 11, there is shown a modified form of reaction plate shown in FIG. 8, which modified form is designated 75 and includes a central opening 76 for mounting on case 22 and nail openings 77. In this form of reaction plate there are provided opposed arcuate reinforcing ribs 78 extending through a substantial portion of the reaction plate, the ribs being preferably pressed from the body portion of the plate as shown to advantage in FIG. 11.

There has been herein shown and described a single cable adapted for connection to the anchor of the present invention and it is to be understood that where multiple steel cables are employed in close relationship, these cables may extend through clusters of anchors made in accordance with the present invention.

While preferred embodiments of the present invention have been shown and described, it is nevertheless to be understood that various changes may be made therein, without departing from the spirit and scope of the claims hereeto appended.

What is claimed is:

1. In a forming and reinforcing apparatus, an anchor for fastening a stressed cable to a body of set concrete, said anchor comprising an elongated, tubular metallic case impervious to the passage of moisture through the walls thereof, said case tapering in diameter from a large end to a small end, the small end being adapted to receive said cable, a seal member encircling the smaller end of said case and having a portion extending beyond the end thereof, said seal member being in sealing relationship with said smaller end and the extending portion being adapted to sealingly engage a sleeve on said cable, a complemental gripping jaw assembly slidably mounted in said case, said assembly comprising at least a pair of jaw segments having a bore extending therethrough, said bore being co-axially aligned with the axis of said case, flexible means maintaining the jaw segments in assembled relationship, said jaw assembly being spaced inwardly of both ends of said case, an anchoring and fastening flange frictionally engaging the outer periphery of said case, said anchoring and fastening flange including a series of apertures therethrough, sealing means engaging the large end of said case, said means being in sealing engagement with the large end and spaced from said jaw assembly thereby preventing the ingress of moisture and unset concrete into said space within said case through said large end.

2. The anchor of claim 1, wherein the sealing means engaging the large end of said case comprises a cylindrical member of a flexible, compressible material having an axial bore through which the cable passes, said cylindrical member being compressed against the large end of the tapered case to effect sealing engagement with the large end of said case and with the cable extending through the axial bore of said case.

3. The anchor of claim 1, wherein the sealing means comprises a closure cap engaged with the large end of said tapered case.

4. The anchor of claim 3, wherein said closure cap is provided with a central opening forming a window and a translucent material covering the central opening of said closure cap, for viewing the position of a tensioning member inserted into the case and preventing the ingress of moisture and unset concrete into the case.

5. In a forming and reinforcing apparatus, an anchor for fastening a stressed cable to a body of set concrete, said anchor comprising a tapered case impervious to the passage of moisture through the walls thereof, said case tapering in diameter from a large end to a small end, the small end being adapted to receive the cable, a complemental gripping jaw assembly slidably mounted in said case, said jaw assembly including jaw segments, the inner walls of said jaw segments having means for grippingly engaging the cable passed therethrough, a closure cap engaged with the large end of the tapered case to prevent the ingress of moisture and concrete, the closure cap having a central opening forming a window, for viewing the position of a cable within the tapered case, a translucent material covering the opening for preventing passage of moisture and concrete through the opening, and a spring interposed between said jaw assembly and closure cap.

6. The anchor of claim 5, wherein said closure cap is of substantially cup shape and includes a central portion which issues into flanged edges, said flanged edges being frictionally engaged with the inner peripheral wall of said case, said central portion being provided with an opening, and translucent moisture-impervious material covering the opening to prevent ingress of moisture or concrete into the tapered case.
7. The anchor of claim 5, with the addition of a moveable thimble-like finder in the smaller end of said tapered case, said finder being adapted to receive the terminal of the cable inserted into the case.

8. The anchor of claim 5, with the addition of a sealer member encircling the smaller end of said tapered case and having a portion extending beyond the end thereof, said sealer member being in sealing relationship with said smaller end and the extending portion being adapted to sealingly engage a sleeve on said cable.

9. The anchor of claim 5, with the addition of a reaction plate secured to the outer periphery of said tapered case intermediate its length, and reinforcing means extending through a substantial portion of said reaction plate.

10. The anchor of claim 9, wherein said reinforcing means comprise flutes radiating outwardly from the outer periphery of said tapered case.

11. The anchor of claim 9, wherein said reinforcing means comprise opposed arcuate reinforcing ribs.

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