United States Patent [19]

Yokota et al.

[11] **3,899,892**

[45] **Aug. 19, 1975**

[54] **STEEL CABLE ANCHOR AND METHOD FOR WITHDRAWING THE SAME**

[75] Inventors: **Hiroomi Yokota,** Tokyo; **Taizo Masuda,** Chiba, both of Japan

[73] Assignee: **Yoshio Ichise,** Tokyo, Japan

[22] Filed: **Jan. 3, 1974**

[21] Appl. No.: **430,548**

[30] **Foreign Application Priority Data**

Feb. 8, 1973 Japan 48-16032

[52] **U.S. Cl.** ..... **61/39;** 61/45 B; 52/712; 52/742; 403/265

[51] **Int. Cl.**[2] **E02B 3/12**

[58] **Field of Search** ..... 52/230, 742, 712–714; 61/39, 45 B; 403/265, 266

[56] **References Cited**

UNITED STATES PATENTS

2,431,104	11/1947	Bright	52/714
3,060,640	10/1962	Harris	52/230
3,114,987	12/1963	Harris	52/230
3,299,644	1/1967	White	61/45 B
3,347,005	10/1967	Preston	52/230
3,579,931	5/1971	Lang	52/230
3,753,354	8/1973	Bauer	61/39

Primary Examiner—Henry C. Sutherland

Attorney, Agent, or Firm—Meyer, Tilberry & Body

[57] **ABSTRACT**

A steel cable anchor comprises a plurality of individual steel cables bundled together to form a steel cable anchor adapted to be embedded within the ground by being buried in a hole filled with a hardening material such as cement. One or more of the individual steel cables have their surfaces coated with an anti-friction material. The remaining individual steel cables have their surfaces free of such anti-friction material.

The method for withdrawing the steel cable anchor from its embedded position in the ground comprises the steps of first withdrawing one or more of the individual steel cables whose surfaces are coated with the anti-friction material and then withdrawing the remaining elemental steel cables whose surfaces are free of such anti-friction material.

5 Claims, 8 Drawing Figures

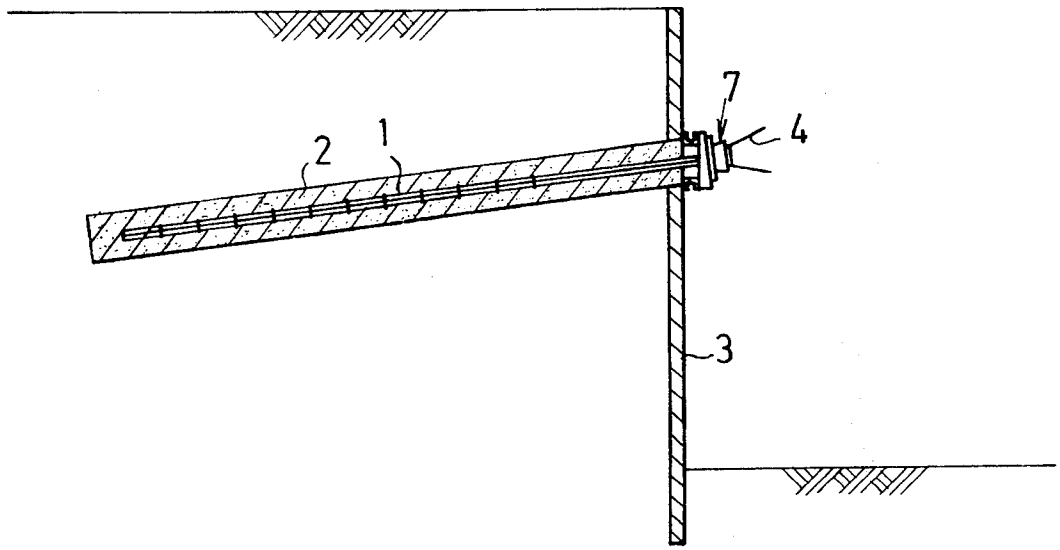


FIG. 1

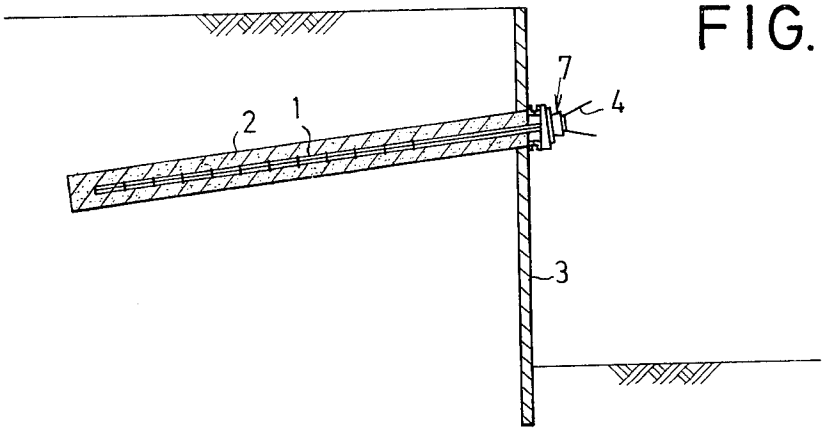


FIG. 2

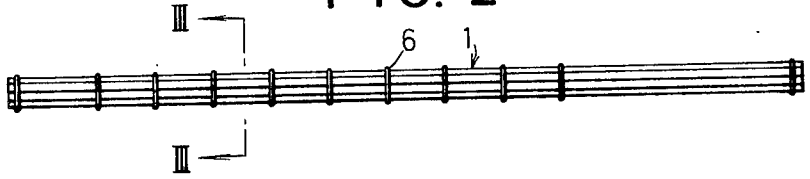


FIG. 3

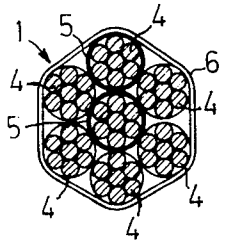


FIG. 4

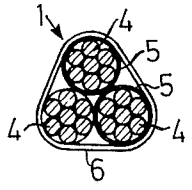


FIG. 5

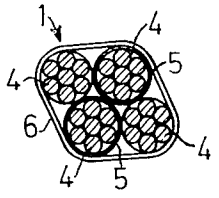


FIG. 6

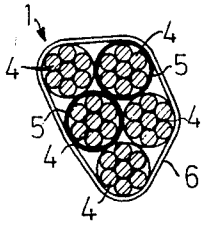


FIG. 7

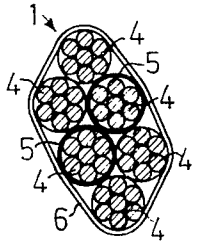
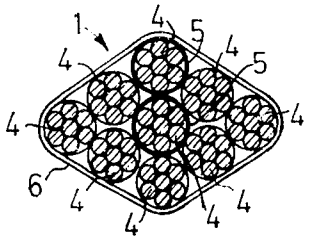


FIG. 8



STEEL CABLE ANCHOR AND METHOD FOR WITHDRAWING THE SAME

This invention relates to steel cable anchors which are embedded within the ground to provide an anchor to which a structural member may be attached.

The present invention is more particularly concerned with a steel cable anchor which comprises a plurality of individual steel cables bundled together by binding wires, and to a method for removing such steel cable anchors from the ground when they are no longer required.

Although it has broader applications, one aspect of the invention is particularly useful as it pertains to a method for use in removing a cable anchor which supports a breast wall or revetment and, more particularly, to a method for withdrawing, after use, the steel tension cable anchor from an elongated hole in the ground, in which hole the anchor was buried in a hardening material filling the hole.

In general, where a breast wall, revetment or other structure is supported by a steel tension cable anchor, there sometimes arises the need to provide one or more cable anchors in an area, such as where a road or underground structure is to be built, from which the cable anchor must be removed after a certain stage of the construction is completed. In such cases, the steel cable anchor may be withdrawn by applying a force thereto which is greater than the tensile strength of the cable anchor so that it is forcibly torn from the ground. Alternatively, a heat producing charge, such as a thermite device, may be included in the construction of the steel cable anchor by being placed on a portion of the tension steel cable which is not covered with mortar or cement. When the cable anchor is no longer required, the thermite charge is ignited and the steel cable is severed by it and the severed portion removed.

Such prior art methods suffer from certain disadvantages. The former method (application of force) is inconvenient in requiring the application of enormous tensile forces to the cable to forcibly remove the same. The latter method (thermite charge) results in a failure to withdraw the whole body of the cable anchor, i.e., there remains a major portion of the steel cable anchor buried within the ground, and involves the obviously inconvenient use of incendiary charges.

It is accordingly a principal object of the present invention to provide a steel cable anchor structure and a method for withdrawing the same from the ground after use, which method requires less force than prior art methods, permits tensile force withdrawing of the cable anchor with much less force than that required by prior art withdrawal methods, which permits recovery of the entire cable anchor, and which does not require the use of incendiary charges.

It is another object of the present invention to provide a method for use in withdrawing a cable anchor of the type described, which insures the positive, mutual binding of the individual tension steel cables while the anchor is in use, thus precluding the possibility of the tension steel cables slipping or being inadvertently withdrawn when in use for supporting a revetment or other structure.

It is a further object of the invention to provide a method for use in withdrawing a steel cable anchor of the type described, wherein the frictional resistance of the individual steel cable or cables first withdrawn is less than the frictional resistance of the remaining individual tension steel cables included in the bundle of cables forming the steel cable anchor.

It is a still further object of the invention to provide a steel cable anchor structure of the type described, which insures the positive fixing of tension steel cables in the ground during use and which can be withdrawn by the method described.

In accordance with the present invention, there is provided a steel cable anchor comprising a plurality of individual steel cables bundled together and embedded into a hardening material, wherein at least one of the individual steel cables has an anti-friction material coated over its surface at least for substantially the effective length of the cable; the embedded steel anchor cable, after use, is withdrawn from the ground by first withdrawing one or more individual steel cables which have an anti-friction coating on about their respective surfaces for at least the effective length thereof, by applying a tensile force thereto sufficient to withdraw such coated cable or cables, thereby loosening the remaining cables, and thereafter applying a tensile force to the remaining (uncoated) cables sufficient to withdraw such uncoated cables.

By having its surface coated with anti-friction material is meant that the entire outer or circumferential surface of the cable is so coated.

In accordance with one aspect of the invention, the individual steel cables are bundled together by a plurality of binding wires fastened about the circumference of the steel cable anchor.

In accordance with another aspect of the invention, a fixing unit is affixed to the exposed end of the embedded steel cable anchor unit by being attached to those of the individual steel cables which do not contain anti-friction coating on their surface, and those cables which contain anti-friction coating about their surfaces are passed through or around the fixing unit but are not affixed thereto.

While not wishing to be bound by the accuracy of the following observation, it appears that those cables coated about their surfaces with anti-friction material are relatively readily withdrawn from a bound bundle of substantially parallel cables in a direction substantially parallel to their longitudinal axes, but these same coated cables nonetheless exert pressure against the uncoated cables so that the holding strength of the anchor as a whole is substantially unaffected. When one or more cables are removed from the bundle, the pressure imposed on the remaining cables transversely to their respective longitudinal axes is of course lessened.

Generally, it is preferred that the ends of the uncoated cables only are affixed to the structure or element to be supported by the steel cable anchor, the corresponding ends of the cables coated with anti-friction material being left free.

The invention may take form in certain parts and arrangements of parts, a specific embodiment of which is described in detail hereinbelow and shown in the accompanying drawings wherein:

FIG. 1 is a cross-sectional view of a steel cable anchor in accordance with the invention supporting a revetment;

FIG. 2 is a lengthwise view of tension cables forming a steel cable anchor, showing one embodiment of the invention;

FIG. 3 is a cross-sectional view of FIG. 2, taken along the line 3—3; and,

FIGS. 4 through FIG. 8 are cross-sectional views corresponding to that of FIG. 3, of tension cables comprising other embodiments of the invention, having various combinations of elemental steel cables.

In the application of steel cable anchors for use in supporting a breast wall or revetment, a hole of a given length and diameter is formed in the ground by any suitable boring or driving technique, and then a bundle 1 of tension steel cables 4 is inserted therein. Thereafter, the hole is filled with a suitable hardening material 2, such as cement mortar, concrete or the like. Bundle 1 of tension steel cables 4 is thus buried in the hardening material 2 within the said hole, with one end of bundle 1 being secured to the revetment 3 to prevent it from leaning or falling to one side under pressure of the earth it is retaining.

Bundle 1, as aforesaid, consists of a plurality of elemental steel cables 4 composed of strand steel wires or wire ropes, and at least one of the elemental steel cables 4 is coated with an anti-friction material 5 over its surface for substantially the effective portion thereof. The "effective portion" or "effective length" of the cable is that segment of the length of the steel cable contained within hardening material 2 to form a part of the steel cable anchor means.

Included among anti-friction material which may be employed in the present invention are greases in general, such as lubricating greases, petrolatums and petroleum jellies, such as that sold under the trademark vaseline, hydrocarbon greases in general, vegetable oils, mineral lubricants, water glass, coal tar, asphalt, viscous material such as polymeric or macro-molecular materials of any suitable kind, talcum powder, soft synthetic resin coatings, etc. In general, any lubricating material such as any suitable oil, grease or jelly or any finely powdered lubricating type powder such as talcum powder, which will reduce the frictional resistance of withdrawing a single steel cable which is squeezed against other like steel cables with which it is bundled under pressure, is suitable for use as an "anti-friction material" in accordance with the present invention. Particularly when the aforesaid mineral lubricants, polymeric viscous material or talcum powder is used, a synthetic resin tape, a paper tape, or the like, may thereafter be wound around the elemental steel cable coated with the anti-friction material, for preventing adhesion of the anti-friction material to hands, removal of the anti-friction material from the cable or mixing of the anti-friction material with the concrete. In short, a protective covering may be applied over the anti-friction material.

The individual steel cable 4 with anti-friction material 5 coated thereon is bundled, by using binding wires 6, together with the other individual steel cables 4 having no friction material thereon, in a manner that the latter (uncoated) cables surround the coated cable. Aside from arranging the coated and uncoated cables relative to each other in the positions specified by the invention, bundles 1 are made in the known manner by arranging individual cables of selected length in lengthwise, parallel arrangement. Binding wires 6 are then secured about the circumference of the bundled cables at selected intervals along their length.

FIGS. 3 to 8 show examples of other embodiments of the invention, wherein two individual steel cables 4 having anti-friction material 5 coated thereon are combined in use with one to seven elemental steel cables 4 having no anti-friction material thereon. In this respect, in case still more steel cables are combined therewith, then the cables 4 which have anti-friction material 5 coated thereon will be increased in number.

As shown in FIG. 1, a fixing unit 7 may be employed to fasten revetment 3 to the bundle 1 of cables forming the core of the steel cable anchor. Such fixing units being well known and conventional in the art, are not further described in detail herein but it suffices to say that the fixing unit provides a cap-like fixture with means therein to permit it to be affixed to the other ends of steel cables 4 so that the fixing unit bears against revetment 3 to fasten revetment 3 to the cable anchor proper, so that the cable anchor takes up the force of the earth, sand, etc. bearing against revetment 3.

In accordance with the present invention, when placing the bundle 1 of tension steel cables 4 in the ground to form the anchor, the individual steel cables 4 having anti-friction material 5 thereon are not affixed to fixing unit 7, but only those cables which do not contain anti-friction material disposed over their surfaces are attached to the fixing unit 7.

After the completion of the construction or digging operation for which the soil, sand, etc. is held inside the revetment 3 with the help of the cable anchor, the cable anchor may be removed. This is accomplished in accordance with the invention, by first applying tension to the exposed ends of the steel cables 4 having anti-friction material 5 thereon in order to withdraw such cable or cables from the bundle of cables. The presence of the anti-friction material 5 on the surface of at least the effective length (that portion enclosed within hardening material 2) of the cable being withdrawn, materially lessens the amount of tensile force required to successfully withdraw the cable. When one or more of the initial, anti-friction material coated cables 4 are withdrawn, the remaining steel cables are loosened because of the absence of the withdrawn steel cables and thus may be withdrawn one by one with relative ease. By withdrawing the steel cables in this manner, the whole bundle of the tension steel cables 4 may be removed completely.

Generally, cables coated with anti-friction material are so positioned that upon their removal from the bundle, one or more non-coated cables are loosened by having a free space form immediately adjacent thereto. Such loosening of course facilitates the removal, by application of tensile forces, of the loosened, noncoated cables.

Preferably, every cable in the bundle will either be in contact with a cable coated with anti-friction material, or in contact with a non-coated cable which is in contact with a coated cable. In other words, preferably, no non-coated cable will have more than one non-coated cable between it and a cable coated with anti-friction material.

It is obviously not always necessary to remove all the anti-friction material coated cables from a bundle before removing any non-coated cables, but such procedure is generally preferred. Further, two or more cables, whether coated or non-coated, may be removed simultaneously, particularly after the initial cable or cables have been removed, or individual cables may be removed one at a time.

The following example illustrates the process of the present invention.

The ground was bored by using a drill casing of five inches (13cm) in diameter. Into the hole thus prepared seven steel cables bundled together as illustrated in FIG. 3 were inserted, and the hole was then filled with concrete to provide a firmly fixed cable anchor. The effective length of the tension steel cables was about 390 inches (10m) and the non-effective length (outside the concrete) thereof was about 156 inches (4m). The bundle of steel cables was prepared from strand steel individual cables of about 0.488 inches (12.4mm) diameter. Grease was applied to the circumferential surfaces of the effective length portions of two of the strand steel cables included in the bundle, and a vinyl tape was then wound around the greased portion of the cables. Five more cables, without any anti-friction material or vinyl tape thereon were included in the bundle, which was bound together by binding wires with the cables arranged, as aforesaid, as illustrated in FIG. 3, items 5 being the anti-friction coatings.

After the concrete set, a test of the resistance to withdrawing of the completed cable anchor was made.

In the withdrawal force test of the steel cable anchor, the cable anchor well resisted against a pulling force or tension of 55 tons exerted by a hydraulic jack, thus proving that the anchor has a withdrawal force resistance of the same level of magnitude as that of a comparable conventional cable anchor.

Subsequently, the same cable anchor is removed as follows. The two strand steel cables having the anti-friction material coated thereon were withdrawan at the same time by applying a force of 1.8 tons thereto. The un-coated strand steel cables which had been in contact with the aforesaid withdrawn coated steel cables were then subjected to a tension force of 6.1 tons exerted by a hydraulic jack in order to separate them from the hardened concrete. After separation, the two steel cables were withdrawn manually and simultaneously. In a like manner, the other two steel cables which had been in contact with the aforesaid withdrawn steel cables were withdrawn, followed by the remaining one steel cable.

While the invention has been described in detail with respect to a specific embodiment thereof, it will be apparent to those skilled in the art upon a reading and understanding of the foregoing description, that many modifications and alterations may be made thereto which modifications and alterations are nonetheless within the spirit and scope of the appended claims, which are intended to include all such modifications and alterations.

What is claimed is:

1. A method for withdrawing a steel tension cable anchor embedded within hardening material in the ground, said cable anchor including a plurality of individual tension steel cables assembled in a bundle of cables, some but not all of said cables having their surfaces coated along at least the effective length thereof with an anti-friction material, the method comprising the steps of first withdrawing from said hardening material at least one individual cable whose surface is coated with said anti-friction material, and thereafter withdrawing the remaining individual steel tension cables.

2. The method of claim 1, wherein all the individual steel cables coated with anti-friction material are removed from said bundle prior to removing any uncoated individual steel cables.

3. A method of assemblying a steel tension cable anchor comprising coating the surface of at least one individual steel cable with anti-friction material along a length thereof,

positioning said at least one coated cable in lengthwise proximity to at least one cable not coated with an anti-friction material, binding said coated and un-coated cables into a bundle, providing a hole in the ground and inserting said bundle therein, filling said hole with a hardening material to cover said bundle up to a length substantially corresponding to the length of individual cable coated with anti-friction material, leaving one end of said coated and un-coated cables to protrude from said hardening material, and

securing the protruding ends of said cables to a structure to be anchored.

4. The method of claim 3, wherein only the cables without anti-friction material thereon are secured to said structure to be anchored.

5. The method of claim 3, further including attaching fixing means to the protruding portion of said cables and positioning said fixing means adjacent a revetment.

* * * * *