United States Patent [19]

Tomioka

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[54] **METHOD OF ANCHORING WIRES AND STRANDS IN PRESTRESSED CONCRETE**

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[30] **Foreign Application Priority Data**

Dec. 3, 1970 Japan 45/107846

[52] **U.S. Cl.** ..... **29/517**, 24/123 W, 52/223 L

[51] **Int. Cl.** **B21d 39/00**, B23p 11/00

[58] **Field of Search** ..... 29/517, 520, 452; 52/223, 223 L; 24/123 W

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Primary Examiner—Charlie T. Moon

Attorney—Oblon, Fisher & Spivak

[57] **ABSTRACT**

A method of anchoring wires or strands in prestressed concrete comprising the steps of twisting a non-circular cross section wire to form a coil in a steel sleeve having a length equal to about two times the diameter of the wire or strand, engaging a free end of the wire with the twisted wire coil by sliding the sleeve and twisted wire coil over the wire or strand, and fixing the sleeve by swaging or pressing within the range of 10–30 percent of reduction ratio. Thus, an anchorage having improved anchorage efficiency which avoids shearing failure of PC wire at the point of anchorage is provided.

11 Claims, 12 Drawing Figures

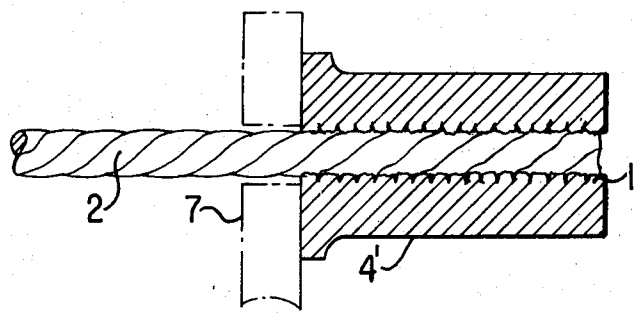


FIG.1

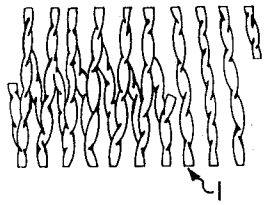


FIG.2

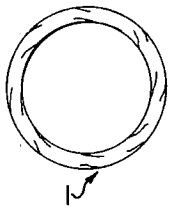


FIG.3

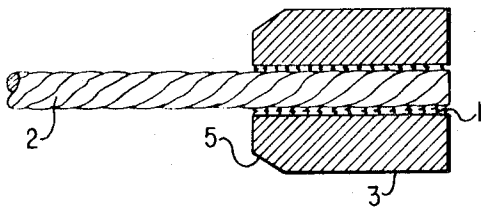


FIG.4

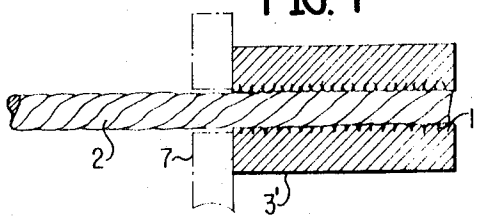


FIG.5

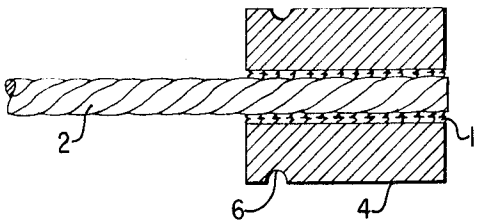
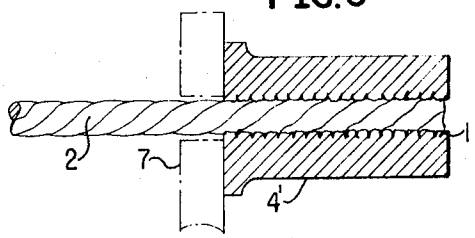


FIG.6



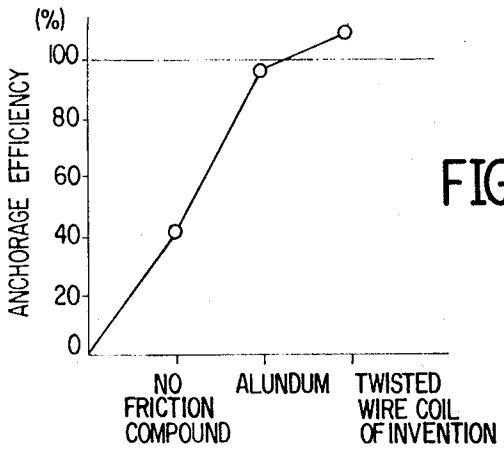


FIG.9

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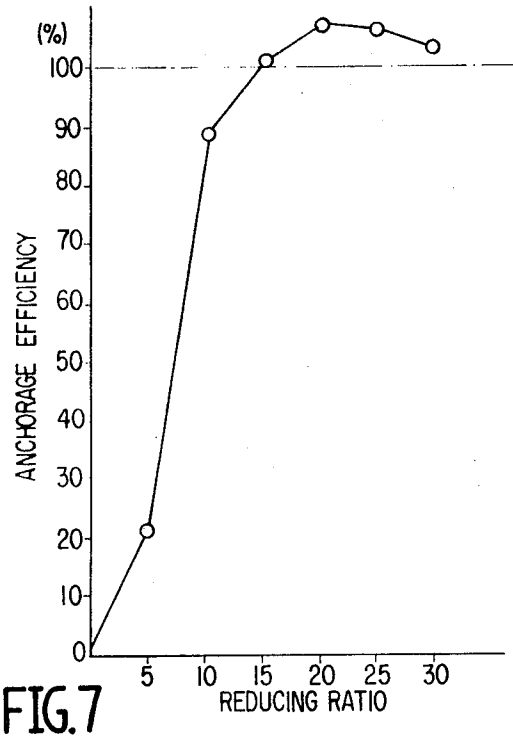

FIG.7

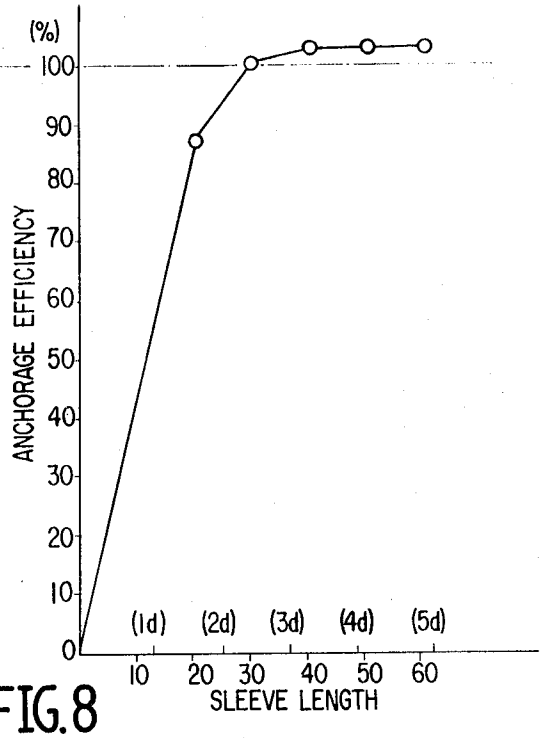

FIG.8

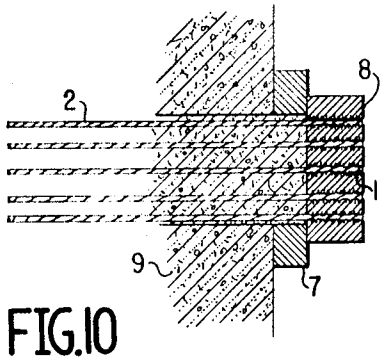

FIG.10

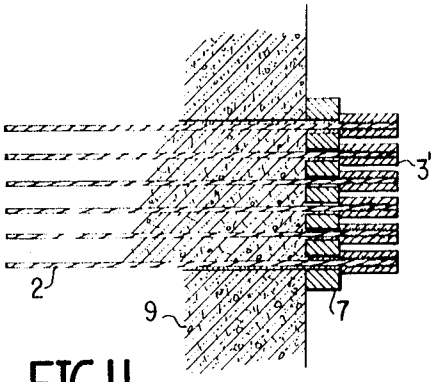

FIG.11

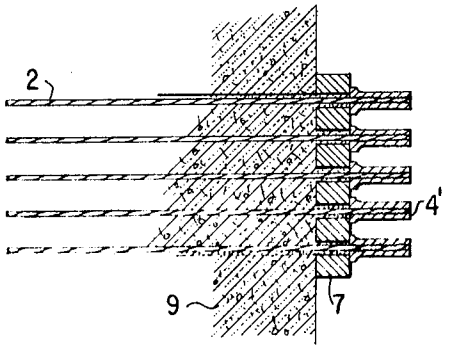

FIG.12

METHOD OF ANCHORING WIRES AND STRANDS IN PRESTRESSED CONCRETE

BACKGROUND OF THE INVENTION

1. Field of the Invention

This invention relates generally to the anchoring of wires and more particularly pertains to an improved method of anchoring wires or strands being employed for making prestressed concrete.

2. Description of the Prior Art

Heretofore, many different methods of anchoring wires for prestressed concrete have been utilized, such as, for example, by gripping the PC wire being utilized with a wedge, by supporting headed PC wire in an anchor plate having a plurality of receiving holes, and by gripping the wire by pressing an outer sleeve thereover with an intervener being positioned therebetween. Such methods have not always proven to be entirely satisfactory, primarily because of failures occurring at the anchorage points as a result of shearing of the wire therefrom.

SUMMARY OF THE INVENTION

Accordingly, it is a primary object of the present invention to provide a method of anchoring wires and strands for prestressed concrete having improved anchorage efficiency characteristics.

Another object of the present invention is to provide a method of anchoring wires and strands for prestressed concrete which avoids shearing failure of the wire or strand at the anchorage.

This invention contemplates an improved method of anchoring wires and strands for prestressed concrete in which the wire or strand is fixed to a sleeve by using an intervener and by pressing or swaging techniques.

A characteristic feature of this invention is that the anchor is fixed by pressing or swaging within the limited range of compressive force, being composed of the wire, a sleeve having a relief in its side near the anchor plate and a substantially helical coil of wire having a non-circular cross section so as to have narrow longitudinal edges which extend substantially in a helix about the axis of the wire.

In this specification, the wire or strand for prestressed concrete hereinafter will be called PC wire. In this invention, as described herein, it is further to be understood that swaging means extruding by die, rolling or hammering, and that pressing means pressing by segment dies.

According to this invention, the twisted coil is a hardened and brittled material. Its edges contact both the sleeve and the PC wire surrounded by the sleeve in turn and become small fragments when the outer sleeve is compressed about the PC wire by swaging or pressing, as will be described in detail herebelow. The gripping force of the sleeve is greatly strengthened by these small fragments which cut into both the sleeve and the wire, and thereby provide a gripping force which is quite consistent and improves the anchorage efficiency.

Another characteristic feature of this invention is the provision of relief of the sleeve at an end close to the anchor plate. The shape of the relief may be different, depending upon the method of forming. For example, when the sleeve is formed by swaging, the sleeve preferably has a tapered end. On the other hand, where the sleeve is formed by pressing, the sleeve has a relief

groove adjacent one end near the side of the anchor plate. In the case of a sleeve having no relief, its sides would become non-planar when the sleeve is reduced and drawn along its axis. Such relief of the sleeve, as will be observed, prevents the side planes from deforming and permit the sleeve to be set firmly on the anchor plate.

The existence of the relief thereby reduces the gripping force of the sleeve being applied through the fragment twisted wire at the area immediately adjacent the anchor plate, which eventually serves to prevent the common problem of shearing failure of the PC wire at its anchorage.

BRIEF DESCRIPTION OF THE DRAWINGS

Various other objects, features and attendant advantages of the present invention will be more fully appreciated as the same becomes better understood from the following detailed description when considered in connection with the accompanying drawings, wherein like reference numerals designate like or corresponding parts throughout the several illustrations and in which:

FIG. 1 is a side view of a twisted wire coil of non-circular cross section which forms a principal part of the present invention;

FIG. 2 is a front elevational end view of the twisted wire coil shown in FIG. 1;

FIG. 3 is a side sectional view of an assembled structure according to this invention before swaging, which is composed of a strand, a sleeve and the twisted wire coil shown in FIGS. 1 and 2;

FIG. 4 is a side sectional view of a fixed structure according to this invention following swaging of the assembly shown in FIG. 3;

FIG. 5 is a side sectional view of another assembled structure according to this invention before pressing, which is likewise composed of a strand, a sleeve and the twisted wire coil shown in FIGS. 1 and 2;

FIG. 6 is a side sectional view of the fixed structure according to this invention after pressing the assembly shown in FIG. 5;

FIG. 7 is a graph showing the relationship between the reduction ratio of the sleeve and the anchorage efficiency obtainable therewith;

FIG. 8 is a graph showing the relationship between the sleeve length and the anchorage efficiency;

FIG. 9 is a graph showing the relationship between various friction compounds utilized in achoring wire and anchorage efficiency available therewith;

FIG. 10 is a side sectional view of an embodiment of an anchorage where the strands are inserted in a sleeve having a plurality of holes and fixed therein by pressing or swaging the sleeve;

FIGS. 11 and 12 are side sectional views of the respective embodiments of anchorage shown in FIGS. 3–4 and 5–6, where a plurality of the assembled and fixed anchorages of this invention are set on an anchor plate having plural receiving holes.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENTS

Referring initially to FIGS. 1 and 2 of the drawings, there is shown a helical coil 1 formed from a wire of non-circular cross section, such as, by way of example, a wire of triangular, square, polygonal, oval or the like cross section, which is twisted about its longitudinal axis prior to coil winding so that the outer face of each

coil is formed by spaced narrow edge portions of the wire alternating with broad face portions, the external diameter of the coil being determined by the edge portions which radially project beyond the face portions.

In FIG. 3 there is shown an anchor constructed according to this invention prior to deformation by forming, wherein the twisted wire coil 1 of non-circular cross section is disposed about a length of PC wire 2 and is covered by a sleeve 3 of suitable metallic material having a relief 5 in the form of a tapered surface at one end thereof. For this swaging type of anchorage, the twisted wire coil 1 has an internal coil diameter equal to or only slightly larger than the diameter of the PC wire 2, and the sleeve 3, which may be constructed of steel or the like, has an internal diameter to just accommodate the twisted wire coil and the PC wire.

Thereafter, the sleeve 3 is reduced through a predetermined range by swaging to the form shown in FIG. 4 so that the narrow edge portions of the twisted wire coil 1 penetrate or cut into the inside surface of sleeve 3' and into the outer surface of the PC wire 2. In this case, the side of the sleeve facing an anchor plate 7 retains a planar surface and also, as before, the gripping force is reduced at this end.

In the pressing type of anchorage, illustrated in FIGS. 5 and 6, a sleeve 4 is provided with an annular relief groove 6 in place of the tapered end as shown with the sleeve 3 of FIG. 3, leaving conditions for the twisted coil 1 and PC wire 2 otherwise being the same as those for the swaging type of anchorage. Compression force is applied to the longer cylindrical portion of the sleeve 4 until it assumes the state or form shown at 4' in FIG. 6. There are two methods of applying pressing force, that is, partial or overall pressing, but no difference in the resulting anchorage effeciency is observed between the two. The partial pressing method is more convenient for field work as a portable pressing device can be employed.

As has been hereinbefore described, this invention provides an improved method of anchoring wires for prestressed concrete so as to obtain sufficient anchorage efficiency by compressing a sleeve to PC wire through twisted edged wires disposed therebetween. It has been confirmed through our experience that the sleeve length and the reduction ratio, respectively, have a close relationship with the anchorage efficiency.

In a specific example of the invention, the materials used were 0.5 in. 7-wire PC strand, and a sleeve of carbon steel containing 0.32–0.38% C, 0.15–0.35% Si, 0.60–0.90% Mn, max. 0.030% P and max. 0.035% S.

FIG. 7 shows relationship between reduction ratio and anchorage efficiency where the sleeve length is 50mm and the friction compound employed is a non-circular cross section of twisted wire coil which is annealed and cooled for the purpose of being brittled.

In FIG. 8, the relationship between the sleeve length and anchorage efficiency is illustrated and there the reduction ratio is 21 percent and the twisted coil was used as mentioned with reference to FIG. 7.

FIG. 9 shows the relationship of anchorage efficiency relative to several types of friction compound under the conditions 21 percent of reduction ratio and 50mm length of sleeve.

From this test result, it is found that the sleeve should have a length equal to two times or more the diameter of the PC wire when the reducing ratio of the sleeve is within the 10–30 percent range.

The examples shown in FIGS. 3 to 6 are for anchoring single strand PC wire, but they are equally applicable to multi-strand PC wires. As shown in FIG. 10, for example, each PC wire 2 is anchored to the same anchor plate 7 after swaging, in the same manner as hereinbefore described. The swaging type of anchorage is preferable for multi-strand anchorage as it employs an easier compressing force than the pressing type of anchorage.

Thus, in FIG. 10, a plurality of PC wires 2 are encased in twisted wire coils 1 of non-circular cross section and in a steel sleeve 8 having a plurality of receiving holes, and an anchor plate 7 is positioned between the sleeve 8 and the concrete 9.

FIGS. 11 and 12 show embodiments where plural numbers of anchorages according to this invention as shown in FIGS. 4 and 6 are secured on the same anchor plate. Thus, in FIG. 11, the PC wires 2 project through separate holes in an anchor plate 7 and are gripped separately in individual sleeves 3' through intervening twisted wire coils as hereinbefore described, the gripping having been effected through swaging of the individual sleeve assemblies. In FIG. 12, the PC wires 2 in the concrete 9 project through separate holes in the anchor plate 7 to be gripped in individual sleeves 4' which have been pressed to secure the same to the wires through twisted wire coils in a similar manner.

Various other modifications and variations of the invention are possible in light of the above teachings. It is to be understood, therefore, that within the scope of the appended claims, the invention may be practiced otherwise than as specifically described herein.

What is claimed as new and desired to be secured by Letters Patent of the United States is:

1. A method of anchoring at least one wire or strand for prestressed concrete comprising the steps of:
   - twisting a wire having a non-circular cross section to form a coil in a steel sleeve having a length equal to at least two times the diameter of the wire or strand;
   - sliding the sleeve containing the twisted wire coil over said at least one wire or strand in said concrete to be anchored to a position adjacent an anchor plate associated with said concrete; and
   - deforming the sleeve to secure the same to the twisted wire coil and to the wire or strand and to abut said anchor plate.

2. A method as set forth in claim 1, wherein said sleeve is secured by swaging.

3. A method as set forth in claim 2, wherein said sleeve is secured by swaging within the range of 10–30 percent of reduction ratio.

4. A method as set forth in claim 1, wherein said sleeve is secured by pressing.

5. A method as set forth in claim 4, wherein said sleeve is secured by pressing within the range of 10–30 percent of reduction ratio.

6. A method as set forth in claim 1, wherein the sleeve has a tapered relief at the end which is slid over the wire or strand and where the wire or strand is closely wound by the non-circular cross section twisted wire coil.

7. A method a set forth in claim 1, wherein the sleeve has a relief groove in its outer periphery at one end which is slid over the wire or strand and where the wire or strand is closely wound by the non-circular cross section twisted wire coil.

8. A method of anchoring a plurality of wires or strands in prestressed concrete comprising the steps of:

twisting a plurality of wires having a non-circular cross sections to form coils;

disposing said plurality of twisted wire coils one each in a plurality of metallic sleeves having lengths equal to at least twice the diameter of the wires or strands;

sliding the sleeves containing the twisted wire coils over free ends of the respective wires or strands in the concrete to be anchored to a position adjacent an anchor plate associated with said concrete; and

deforming each of said sleeves to cause said twisted wire coils therein to penetrate the interior surfaces of said sleeves and the exterior surfaces of said wires or strands and to cause said sleeves to abut said anchor plate.

9. A method as set forth in claim 8, wherein said sleeves are deformed by swaging.

10. A method as set forth in claim 8, wherein said sleeves are deformed by pressing.

11. A method of anchoring at least one wire or strand for prestressed concrete comprising the steps of:

twisting a wire having a non-circular cross section to form a coil for each of said at least one wire or strand;

positioning each of said twisted wire coils in a separate metallic sleeve having a length at least twice the diameter of said at least one wire or strand;

relieving said separate metallic sleeves adjacent one end thereof adapted to be positioned against an anchoring plate;

sliding each of the relieved sleeves containing a twisted wire coil over the free end of one of said at least one wire or strand adapted to be anchored in said concrete with the anchoring plate positioned between said concrete and said free ends of said at least one wire or strand; and

deforming each of said sleeves about said at least one wire or strand to cause said twisted wire coils therein to penetrate the interior surfaces of said sleeves and the exterior surfaces of said at least one wire or strand and to provide a planar surface of contact between said sleeves and said anchoring plate through the relief of said sleeves adjacent said one end thereof adjacent said anchoring plate.

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