

(19)



Europäisches Patentamt
European Patent Office
Office européen des brevets



(11) Publication number:

0 247 130 B1

(12)

EUROPEAN PATENT SPECIFICATION

(45) Date of publication of patent specification: **29.01.92** (51) Int. Cl.⁵: **E04C 5/08**

(21) Application number: **86906911.2**

(22) Date of filing: **18.11.86**

(86) International application number:
PCT/HU86/00060

(87) International publication number:
WO 87/03322 (04.06.87 87/12)

(54) **STRAND FOR STRESSED CONCRETE STRUCTURE AND PROCESS FOR ITS PRODUCTION.**

(30) Priority: **26.11.85 HU 451185**

(43) Date of publication of application:
02.12.87 Bulletin 87/49

(45) Publication of the grant of the patent:
29.01.92 Bulletin 92/05

(84) Designated Contracting States:
AT DE FR GB IT SE

(56) References cited:
DD-A- 133 533 DE-A- 1 954 779
DE-A- 2 416 633 DE-A- 2 855 869
GB-A- 793 305 US-A- 3 735 625

RORORO-TECHNIK-LEXIKON "BAUTECHNIK
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Description

The invention relates to a stressed concrete structure strand comprising at least three wires twisted together and to a method for producing a stressed concrete structure strand wherein a first cross-section of individual wires is formed and then at least three wires are twisted to form a strand.

As known, different strands are used for pre-stressed, or after-stressed (reinforced) concrete structures to take up the stretching force. These are formed generally with three to seven pieces of 2 to 5 mm thick cold drawn individual steel wires, so-called "elementary filaments" to cable-type strand with the use of twisting (stranding) machine. These strands transmit the stretching force to the concrete structure through adhesion, or anchorage between the strand and the concrete.

The experts have been trying to find a solution for a long time, whereby adhesion or holding power of the strands to the concrete could be improved, since this way the stretching force could be increased, which would be particularly desirable especially in case of high load bearing stressed concrete structures, or long spans.

Such strands and cables are already known from the British patent specification No. 1 194 758 and GFR patent specification No. 1 659 265, where evenly distributed (periodic) profiling of small depth is produced by rolling after cold drawing on the surface of the covering wires of the strand, just as in case of the simple concrete reinforcing rods.

Although the adhesive capacity of the strand in the concrete is improved by the periodic profiling formed with such indentation, i.e. "the anchoring length" will be shorter, however the increased risk of cracking or breakage must be reckoned with in the elementary filaments at the corners of the indentations upon the bending and torsional stresses arising during loading of the strand. Furthermore, the arrangement of the periodic surface profiles within the strand is incidental, in other words, the "functional" cross section surfaces of the sections perpendicular to the longitudinal axis of the strand are different from each other, consequently the stress conditions arising during loading are also different. This implies that the possibly smallest cross section is to be reckoned with for strength calculation of the strand, which however is unfavourable in respect of the steel utilization.

Furthermore such process for strand production is recommended by the British patent specification No. 1 336 200, where the strand twisted from round wires is tightened by deformation with radial external pressure. In the course of this, mainly the covering wires pass through free deformation, while their concentric cross section will be deformed to irregular shape. The purpose of tight-

ening is to obtain the possibly smallest strand cross section mainly for the after-stressed structures. This tightening however inevitably entails reduction of the outer surface of the strand in contact with the concrete, which in view of the foregoing is undesirable in respect of the adhesion.

DE-A-2 416 633 discloses reinforcement strands made from rods or strips for normal unstressed concrete structures. However, said strands cannot be stressed because they do not go through the whole concrete element. The length to diameter ratio is preferably between 70 and 160. With a diameter of 0,35 mm, the length will be between 2,50 cm and 5,6 cm. Even if the strands were long enough for use unstressed concrete the suggested tensile strength range of 830 N/mm² to 1370 N/mm² is inadequate for stressed concrete. The round wires of said document are fixed together by a binder and are arranged uniplanar.

It is therefore an object of the invention to eliminate the above short comings, i.e. when realizing and manufacturing such strand for stressed reinforced concrete structures, whereby the adhesion to concrete can be improved and at the same time identical stress conditions can be assured in all strand cross sections.

The object is solved in that all the wires forming the strand have the same non-circular cross-section along their whole length.

The object is also solved by a method for producing a stressed concrete structure strand, wherein a first cross-section of individual wires is formed and then at least three wires are twisted to form a strand by forming all the individual wires with the same cross-section as a uniform non-circular one along their length by cold drawing the wire through a drawplate.

Further embodiments are included in the sub-claims 2 to 6 and 8 to 10.

Initially such strand was used, which has a twist formed with at least three wires provided with surface profiling. This was further developed according to the invention in that the surface profiling of the wires is formed as non-circular cross section-profile continuously passing through the wire in longitudinal direction.

The cross section profile of the wires continuously passing through in longitudinal direction may suitably be a polygonal profile, preferably a rounded regular hexagon. This enables a very simple production.

According to a further characteristic feature of the invention such construction is also conceivable, where the cross section profile of the wires continuously passing through in longitudinal direction is formed as such circular or polygonal cross section, which is provided with longitudinal groove-like recesses and/or rib-like extensions evenly distributed

along the circumference.

In the course of the development of the method for the production of the strand according to the invention the starting point was such conventional method where first the surface profiling of the wires is formed with cold deformation, then at least three wires are formed to strand with simultaneous twisting.

The essence of the process according to the invention is that the surface profiling of the wires is formed by drawing through drawplate of non-circular, preferably rounded hexagonal cross section.

It is advisable to form the wires by turning around their longitudinal axis during or after formation of the profile, but before twisting. It is expedient if the turning direction of the wires coincides with the subsequent twisting direction of the strand. Furthermore, it is preferable if the pitch of the twisting is selected to the multiple, suitably at least to tenfold of the pitch of wire-turning.

The invention is described in detail with the aid of drawing, showing the cross section of the strand according to the invention given by way of example, and drawn to enlarged scale. As seen, the strand denoted with reference number 1, in this case consists of a central wire 2, (i.e. "supporting core wire") and tangentially surrounding six covering wires 3.

According to the invention the covering wires 3 in contact with the concrete in built-in state and the cover wire 2 have non-circular cross section profile continuously passing through in longitudinal direction for the purpose of increased adhesion to the concrete, and establishing identical stress conditions in all strand cross sections. In the presented case the covering wires 3 are of regular hexagonal cross section, rounded on the corners. In the drawing the diameter of the circle drawable into the hexagon in case of the cover wire is marked with D_3 , diameter of the circle drawable around the hexagon with D'_3 , and the embracing face-distance of strand 1 with L_1 , while its distance between centres is marked with L_2 .

It is advisable to dimension the diameter of the central wire 2 greater by 3-4 % than the diameter D'_3 of the covering wires 3 for better seating of the covering wires 3. In case of the 1/2" strand - given by way of examples - the diameter of central wire 2 was selected to 4.26 mm, and the diameter D'_3 of the covering wires 3 to 4.11 mm.

It is noted that the covering wires 3 are shown in ideal state in the drawing, where the hexagonal faces of the adjacent wires 3 bear up on each other. In the reality this rarely occurs.

Production of the strand 1 according to the invention is the following:

The production technology of the central wire 2 and covering wires 3 is essentially conventional. In

the production of the covering wires 3 according to the invention only the last step of the cold deformation is different, where special drawplate of hexagonal opening cross section was used to obtain the required cross section.

In the present case the covering wire 3 is turned around its longitudinal axis (naturally this can be dispensed with in given case) while passing through the drawplate. The pitch of wire-turning is determined by the pitch of the drawplate. During the experiments the drawplate was embedded as to be capable to turn around the advanced wire.

After finishing the production of the covering wires 3, the twist, i.e. the strand 1 is formed on a conventional twisting machine with the central wire 2 and six covering wires 3. In the course of the experiments the turning direction of the covering wires 3 was selected to be identical with the direction of twisting, furthermore the pitch of twisting was selected to about tenfold of the turning pitch. As a result of this, after the twisting favourable contact between the wires 2 and 3, and after building in the strand 1 the possibly most favourable anchorage were accomplished with the illustrated helical hexagon profile.

Naturally the strength properties of the strand can be improved by the conventional heat treatments widely used in the practice (e.g. tempering, stabilization), which however are obvious for the expert in the art, thus their description is unnecessary.

The experiences of the experiments demonstrated that the illustrated strand 1 according to the invention can be produced simply and productively at relatively low additional cost, with traditional equipment. Owing to the hexagonal cross section of the covering wires continuous in longitudinal direction, any cross section of the strand is identical, consequently the arising stress conditions too are identical. The surface area increased according to the periodic profiling results in improved anchoring capacity of the strand 1, consequently the load bearing capacity of the strand 1 and its safety factor are also increased. Or assuming for instance identical load bearing, compared to traditional strand of periodic profiling, the use of steel, i.e. material is less for the strand provided with covering wires of helical hexagon cross section according to the invention.

Naturally for example in the case of a three-wire strand the central wire 2 is omitted. Moreover, in case of multi-wire strands the central wire may be identical with the covering wires. Furthermore, according to the invention in place of the above described hexagon profile any other non-circular profile can also be used with similar result, e.g. as polygonal cross sections, thus regular pentagon, octagon, etc. In addition, such circular or polygonal

profile too may come into question at least for the covering wires, which is provided with groove-like recesses passing through in longitudinal direction, and/or rib-like, or web-like extensions passing through in longitudinal direction. The cold deformation of the three latter ones may be accomplished in any other way, e.g. by rolling.

Claims

1. Stressed concrete structure strand comprising at least three wires (2, 3) twisted together, characterized in that all the wires (2, 3) forming the strand have the same, uniform non-circular cross section along their whole length. 10 15
2. Strand according to claim 1, characterized in that the uniform non-circular cross-section is polygonal. 20
3. Strand according to claim 2, characterized in that the polygonal cross-section has rounded corners. 25
4. Strand of claim 1, characterized in that the uniform non-circular cross-section is a regular hexagon and the wires (3) are twisted along their longitudinal axes. 30
5. Strand of claim 1, 2, 3 or 4, characterized in that at least some of the wires (3) are provided with longitudinal groove-like recesses continuously along their whole length. 35
6. Strand of claim 1, 2, 3 or 4, characterized in that at least some of the wires (3) are provided with longitudinal web-like extensions continuously along their whole length. 40
7. Method for producing a stressed concrete structure strand wherein a first cross section of individual wires is formed and then at least three wires are twisted to form a strand, characterized by forming all the individual wires with the same cross section as a uniform non-circular one along their whole length by cold drawing the wire through a draw plate. 45
8. Method according to claim 7, characterized in that prior to the twisting step the individual wires (3) are deformed by being turned about their respective individual longitudinal axes. 50
9. Method according to claim 8, characterized in that the turning direction for the individual wires (3) coincides with the subsequent twisting direction for the whole strand (1). 55

10. Method according to claim 9, characterized in that the pitch of the strand's twisting is selected to be a multiple, preferably tenfold of the pitch of the wire-turning for the individual wires.

Revendications

1. Toron pour structure en béton précontraint, comprenant au moins trois fils métalliques (2, 3) câblés ensemble, caractérisé en ce que tous les fils (2, 3) formant le toron présentent la même section transversale uniforme non-circulaire, sur toute leur longueur.
2. Toron selon la revendication 1, caractérisé en ce que la section transversale uniforme non-circulaire est polygonale.
3. Toron selon la revendication 2, caractérisé en ce que la section transversale polygonale présente des coins arrondis.
4. Toron selon la revendication 1, caractérisé en ce que la section transversale uniforme non-circulaire est un hexagone régulier et en ce que les fils métalliques (3) sont câblés le long de leur axe longitudinal.
5. Toron selon la revendication 1, 2, 3 ou 4, caractérisé en ce qu'au moins certains des fils (3) sont pourvus de cavités longitudinales en forme de rainures, ménagées de façon continue sur toute leur longueur.
6. Toron selon la revendication 1, 2, 3 ou 4, caractérisé en ce qu'au moins certains des fils (3) sont pourvus de prolongements longitudinaux en forme de bande, ménagés de façon continue sur toute leur longueur.
7. Procédé de fabrication d'un toron pour structure en béton précontraint, dans lequel on réalise une première section transversale des fils individuels et ensuite, on câble au moins trois fils pour former un toron, caractérisé par la réalisation de tous les fils individuels, avec la même section transversale uniforme non-circulaire, sur toute leur longueur, par étirage à froid du fil dans une plaque d'étirage.
8. Procédé selon la revendication 7, caractérisé en ce qu'avant l'étape de torsion, les fils individuels (3) sont déformés en les faisant tourner autour de leurs axes longitudinaux individuels respectifs.
9. Procédé selon la revendication 8, caractérisé

en ce que le sens de rotation des fils individuels (3) coïncide avec le sens du câblage de la totalité du toron (1).

10. Procédé selon la revendication 9, caractérisé en ce que le pas du câblage du toron est sélectionné pour être un multiple, de préférence un décuple du pas de rotation des fils individuels.

Patentansprüche

1. Spannbetonstruktur-Seil, mit wenigstens drei zusammengedrehten Drähten (2, 3), dadurch **gekennzeichnet**, daß alle die Drähte (2, 3), die das Seil bilden, denselben, gleichförmigen, nicht kreisförmigen Querschnitt entlang ihrer gesamten Länge aufweisen.
2. Seil nach Anspruch 1, dadurch **gekennzeichnet**, daß der gleichförmige, nicht kreisförmige Querschnitt polygonal ist.
3. Seil nach Anspruch 2, dadurch **gekennzeichnet**, daß der polygonale Querschnitt abgerundete Ecken aufweist.
4. Seil nach Anspruch 1, dadurch **gekennzeichnet**, daß der gleichförmige, nicht kreisförmige Querschnitt ein reguläres Hexagon ist, und die Drähte (3) entlang ihrer longitudinalen Achsen verdreht sind.
5. Seil nach Anspruch 1, 2, 3 oder 4, dadurch **gekennzeichnet**, daß wenigstens einige der Drähte (3) mit longitudinalen, rillenähnlichen Vertiefungen kontinuierlich entlang ihrer gesamten Länge versehen sind.
6. Seil nach Anspruch 1, 2, 3 oder 4, dadurch **gekennzeichnet**, daß wenigstens einige der Drähte (3) mit longitudinalen, gewebeähnlichen Fortsätzen kontinuierlich entlang ihrer gesamten Länge versehen sind.
7. Verfahren zum Herstellen eines Spannbetonstruktur-Seiles, worin ein erster Querschnitt einzelner Drähte gebildet wird, und dann wenigstens drei Drähte verdreht werden, um ein Seil zu bilden, **gekennzeichnet**, durch Bilden aller der einzelnen Drähte mit demselben Querschnitt als einen gleichförmigen, nicht kreisförmigen entlang ihrer gesamten Länge, durch Kaltziehen des Drahtes durch eine Ziehplatte.
8. Verfahren nach Anspruch 7,

dadurch **gekennzeichnet**, daß vor dem Verdrillungsschritt die einzelnen Drähte (3) deformiert werden dadurch, daß sie um ihre jeweiligen individuellen longitudinalen Achsen gedreht werden.

9. Verfahren nach Anspruch 8, dadurch **gekennzeichnet**, daß die Drehrichtung für die einzelnen Drähte (3) zusammenfällt mit der nachfolgenden Verdrillungsrichtung für das gesamte Seil (1).

10. Verfahren nach Anspruch 9, dadurch **gekennzeichnet**, daß die Steigung der Verdrillung des Seiles gewählt wird, ein Vielfaches, bevorzugtermaßen das Zehnfache der Steigung der Drahtdrehung für die einzelnen Drähte zu sein.

