Jan. 27, 1970 K. BAUER 3,491,497

EARTH ANCHOR AND METHOD OF FORMING SAME

Filed Jan. 24, 1966

FIG. 1

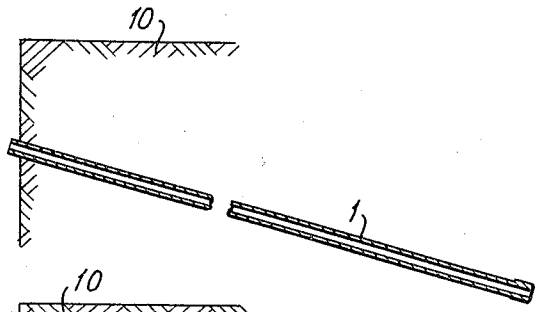


FIG. 2

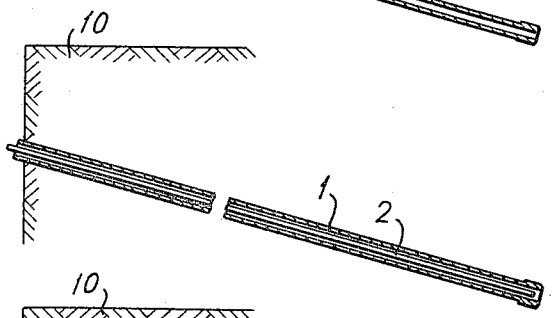


FIG. 3

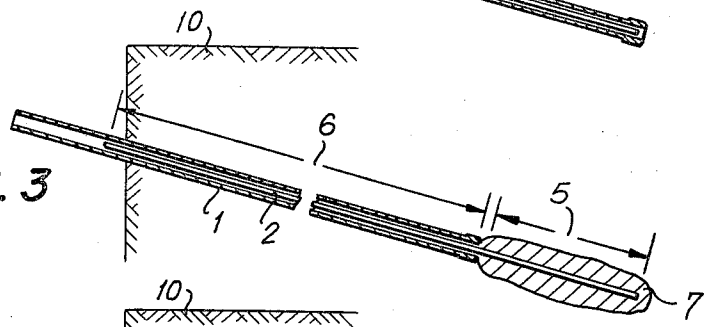


FIG. 4

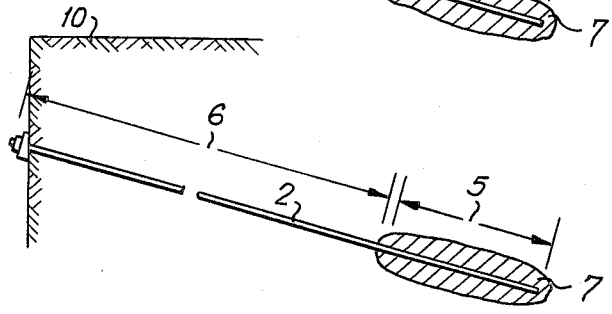
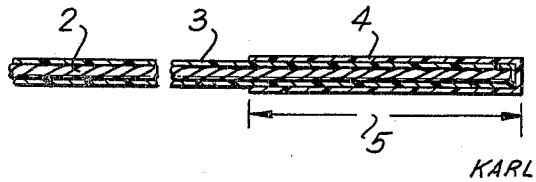


FIG. 5



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United States Patent Office 3,491,497 Patented Jan. 27, 1970

3,491,497

EARTH ANCHOR AND METHOD OF FORMING SAME

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Filed Jan. 24, 1966, Ser. No. 522,642
Int. Cl. E02d 5/74
U.S. Cl. 52—166 4 Claims

ABSTRACT OF THE DISCLOSURE

A process for forming an anchorage capable of withstanding tensile stresses in the range of from 50 to 150 kilopounds per square centimeter includes the bonding of a tensile force transmitting tie rod to a concrete anchoring mass which is accomplished when neither the resin nor the concrete has hardened so that there will be a penetration bonding of the resin into the concrete. The method is advantageously carried out by forcing a pipe section into a receiving structure such as the ground and thereafter injecting concrete downwardly through the pipe and around at least a portion of the steel rod member which has the resinous material coated thereon in a layer which has not fully hardened. The anchorage formed in this manner is capable of resisting very high tensile forces.

SUMMARY OF THE INVENTION

This invention relates, in general, to an anchorage construction and to a method of effecting the same, and in particular, to a new and useful anchorage which includes a tie member of a metal material anchored in a hardening material such as concrete by an adhesion bridge of a hardening synthetic resin material and to a method of forming such anchorage.

At the present time, anchorages are being made with the use of a metallic tensioning member having a widened tension transmitting part which is anchored directly in concrete. The holding force is achieved by direct frictional contact between the tensioning member and the concrete. A disadvantage of such construction is that the capacity of the device depends on the type of tension transmission formation or shoulder which is formed at the inner end of the tension member and the friction between the tie member and the holding material which may be concrete. It is desirable that the tension be transmitted over a given length of tie member before it is transmitted to the surrounding earth. In order to effect a short transmission length of tie member, it is presently necessary to employ a transmission portion or shoulder of relatively great cross section and the necessary borings to insert such a member is very expensive.

In accordance with the invention, there is provided an anchorage construction which includes a tie member of metal material in which the adhesion is effected between a hardening structural material such as concrete by the use of an intermediate layer or formation of a plastic material. In the preferred process of the invention, the plastic material or adhesive body is formed between the hardening material and the tie member to form an elastic adhesion bridge of water-resistant synthetic resin cement. The adhesion bridge is established by the hardening of the resin around the steel tie member simultaneously with the hardening of the structural material which is injected into the excavation around the resin.

The invention is based on the discovery that concrete and steel, may be connected in a better manner than a direct connection by an adhesion bridge effected by the polycondensation or polyaddition of synthetic resin components through which the adhesion to their surrounding

surfaces is established by so-called physical adhesion or absorption between micromolecules of plastics and the free existing valences of the surrounding surfaces by a so called "Van der Wall" tower. The adhesion begins during the process of polymerization or polyaddition between a plurality of compounds of such synthetic resin compounds and they are explained as being electrical powers according to the known art. The resistance of the hardening synthetic resin cement permits an increase of the holding force of the anchorage up to the limit of the loading capacity of the tie member and the injection material. Thus, with the invention it is possible to achieve a much greater holding force with the usual length of tension transmission member. It is also possible to use thinner tie members for equal anchor loads and thus borings of smaller diameter.

In a further aspect of the method of the invention, a steel tie rod is advantageously employed which is first degreased and then sand-blasted. It is thereafter coated with a layer of hardening synthetic resin to form a smooth surface on the exterior of the rod. This has the added advantage that it protects the tie rod against corrosion. The anchorage foundation is then made in the ground by drilling a pipe to the required depth and the tie rod is inserted into the pipe with a layer of synthetic material being formed at the lower ends thereof either before or after insertion. Before the hardening of the synthetic material, a hardening structural material such as concrete is also formed around the synthetic material and the two are permitted to harden together around the tie member.

Accordingly, it is an object of the invention to provide an improved method for forming an anchorage which includes forming a synthetic layer around a steel rod member and before the layer hardens forming a concrete anchoring base around the synthetic layer.

A further object of the invention is to provide an anchorage construction which includes a steel tie rod member having a coating of a plastic resinous material and including a bonding between a hardened concrete and a layer of resin material formed around the lower end of the rod member.

A further object of the invention is to provide an anchorage which is simple in design, rugged in construction and economical to manufacture.

The various features of novelty which characterize the invention are pointed out with particularity in the claims annexed to and forming a part of this specification. For a better understanding of the invention, its operating advantages and specific objects attained by its use, reference should be had to the accompanying drawings and descriptive matter in which there are illustrated and described preferred embodiments of the invention.

In the drawings:

FIGS. 1–4 are somewhat schematic indications of an anchorage formed in accordance with the process of the invention; and

FIG. 5 is a partial elevational and partial sectional view of an anchorage constructed in accordance with the invention.

As indicated in FIG. 1, the process of the invention is carried out by first drilling a bore hole into the ground or wall structure **10** by using a drilling pipe **1**. The pipe is driven into the ground **10** up to the earth statically required depth. For this purpose a drilling pipe which surrounds a tie member **2** may be employed, as indicated in FIG. 2, or the drilling may be accomplished first and then the tie member **2** may be inserted later. It should be appreciated that the tie member **2** which is schematically indicated may be either a single rod, a wire bundle or a rope or cable advantageously all made of a metallic material and with only a very limited free space

between the rod 2 and the surrounding pipe 1. The clearance for example may be small enough so that the tie member 2 may be inserted into the pipe and leave only sufficient space around the member for the insertion of an injection liquid.

After the final depth of the bore hole has been reached, the previously prepared tie member 2 is located at the proper depth for forming the anchorage. The tie member is preferably prepared a few days before the insertion, as indicated in FIG. 5. This preparation requires first a complete coating of the tie member preferably with a 0.15 mm. thick layer of synthetic resin 3. This is done after the tie member 2 has first been degreased and sand-blasted. Immediately before the tie member is inserted into the pipe 1, a second layer of synthetic material 4 is advantageously applied over the first layer so that the lower end, preferably only in the area in which the power transmission or holding force of the anchorage is to be transmitted. The second layer thickness 4 is advantageously 0.15 mm. Thus, the entire combined coating in the area of the power transmission is the combined thickness of the layers 3 and 4 which would be around 0.30 mm.

Abrasion of the not yet hardened layer of the synthetic resin of the power transmission parts in the area coated by the layer 4 will not be expected during the insertion into the pipe since the synthetic resin toughens very quickly after its application.

An alternate method of preparing the tie rod 2 may be chosen. In this method, before complete hardening of a first layer 3 of the tie member, the power transmission section of the member is rolled in quartz sand of a grain size of preferably less than 1 mm. in diameter. By this rolling the grains are pressed into the layer up to at least ⅓ of their surface. By enlargement of the surface and structural formation of the quartz material the friction between the synthetic resin bridge and an adhesion body 7 of a hardening structural material injected into the earth, as indicated in FIGS. 3 and 4, will be increased.

With the tie member 2 inserted to its final anchoring position, the drilling pipe 1 is withdrawn up to the length of the power transmission section or substantially the length of the extra coating 4. A hardening structural material such as concrete is passed through the drilling pipe under pressure and is formed into a hardened mass 7. Thereafter the drilling pipe 7 is completely withdrawn and eventually the open boring may be filled with an additional hardening structural material.

Since the tie member 2 is coated over its length with a synthetic resin layer 3 which has already hardened before insertion of the tie member, this layer will form a completely smooth surface on the exterior of the tie member and adhesion between the tie member and the surrounding earth will not occur in this area. Thus, the power transmission or holding force is effected completely in the area of the layer 4, that is, the area designated by the numeral 5 in FIGS. 3, 4 and 5. The power transmission is effected in the area 5 through the adhesion between the tie member 2, synthetic resin bridge 3 and 4, and the injection material 7 in the area required for earth statical reasons, as shown in FIG. 4.

When a pile hammer bit is used to advance the bore hole, the bit is permitted to remain in the earth as an anchorage part. It may, however, be firmly attached to the tie member after the latter has been inserted and thus will contribute to the holding power of the anchorage. After the injection material has set and the adhesion bridge of synthetic resin has hardened, the tension anchor is prestressed to the desired permissible load.

In accordance with another method of forming the anchorage, the concrete material is injected into the pipe before the tie member is inserted and after scavenging the drilling pipe, the tie member which is prepared in accordance with the previous method is rammed into the concrete which has not yet set. Such an arrangement permits a further reduction of the drilling diameter and the soil condition requirements.

According to a still further method of forming the anchorage, the hardenable injection material may be introduced into the ground by vertical drilling and the tie member may be introduced by drilling oblique thereto to intersect the vertical drilling and become embedded in the not yet hardened concrete material to complete the anchorage.

The process of the invention may be used in rock-like soil, whereby the function of the drilling pipes as protective pipes during the introduction of the tie member may be omitted since a drilling hole in the rock will remain open.

The process according to the invention is suitable for securing building excavations. Since the adhesion bridge of synthetic resin cement is at the same time highly effective protection against corrosion and since the tie member is preferably coated with a smooth layer of synethic resin which has already hardened before it is inserted, such anchorings may also be used as suitable anchorings for wet dock walls and dock structures for protection against upward pressure of underground water or for reinforcement of steep slopes in road building, etc.

Tests with anchorages of the type made by the process of the invention have unexpectedly shown that tension stresses between power transmission parts and the adhesion body of injected hardening structural material are from 50 to 150 kilopounds per square cm of smooth adhesion surface may be reached using the connection of synthetic resin cement, provided that this synthetic resin cement bridge is hardened simultaneously with the hardening of the injected structural material. Higher values will be obtained by proper selections of the synthetic resin cement and the structural tie material. There is no tendency for the adhesive bridge to peel from its cemented connection.

By the process of the invention it has been found that the power transmission service required for maintaining the holding loads which were previously effected may be one fifth of the surface which was previously required. This has the advantage that the boring depth and the length of the anchor must only be established over the earth statically required length. Thus, it is impossible to keep the power transmission part very short, which makes it possible to have a considerable reduction of boring length, steel length and injection material.

While specific embodiments of the invention have been shown and described in detail to illustrate the application of the inventive principles, it will be understood that the invention may be embodied otherwise without departing from such principles.

What is claimed is:

1. A tensive force resistant anchorage capable of withstanding tensile stresses in the magnitude of from 50 to 100 kilopounds per square centimeter, comprising a steel tie rod having one end for transmitting tensile force and an opposite anchored end, a mass of concrete engaged around said anchored end of said tie rod for anchoring said tie rod, and a resin material coated over and bonded to said opposite anchored end of said tie rod and bonded with said concrete, wherein said steel rod includes a uniform coating of a first layer of synthetic resin material and thereafter a second layer on top of said first layer at a location adjacent its end, at least said second layer being formed with and bonded into said concrete.

2. A process for forming an anchorage capable of withstanding tensile stresses in the range of from 50 to 150 kilopounds per square centimeter, comprising forming a layer of resin material around a metal tie rod, and before the layer hardens forming a base of structurally hardenable material, such as concrete, around the resin layer to form an adhesive bridge of resin between the

tie rod and the concrete, coating the entire length of the steel tie rod with a resin material which is permitted to harden and, thereafter, coating a portion of the length of the rod with an additional layer of a hardenable resin material and bonding the additional layer with the concrete before it is permitted to harden.

3. A process for forming an anchorage capable of withstanding tensile stresses in the range of from 50 to 150 kilopounds per square centimeter, comprising forming a layer of resin material around a metal tie rod, and before the layer hardens forming a base of a structurally hardenable material, such as concerete, around the resin layer to form an adhesive bridge of resin between the tie rod and the concrete, forming an excavation by inserting a drilling pipe into a anchoring base such as the ground, and, thereafter, inserting a steel tie rod which has been coated with the resinous material which has not yet hardened into the pipe, withdrawing the pipe by a predetermined amount and simultaneously directing concrete through the pipe to fill the area withdrawn to permit it to become hardened over the layer of resinous material at the end of the tie rod exposed by the withdrawal of the pipe.

4. A process for forming an anchorage capable of withstanding tensile stresses in the range of from 50 to 150 kilopounds per square centimeter, comprising forming a layer of resin material around a metal tie rod,

and before the layer hardens forming a base of a structurally hardenable material, such as concrete, around the resin layer to form an adhesive bridge of resin between the tie rod and the concrete, wherein the steel tie rod is treated before it is bonded to the concrete by first coating it with a uniform layer of a plastic resinous material which is permitted to harden and, thereafter, rotating it in a quartz sand material in order to treat the surface thereof, and then applying a further layer of a hardening synthetic cement which is directed into the concrete before the further layer is permitted to harden.

References Cited

UNITED STATES PATENTS

2,921,463	1/1960	Goldfein	52—223
3,115,226	12/1963	Thompson	52—166 X
3,204,416	9/1965	Williams	52—743 X

FOREIGN PATENTS

410,973	5/1934	Great Britain.

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U.S. Cl. X.R.

52—146; 61—35