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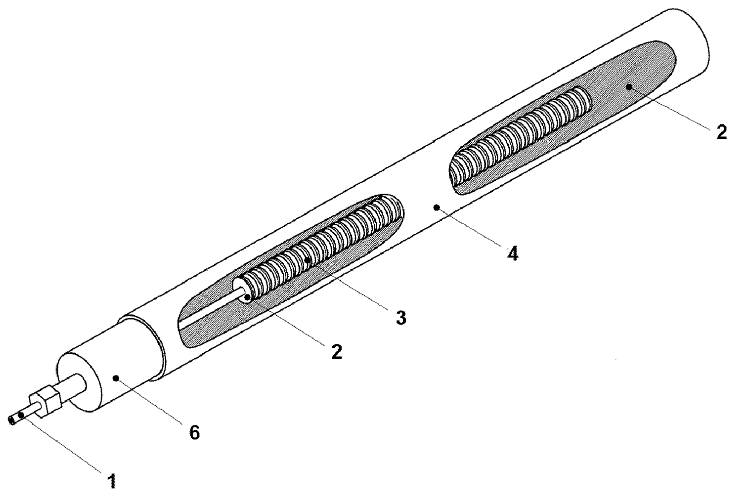
(54) A METHOD OF TESTING A STRUCTURE, AN ASSEMBLY FOR TESTING A STRUCTURE, AND USE OF AN ASSEMBLY FOR TESTING A STRUCTURE

(57) Method of testing a structure comprising the steps of providing at least one ten-sile element, providing at least one removable and/or sacrificial core, arranging the core at a position where a cavity is to be created, embedding the at least one tensile element and the at least one core in a first hardening and/or hardenable material, allowing or causing said first material to harden, creating at least one cavity in the first material by removing at least one core from the hardened first material if necessary, applying a load to the structure to a predetermined load level and maintaining said load level, filling a hardening and/or hardenable second material into the at least one cavity created, permitting or causing said second material to harden while maintaining the load, and removing the load from the structure after the second material has reached a compressive strength that is at least equal to the compressive strength of the first material.

Fig. 1



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Description

[0001] The present invention relates to a method of testing a structure, in particular a strand ground anchor, comprising at least one tensile element, an assembly for testing a structure, and the use of an assembly for testing a structure.

[0002] Pre-stressed concrete structures are widely employed in constructions ranging from bridges to ground anchors. Such structures have at least one tensile element, such as a stressed rod or other elongate member, extending along the length of the structure, wherein the tensile elements are embedded in cement grout or another hardened material.

[0003] It has been found that cracks may develop upon tensioning concrete structures of the aforesaid kind. If the stressed member or members are made of metal or metal alloy, moisture penetrating through these cracks may lead to serious corrosion of the stressed member or members. Hence, such cracking is extremely serious and might be the cause of collapse of the structure with the serious risk of consequential loss of human life, if these cracks exceed certain dimensions and unless the structure exhibiting such cracks is replaced or is satisfactorily repaired.

[0004] Consequently, the reliable and accurate assessment of the condition and integrity of pre-stressed structures, including the differentiation of cracks of different origin, remains an important topic.

[0005] Strand ground anchors are widely used in geotechnical engineering applications such as slope stabilization, deep excavation, anti-lifting foundation, and dam stabilization.

[0006] The integrity assessment of ground anchorages is defined and described in the European standard EN 1537. According to the method "type B" described therein, the maximal crack width in the cement grout under a given service load must be less than 0.1 mm if the cement grout is to be considered as an effective corrosion protection barrier.

[0007] In this test, an assembled anchor is installed into a sealed steel frame and cementitious grout is poured to fill both the space inside the corrugated plastic duct housing the tensile element and the outer space between said duct and the steel testing frame. After the grout has achieved the desired strength, the anchor is loaded to a maximum load it will be subjected to during testing in situ. After unloading of the ground anchor, the steel frame is opened to expose the corrugated duct and the inner cementitious grout for assessment. Subsequently, the distribution of the cracks formed under load and the crack width are measured and the maximum crack width at the proof load is calculated based on the maximum crack spacing of the inner grout and the strain in the tendon at the proof load.

[0008] However, in practice, it is very difficult to achieve a relevant crack assessment for inner grout through the corrosion test "type B" for a number of reasons. Firstly, the elongated strands are not fully reset to their original state after unloading due to friction between strand and grout, which creates a residual compressive stress on the inner grout body. The residual compressive stress might induce longitudinal cracks in the slender inner grout body upon changing from a confined condition to an unconfined condition, i.e. at the moment the steel frame and the external grout are removed. Moreover, additional cracks are induced in the inner grout body upon dismantling of the steel frame and excavating the corrugated duct from the hardened external grout as the inner grout body inevitably bears an extra force and vibration during these steps. It is therefore not possible to distinguish clearly between cracks of different origin.

[0009] Accordingly, it is the object of the present invention to remedy these and other disadvantages of the state of the art and in particular to provide a method of testing pre-stressed structures, in particular strand ground anchors, which allows for reliable crack width and distribution measurements as well as differentiation between cracks of different origin.

[0010] The object is achieved by a method of testing a structure, an assembly for testing a structure, and the use of an assembly for testing a structure pursuant to the independent claims.

[0011] According to the present invention, the method of testing a structure comprises the steps of providing at least one tensile element, providing at least one removable and/or sacrificial core, arranging the core at a position where a cavity is to be created, embedding the at least one tensile element and the at least one core in a first hardening and/or hardenable material, allowing or causing said first material to harden, optionally creating at least one cavity in the first material by removing at least one core from the hardened first material, applying a load to the structure to a predetermined load level and maintaining said load level, filling a hardening and/or hardenable second material into the at least one cavity created, permitting or causing said second material to harden while maintaining the load, and removing the load from the structure after the second material has reached a compressive strength that is at least equal to the compressive strength of the first material.

[0012] In the context of the present specification, the term *tensile element* refers to the part of a pre-stressed structure carrying only tension and no compression or preferably bending, typically comprising a single high tensile steel bar or wire, a bundle of identical wires or a bundle of multiple strands.

[0013] In the context of the present specification, the term *core* refers to an object which, in the course of the method described herein, is embedded in the first hardening and/or hardenable first material and allows the creation of a cavity in the hardened first material. The cavity is used to transport the hardening and/or hardenable second material into any cracks or voids in the hardened first material that are in fluid communication with said cavity. The core can be completely or partially hollow or completely or partially solid. Furthermore, the core can be removable from the first material or non-removable therefrom. In the latter case, the core is a sacrificial element that is at least partially destroyed prior to or in the course of filling with the hardening and/or hardenable second material.

[0014] The method according to the invention has the advantage that both the position and the extent of cracks originating from loading the tensile element are marked and conserved by the second filling material and, hence, the cracks can be readily identified among cracks of various origins, including cracks resulting from disassembling the testing frame or excavating the tensile element, i.e. cracks originating from work on the test specimen.

[0015] In certain embodiments, the structure comprising at least one tensile element is a strand ground anchor.

[0016] In certain embodiments, the at least one tensile element comprises at least one strand bundle.

[0017] In certain embodiments, said removable core is a rigid or flexible string. The use of strings, in particular flexible strings, has the advantage that upon pulling their cross section is reduced and thus the friction to the surrounding hardened first material is also reduced, which makes it easier to remove the strings.

[0018] Preferably, said removable cores are non-stick coated to facilitate their removal from the hardened first material.

[0019] The core can also be a sacrificial core. In this case the material does not need to be removed to create a cavity but the cavity is created by sacrificing the core or parts of the core before or during introduction of the second material. For example, a sacrificial core may comprise at least one predetermined breaking point, preferably several predetermined breaking points distributed over substantially the entire length of the sacrificial core, that can be opened by the second material under load or overload, e.g. at a certain pressure. After opening said breaking points, the second material can pass through the sacrificial core and into any voids in the first material along the specimen. In another example, a sacrificial core may comprise a heat-induction wire covered by a low-melting polymer. Preferably, the core material is different from the first material.

[0020] In certain embodiments, the first hardening and/or hardenable material is cement grout.

[0021] In the context of the present specification, the term *grout* refers to cementitious material that transfers load from the tensile element to the environment surrounding the grout. Grout may fill the remainder of the first casing and/or second casing and/or contribute to corrosion protection of tensile elements made of steel.

[0022] In certain embodiments, the load applied to the structure is a tensile load.

[0023] Surprisingly and in contrast to existing methods known from the state of the art, a complete filling of cracks existing inside pre-stressed structures is made possible by applying at least one core acting as a means for creating a cavity, which serves as a kind of supply channel to fill any cracks resulting from the loading of the structure's tensile element with a filling material. It should be emphasized that no drilling is required to fill the cracks existing inside the structure. In particular, no drilling is required after tensioning of the tensile element.

[0024] Preferably, the core is arranged substantially coaxially to the tensile element, and is placed as close as feasible to the tensile element.

[0025] Arranging the core substantially coaxially to the tensile element has the advantage that the cavity to be created will also extend in the expansion direction of the tensile element and will be generated at a distance from the tensile element where load-induced cracks typically occur in the first material surrounding the tensile element, thus allowing an efficient filling of cracks.

[0026] In the method of the present invention, the hardening and/or hardenable second material employed in filling cracks and other voids in fluid communication with the cavity may comprise a compound of which the major proportion is a synthetic resin, for instance a polyester resin or an epoxy resin, to which suitable colorants or fillers may be added. This compound may also be mixed under vacuum in order to prevent air from entering the system.

[0027] Preferably, the hardening and/or hardenable second material is a curable liquid.

[0028] The use of a curable liquid has the advantage that even small cracks of a width of less than 0.05 mm can be filled in the best possible way prior to curing.

[0029] The method according to the invention can further comprise the steps of providing a first casing for at least partially housing said at least one tensile element and filling the volume between the at least one tensile element and said first casing with said first hardening and/or hardenable material, in particular with cement grout.

[0030] By providing a first casing it is possible to embed the at least one tensile element in a defined shape given by the geometry of the first casing, as might be necessary, for example, to carry out a test according to a standard.

[0031] In certain embodiments, said first casing for at least partially housing said at least one tensile element is a testing frame.

[0032] The use of a testing frame makes it possible to carry out a test according to the specifications of a relevant standard, such as EN 1537, with an already existing testing frame and without the need to acquire special and/or costly molds.

[0033] The method according to the invention can further comprise the steps of providing a second casing between the first casing and the tensile element, wherein the second casing extends circumferentially around the tensile element along the axial direction of the tensile element, and filling the volume between the first casing and the second casing with a hardening and/or a hardenable material, in particular with cement grout.

[0034] A second casing which surrounds the at least one tensile element circumferentially and extends along the axial direction over at least part or several parts of the total length of said tensile element serves as a barrier to define an inner volume between tensile element and second casing and an outer volume between first casing and second casing. Separating the inner volume from the outer volume by providing said second casing makes it possible to use a material for embedding the tensile element which is different from the material used to fill the outer volume and/or to restrict the area in which cracks around the tensile element have to be examined, for example.

[0035] In certain embodiments, said second casing is a corrugated duct.

[0036] In the context of the present specification, the term *duct* refers to a tubular body generally corrugated both inside and outside to isolate the tensile elements from the environment and to transfer load between the inner and outer grout volume along the bond length. Extensions may be either corrugated or smooth over the unbonded length.

[0037] In the context of the present specification, the term *bond length* refers to the length of tensile element physically, and/or mechanically and/or chemically bonded directly to the first hardening and/or hardenable material through which the tensile element is capable of transmitting tensile stress to said first material and the neighboring environment, respectively.

[0038] In the context of the present specification, the term *unbonded length* refers to the length of tensile element between the prestressing head and the proximal end of the tensile element bond length that is specifically isolated from direct contact with the first hardening and/or hardenable material.

[0039] The use of a corrugated duct causes an increase in friction and/or mechanical interlock with the surrounding hardening and/or hardenable material through interlocking of the corrugations with the surrounding hardening and/or hardenable material, which ultimately enables greater stability and force transmission into the adjacent material.

[0040] The crack filling second material used in the method according to the invention can be a material which enables a visual inspection of the cracks and/or the crack width created in the first material under load of the tensile element.

[0041] For example, the presence of pure UV light pigments or fluorescent dyes in the crack filling second material makes the non-fluorescent colors of the first material appear dull under UV light and, consequently, cracks filled with a crack filling second material comprising such substances can be readily identified.

[0042] Preferably, the crack filling second material is colored differently than the first material.

[0043] This allows a quick and easy differentiation between cracks of different origin even with the naked eye.

[0044] In certain embodiments, the crack filling second material comprises an apparent viscosity between 100 mPas and 800 mPas, determined using the Brookfield method at 20-25°C. according to ISO 2555.

[0045] The use of materials with an apparent viscosity in the specified preferred ranges makes it possible to fill even fine cracks completely and without applying excessive pressure which could possibly cause further cracks in the concrete structure or lead to propagation of existing cracks.

[0046] The method according to the invention can further comprise the steps of providing at least one inlet for introducing the hardening and/or hardenable second material into the at least one cavity and at least one outlet for draining and/or pressure compensation.

[0047] The presence of inlets renders the injection of the crack filling material easier. Outlets allow air to be efficiently removed from the inside of the cavity and from the cracks, for example by evacuation, allowing complete filling of the cavity and any cracks in fluid communication with it.

[0048] Preferably, the inlet and the outlet are hollow, in particular tubes, and the inlet and outlet are installed before embedding the tensile element in the first material.

[0049] The use of hollow tubes allows the direct connection of a reservoir containing the hardening and/or hardenable crack filling second material and thus an efficient and simple implementation of the injection step.

[0050] In certain embodiments, the at least one removable and/or sacrificial core each comprises a diameter or equivalent diameter between 1 mm and 6 mm.

[0051] The use of cores comprising a diameter in specified preferred range ensures a sufficiently large throughput, i.e. a sufficient amount of hardening and/or hardenable second material can be introduced into the interior of the pre-stressed structure within a certain period of time without the risk of premature hardening and thus clogging of the cavity or partial filling of cracks.

[0052] The method according to the invention can further comprise the step of providing at least one distancer, preferably several distancers, for spacing the removable and/or sacrificial core from the at least one tensile element.

[0053] By using distancers, the distance between the core and the tensile element can be precisely adjusted and clamping of the core by the tensile elements, which can lead to a closure of the cavity and thus to regions inside the pre-stressed structure that cannot be filled with the second material anymore, can be avoided.

[0054] In certain embodiments, said distancers are selected from rigid tubes, preferably with a wall thickness between 0.5 mm and 5 mm.

[0055] Rigid tubes are an inexpensive and effective means of adjusting the distance between core and tensile element.

[0056] In certain embodiments, said distancers are placed on the cores, in particular on the strings, to extend over substantially the entire length of the cores. Alternatively, said distancers are placed on the cores at intervals of up to 2,0 m.

[0057] Placing the distancers on the core at the specified preferred interval from another results in an efficient and effective use of said distancers to avoid the clamping of strings by the at least one tensile element and to avoid contamination of the at least one tensile element with any anti-bonding coating of the strings. By placing the distancers over substantially the entire length of the cores, it is ensured that the cavity to be created is not in direct contact with the tension element at any point. For example, the distancers can be tubes with a length of 5 mm to 20 mm, where the second hardening material can pass through the gaps between adjacent tubes.

[0058] In certain embodiments, said distancers are fixed to the tensile element by means of strips and/or adhesive.

[0059] The use of strips or adhesive or a combination thereof depicts a particularly simple and secure fastening method.

[0060] In certain embodiments, the cores, in particular the strings, are kept straight by applying a tensile load onto the removable and/or sacrificial core before embedding the tensile element in the hardening and/or hardenable material.

[0061] This ensures that there are no kinks in the cores which could subsequently impair or disturb the inflow of the second material into the cavity.

[0062] In order to ensure that all cracks and other voids in fluid communication with the cavity will be substantially filled with hardening and/or hardenable material, the crack filling second material may be introduced at a pressure in excess of atmospheric pressure.

[0063] In certain embodiments, the filling material is introduced, in particular injected, into the at least one cavity at a pressure of up to 5 bar.

[0064] In this preferred pressure range, filling of the cavities and cracks takes place without significant risk of crack propagation and/or enlargement of existing cracks. Furthermore, the danger of creating additional pressure-induced cracks is minimized in this relative pressure range.

[0065] In certain embodiments, the inlet and outlet are temporarily covered to avoid ingression of the first material into the cavity.

[0066] Temporarily covering the inlet and outlet prevents clogging of the cavity and ensures the unimpaired flow of the second material through the cavity.

[0067] The object is further achieved by an assembly for testing a structure, the assembly comprising at least one tensile element, a first casing, and a volume inside the first casing. The tensile element is arranged inside said volume and at least one removable and/or sacrificial core is arranged coaxially to the tensile element.

[0068] Such an assembly allows the method described herein to be carried out efficiently and economically.

[0069] In certain embodiments of the assembly described herein, the tensile element is a strand bundle.

[0070] In certain embodiments of the assembly described herein, the removable and/or sacrificial core is a rigid or flexible string.

[0071] Preferably, the assembly disclosed herein is used for testing a strand ground anchor.

[0072] In certain embodiments, the assembly described herein is used in a method as previously described.

[0073] In certain embodiment, the assembly described herein further comprises a second casing arranged between the tensile element and the first casing. The second casing extends around the tensile element in the axial direction of the tensile element, thereby creating an inner volume between tensile element and second casing and an outer volume between first casing and second casing.

[0074] Such an assembly has the advantage that two separate compartments, i.e. said inner volume and said outer volume, are created, into each of which different materials can be filled. This way, compatibility problems of different materials can be avoided, for example.

[0075] In certain embodiments of the assembly, said second casing is a corrugated duct.

[0076] In certain embodiments of the assembly, an inlet is provided to facilitate the removal of the core and/or introduction of a crack filling second material.

[0077] Preferably, the assembly described herein also comprises an outlet. The presence of an outlet allows air trapped inside the cavity and/or air trapped in cracks that are in fluid communication with the cavity to be effectively removed from the pre-stressed structure. This ensures that all cavities and cracks can be substantially completely filled with the crack filling second material.

[0078] In certain embodiments, the inlet of the assembly described herein comprises a removable cover. Preferably, the inlet and the outlet of the assembly described herein comprise a removable cover.

[0079] By providing the inlet and preferably the outlet with removable covers, the unintended ingression of material into the cavities created by the cores is avoided.

[0080] The object is further achieved by the use of the assembly described herein for distinguishing cracks due to tensile stress in a structure from cracks due to dismantling or shrinkage.

[0081] In particular, the object is achieved by the use of the assembly described herein in accordance with a method described herein.

[0082] In certain embodiments, the assembly described herein is used for distinguishing cracks due to tensile stress in a post-tensioned ground anchor.

[0083] The invention is further explained in more detail by means of figures, in which like reference numerals are used to refer to the same or similar elements.

Figure 1: Schematic illustration of a strand ground anchor test assembly;

Figure 2: Schematic illustration of one embodiment of the assembly according to the invention;

Figure 3: Schematic cross-sectional view of an assembly according to the invention.

[0084] Figure 1 illustrates a typical assembly as used in the corrosion protection test B according to EN 1537. A strand ground anchorage known form the state of the art typically comprises a tensile element (1), e.g. post-tensioning steel strands, surrounded by a first casing (4), a second casing (3), and accessories for positioning of the tensile element (not shown). In the present example, the second casing (3) is a corrugated plastic duct. The inner volume between the second casing (3) and the tensile element (1) is filled with a first hardening and/or hardenable material (2), e.g. a cementitious internal grouting material, which protects the tensile element against corrosion by acting as a barrier against the ingress of aggressive substances to the steel surface of the tensile elements. In addition to corrosion protection, the cementitious material also exhibits a load-transferring function. The first casing (4) houses both the tensile element (1) and the second casing (3), wherein the outer volume between first casing (4) and second casing (3) is filled with a further hardening and/or hardenable material, e.g. a cementitious external grouting material. In the present example, the first and further hardening and/or hardenable material, i.e. the internal and external grout, are both denoted with the reference number 2. The testing setup further comprises a stressing jack (6) to stress the at least one tensile element, e.g. all the strands in a tendon, accurately and at the same time.

[0085] Referring to figure 2, the assembly according to one embodiment of the invention comprises a first casing (4) with an end plate (11) at one end. An inlet (8) is arranged at one end of a core (7) to facilitate the injection of a crack filling second material (not shown) into the cavity created after removal of the core (7) which, in this example, is an elastic string. In this example, the assembly further comprises an outlet (9). The core (7) is spaced from the tensile element (1), wherein the distance between the core (7) and the tensile element (1) is defined by the material thickness of the distancers (10) used for this purpose. In the present example, the distancers are rigid tubes which were pulled over the elastic string. Consequently, the distance between the core (7) and the tensile element (1) is defined by the wall thickness of said tubes. It is also conceivable that the tubes are slotted on their long side, which allows that the tubes can be easily and quickly expanded and slipped over the core at the desired position. The distancers (10) are glued (not shown) onto the tensile element (1) in order keep the core (7) in place upon grouting. In this embodiment, the assembly further comprises a second casing (3) which at least partially encapsulates the tensile element (1) and the core (7) in longitudinal direction. Subsequently, both the volume between the first casing (4) and the second casing (3) and the volume between the second casing (3) and the core (7) are filled with a first hardening and/or hardenable material (2), which in this example is cement grout. After the first material (2) has hardened, the inlet (8) is excavated from the cement grout (2) and the elastic string (7) is removed to create the cavity (71, see Fig. 3) in which the second material is injected (not shown).

[0086] Figure 3 shows a schematic cross-sectional view of an assembly according to the invention. In this embodiment, the assembly comprises a first casing (4) and a second casing (3), which in this case have a circular cross-section and are arranged concentrically. The second casing (3) houses four tensile elements (1), which in this case are steel strands. A flexible string is used as removable core (7) to form the cavity (71) into which the second material (5) is injected (not shown).Alternatively, a hollow tube made of can used as a sacrificial core (7), wherein the interior of said hollow tube defines the cavity (71) into which the second material (5) is injected (not shown). Both the volume between the first casing (4) and the second casing (3) and the volume between the second casing (3) and the core (7) are filled with a first hardening and/or hardenable material (2), which in this example is cement grout.

Claims

1. A method of testing a structure, in particular a strand ground anchor, comprising at least one tensile element, the method comprising the steps of:

   - Providing at least one tensile element, in particular at least one strand bundle;
   - Providing at least one removable and/or sacrificial core, in particular at least one rigid or flexible string;
   - Arranging the core at a position where a cavity is to be created, in particular arranging the core substantially coaxially to the tensile element, and is placed as close as feasible to the tensile element;
   - Embedding the at least one tensile element and the at least one core in a first hardening and/or hardenable material, in particular in cement grout;
   - Allowing or causing said first material to harden;
   - Optionally, creating at least one cavity in the first material by removing at least one core from the hardened first material;
   - Applying a load, in particular a tensile load, to the structure to a predetermined load level and maintaining said load level;
   - Filling a hardening and/or hardenable second material, preferably a curable liquid, into the at least one cavity created;
   - Permitting or causing said second material to harden while maintaining the load;
   - Removing the load from the structure after the second material has reached a compressive

strength that is at least equal to the compressive strength of the first material;

2. The method according to claim 1, further comprising the steps of:

   - Providing a first casing, in particular a testing frame, for at least partially housing said at least one tensile element;
   - Filling the volume between the at least one tensile element and said first casing with said first hardening and/or hardenable material, in particular with cement grout.

3. The method according to claim 2, further comprising the steps of:

   - Providing a second casing, in particular a corrugated duct, between the first casing and the tensile element, the second casing extends circumferentially around the tensile element along the axial direction of the tensile element;
   - Filling the volume between the first casing and the second casing with a hardening and/or a hardenable material, in particular with cement grout.

4. The method according to any one of the previous claim, **characterized in that** the crack filling second material is a material which enables a visual inspection of the cracks and/or the crack width created in the first material under load of the tensile element, preferably coloured differently than the first material.

5. The method according to any one of the preceding claims, wherein the crack filling second material comprises a viscosity between between 100 mPas and 800 mPas.

6. The method according to any one of the preceding claims, further comprising the step of:

   - Providing at least one inlet for introducing the hardening and/or hardenable second material into the at least one cavity and at least one outlet for draining and/or pressure compensation, preferably the inlet and the outlet are hollow, in particular tubes, the inlet and outlet being installed before embedding the tensile element in the first material.

7. The method according to any one of the preceding claims, wherein said at least one pre-embedded removable and/or sacrificial core each comprises a diameter or equivalent diameter between 1 mm and 6 mm.

8. The method according to any one of the preceding claims, the method further comprising the step of:

   - Providing at least one distancer, preferably several distancers, for spacing the removable and/or sacrificial core from the at least one tensile element.

9. The method according to claim 8, wherein

   - said distancers are selected from rigid tubes, preferably with a wall thickness between 0.5 mm and 5 mm; and/or
   - said distancers are placed on the cores, in particular on the strings, to extend over substantially the entire length of the cores or said distancers are placed on the cores at intervals of up to 2,0 m; and/or
   - said distancers are fixed to the tensile element by means of strips and/or adhesive.

10. The method according to any one of the preceding claims, wherein the cores, in particular the strings, are kept straight by applying a tensile load onto the removable and/or sacrificial core before embedding the tensile element.

11. The method according to any one of the preceding claims, wherein the filling material is introduced, in particular injected, into the at least one cavity at a pressure of up to 5 bar.

12. The method according to claims 6 to 11, wherein the inlet and outlet are temporarily covered to avoid ingression of the first material into the cavity.

13. An assembly for testing a structure, preferably for testing a strand ground anchor, in particular using a method according to one of claims 1 to 12, the assembly comprising at least one tensile element, in particular at least one strand bundle, a first casing, a volume inside the first casing, wherein the tensile element is arranged inside the volume, **characterized in that** at least one removable and/or sacrificial core, in particular at least one rigid or flexible string, is arranged coaxially to the tensile element.

14. The assembly according to claim 13 comprising a second casing, in particular a corrugated duct, the second casing being arranged between the tensile element and the first casing, the second casing extending around the tensile element in the axial direction of the tensile element, to create an inner volume between tensile element and second casing and an outer volume between first casing and second casing.

15. Assembly according to any one of claims 13 or 14, **characterized in that** an inlet, and preferably an out-

let, is provided to enable removal of the core and/or introduction of a crack filling second material.

16. Assembly according to claim 15 **characterized in that** the inlet and preferably the outlet comprise a removable cover.

17. Use of the assembly according to one of claims 13 or 16 for distinguishing cracks due to tensile stress in a structure from cracks due to dismantling or shrinkage, in particular in a post-tensioned ground anchor, in particular in accordance with a method according to one of claims 1 to 12.

Fig. 1

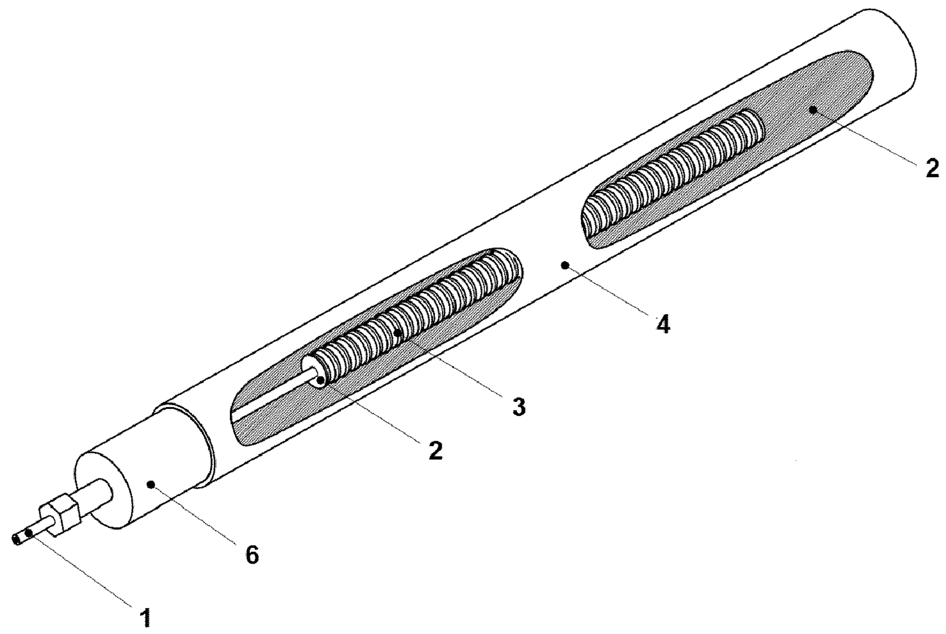


Fig. 2

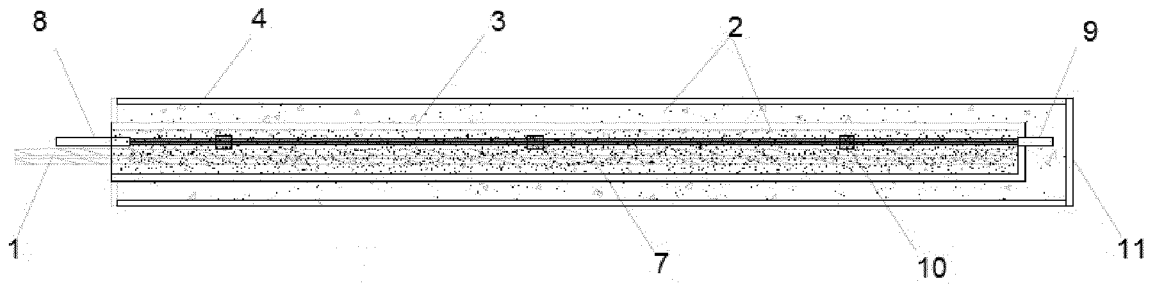
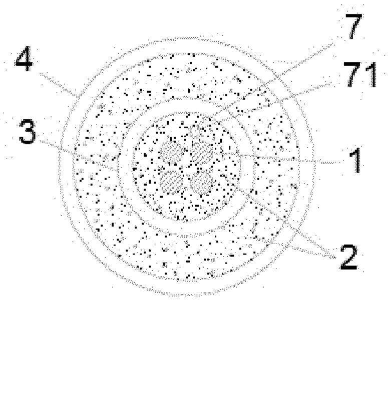


Fig. 3



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EUROPEAN SEARCH REPORT

Application Number
EP 21 18 0615

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1 The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
Munich	3 December 2021	Kremsler, Stefan

CATEGORY OF CITED DOCUMENTS

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