METHOD OF REINFORCEMENT OF A STRUCTURE AND STRUCTURE THUS REINFORCED

Inventors: Christian Tourneur, Velizy Villacoublay (FR); Dominique Deschamps, Velizy Villacoublay (FR)

Correspondence Address:  
BANNER & WITCOFF, LTD.  
TEN SOUTH WACKER DRIVE, SUITE 3000  
CHICAGO, IL 60606 (US)

Assignee: Freyssinet, Velizy Villacoublay (FR)

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ABSTRACT

Method for reinforcing a structure (1), comprising the following stages:

a) placing in one part (11, 12) of the structure (1) an anchoring element (3) secured to strands of reinforcing wires (41, 42) such that the anchoring element (3) is at least partially incorporated into the part (11, 12) of the structure (1) and in that at least one portion (42) of the strands of reinforcing wires protrudes from a part (12) of the structure (1);

b) securing the anchoring element (3) to the part (11, 12) of the structure (1);

c) applying at least one layer of fabric (5) onto a surface (15) of the structure (1) such that at least one part of the portion (42) of the protruding strands of reinforcing wires is secured to the surface (15) of the structure (1) by bonding said layer of fabric (5). Structure thus produced. Anchoring element of a structure.
METHOD OF REINFORCEMENT OF A STRUCTURE AND STRUCTURE THUS REINFORCED

[0001] This invention relates to the field of structural reinforcement of structures.

[0002] In this field, it is usual to bond reinforcements onto the parts of a structure to be reinforced, using suitable resins.

[0003] In a standard method commonly applied, known as the I. Hermite method, the reinforcement consists of a steel sheet bonded onto concrete after preparation of the bonding surface. This standard method has undergone various developments, in particular taking account of the technological progress in materials and more particularly the development of substitute materials for sheet steel, which often gives rise to application problems and requires precautions to be taken against corrosion.

[0004] Thus in recent years reinforcement techniques have been introduced, based on composite materials in the form of bonded plates (see for example FR-A-2 594 871), then in the form of bonded fibres (for example EP 0 441 519) and bonded fabrics (see for example FR-A-2 747 146). The latter types of reinforcement have many advantages, in particular their ease of use and their suitability for application onto surfaces of various shapes.

[0005] These different types of bonded reinforcements very significantly improve the dynamic behaviour of the reinforced structure. Moreover, a breakage of the reinforcement itself is seldom observed.

[0006] These reinforcements are suitable for reinforcing and/or repairing structures made in particular from brickwork or reinforced concrete, and are used on structural elements such as for example beams, posts, slabs and walls.

[0007] They can also be used for connecting construction elements to each other.

[0008] However, their use makes it necessary to gain access to the surfaces of the elements to be reinforced, in order to place the fibres on them in the areas to be reinforced.

[0009] This access can prove difficult and/or costly in certain structures, or when particular strength requirements for a building are desired.

[0010] The case of reinforcement against earthquakes can be mentioned, where it is appropriate not only to reinforce the elements constituting a structure, but also to provide general stability between the elements, and for example to provide a connection between elements of which a part is inaccessible or hidden.

[0011] Examples of a part difficult to access include foundation slabs and embedded walls, in particular partially or totally embedded.

[0012] In such cases, it can be envisaged to dig excavations, carry out the reinforcement, then backfill the excavations, but this would result in more extensive, costly and possibly complex works, for example in the case of party walls.

[0013] The aim of this invention is to avoid the above drawbacks and to improve the reinforcement of structures, in particular in the case where a part of the structure is not directly accessible.

[0014] The invention thus proposes a method for reinforcing a structure, comprising the following stages:

[0015] a) placing in one portion of the structure an anchoring element secured to strands of reinforcing wires such that the anchoring element is at least partially incorporated into the part of the structure and in that at least one portion of the strands of reinforcing wires protrudes from a part of the structure.

[0016] b) securing the anchoring element to the part of the structure;

[0017] c) applying by bonding at least one layer of fabric onto a surface of the structure such that at least one portion of the portion of the protruding strands of reinforcing wires is secured to the surface of the structure by bonding of said layer of fabric.

[0018] Using the method according to the invention, it is possible to reinforce a structure by securing together elements of the structure to which access is difficult and/or direct access is not possible for structural repairs.

[0019] After having secured the different elements, in particular the anchoring element to the structure, and the fibre strands to a surface of the structure by bonding of at least one layer of fabric, the load transfer can be ensured between the part into which the anchoring element is incorporated and the part of the structure to the surface of which the layer of fabric is bonded. Thus load transfers can advantageously be carried out between several areas or several parts of the structure and thus structures the strength of which is very significantly improved can be obtained. Such structures are capable of withstanding earthquakes effectively.

[0020] According to different embodiments, which can be combined:

[0021] the method also comprises a preliminary stage of creating a cavity, in particular by drilling, in the part of the structure in order to at least partially house the anchoring element;

[0022] the strands of reinforcing wires include carbon fibres;

[0023] the strands of reinforcing wires are preimpregnated with a resin;

[0024] the anchoring element has an elongated shape, in particular approximately cylindrical;

[0025] the anchoring element is made of metal, in particular steel, or a composite material, in particular comprising reinforcing fibres impregnated with a resin;

[0026] the strands of reinforcing wires are secured to the anchoring element by threading said strands into a return portion situated at one end of the anchoring element;

[0027] the anchoring element is secured to the part of the structure with a masonry fixing, in particular with a cement or concrete grout, or with a resin;

[0028] the layer(s) of fabric bonded onto the surface of the structure connect(s) two different parts of the structure;

[0029] the anchoring element is placed in a first part of the structure and at least one part of the portion of the protruding strands of reinforcing wires is secured by bonding a layer of fabric onto a surface of a second part of the structure.

[0030] The anchoring element can take many forms and can have different dimensions. An elongated shape is preferred, but it can easily be envisaged to give it a shape where two dimensions are of the same order of size, such as a plate.

[0031] Similarly, although a cylindrical shape is advantageous, it is also possible to use parallelepiped anchorage elements. It is also possible to shape the anchoring element like a hairpin, where two cylinders are connected together by an arc.
The anchoring element can comprise a return portion for threading the strands of reinforcing wires, but it can also be envisaged to secure the strands of reinforcing wires to the anchoring element by any other means such as for example by bonding to the reinforcing element or by tying the strands of reinforcing fibres onto the reinforcing element.

The return portion can be made up of a hole, in particular oblong, in the anchoring element, but also by a curved part of the anchoring element which forms a loop or a hook, by a ring secured to the anchoring element, by the arc of a hairpin-shaped anchoring element, or by any other means capable of allowing the strands of reinforcing wires to be secured to the anchoring element.

The operation of bonding at least one layer of fabric can be carried out according to the information contained in patent FR 2 747 146 or according to any other fabric bonding technique known to a person skilled in the art.

The invention also relates to a structure, a part of which comprises an anchoring element at least partially incorporated into and secured to said part, strands of reinforcing wires secured to the anchoring element where at least one portion of the strands of reinforcing wires protrudes from said part, at least one layer of fabric bonded with said part of the strands of reinforcing wires onto a surface of the structure.

The invention also relates to an anchoring element having an elongated shape, in particular cylindrical, comprising at one of its ends an oblong hole capable of allowing the threading of strands of reinforcing wires and forming a return portion of the strands.

According to different embodiments, which can be combined:

- the anchoring element comprises a first part having an elongated shape, in particular a bar or a strip, and a second part secured to the first part, in particular by screwing, where the second part comprises the oblong hole;
- the anchoring element is made of steel or a composite material.

Other characteristics and advantages of this invention will become apparent in the description below of non-limitative embodiments, with reference to the attached drawings, in which:

FIG. 1 shows a diagrammatic cross section perspective view of a structure according to the invention;

FIG. 2 shows a diagrammatic view of an anchoring element used in FIG. 1.

For reasons of clarity, the dimensions of the different elements shown in these figures are not necessarily proportional to their actual dimensions. On the figures, identical references correspond to identical elements.

FIG. 1 shows a structure 1 according to the invention, where the structure 1 comprises a foundation slab 11 surmounted by a semi-embedded wall 12. A slab 14 is fixed to the wall 12. The wall 12 is surmounted by a wall 13 which protrudes from the ground. As an example, the foundation slab 11, the semi-embedded wall 12 and the slab 14 are made of reinforced concrete and the wall 13 is made of brickwork.

A vertical axis is shown by a broken line. By convention, it will be understood that this line limits the external face of the walls 12 and 13 and that the opposite face of these walls is an internal face.

In the structure shown, the level of the slab 14 is below the level of the ground 6 so that the face 15 of the semi-embedded wall 12 is accessible while the opposite face of this wall is embedded. The part of the semi-embedded wall 12 situated below the level of the slab 14 is for its part completely embedded, as is the foundation slab 11.

In order to reinforce this structure, a cavity 2 has been cut at an angle in the wall 12 and the foundation slab 11. In the example shown, the cavity 2 is approximately cylindrical and can measure several metres in length and have a diameter of the order of a few dozen centimetres.

An anchoring element 3, comprising an end 33 through which strands of reinforcing wires have been threaded, has then been placed in the cavity 2. A loop 41 has been formed with said strands so as to allow the strands to penetrate partially into the cavity 2. The anchoring element 3 is fixed, for example with a cement or mortar or concrete grout, by filling the cavity 2. In FIG. 1 it is possible to see the area 21 of the internal face 15 of the wall 12 corresponding to the filling carried out after having placed and fixed another anchoring element 3 in the structure in a way similar to that described above. Portions 42 of strands of reinforcing wires protrude from this area 21. Said portions 42 of strands of reinforcing wires are secured to the internal face 15 of the wall 12 by bonding with at least one layer of fabric 5.

It is possible to pre-bond the portions 42 of the strands of reinforcing wires onto the face 15, then to apply the layer(s) of fabric 5, or to proceed with a single bonding operation. The portions 42 of the strands of reinforcing wires are generally covered by at least one layer of fabric 5, but it is also possible for them to be placed and bonded over a layer of fabric 5. They can in particular be incorporated between two layers of fabric.

The layer of fabric 5 is placed partially on the internal face 15 of the wall 12 and partially on the internal face 16 of the wall 13. This results in an advantageous securing of the elements of the structure as a whole, in particular the foundation slab 11 and the walls 12 and 13, which makes it possible in particular to increase the earthquake resistance of the structure 1.

It should be noted that in the structure shown, the securing is carried out between superposed elements, but that the invention is in no way limited to this configuration and that according to the method of the invention, it is also possible to secure elements having a non-zero angle between them, and even perpendicular to each other. Similarly, it is possible to secure non-abutting elements in this way.

FIG. 2 shows an example of anchoring element 3 according to the invention. This anchoring element 3 is composed of two parts, a part 31 having an elongated shape, in this case a cylinder, and a second part 33 which can be secured to the part 31 having an elongated shape.

The part 31 comprises at one end a threaded area 32, preferably of a smaller diameter than the remainder of this part 31.

It is noted that in the embodiment exemplified in FIG. 1, the reinforcing element 3 is totally incorporated into the structure 1 and is thus protected from corrosion, allowing in particular the use of steel.

The part 31 can be made of steel, in particular HA steel, or a composite, comprising long or short reinforcing fibres and a resin. This part 31 can be solid or hollow.

The part 33 comprises an oblong hole 34 and a screw thread (not shown) to allow securing by screwing to the threaded area 32 of the part 31. The part 33 is preferably compact and much shorter than the part 31 with an elongated shape. The oblong hole is designed for the strands of rein-
forcing wires to pass through and forms a return portion for said strands. In order to avoid damaging these strands, for example while they are being threaded through the hole 34 and/or when the anchoring element and the strands are placed in a structure and force is applied to the strands, a rounded contact surface 35 can be provided in the form of the eye of a needle in the area of the hole 34 in the part 33 where the strands will come into contact when the structure is under load.

[0057] It is also possible to assemble the part 33 with the part 31 having an elongated shape by hot or cold crimping or by bonding.

[0058] It is noted that the anchoring element according to the invention is not limited to the above embodiment, but could equally well be obtained by cold or hot forging of the end of a metal bar to form an oblong hole.

[0059] An anchoring element of this type can also be produced with a strip of composite material. The invention is not limited to these types of embodiment and must be interpreted non-limitatively, encompassing any equivalent embodiment.

1. Method for reinforcing a structure (1), comprising the following stages:
   a) placing in one part (11, 12) of the structure (1) an anchoring element (3) secured to strands of reinforcing wires (41, 42) such that the anchoring element (3) is at least partially incorporated into the part (11, 12) of the structure (1) and in that at least one portion (42) of the strands of reinforcing wires protrudes from a part (12) of the structure (1);
   b) securing the anchoring element (3) to the part (11, 12) of the structure (1);
   c) applying at least one layer of fabric (5) by bonding onto a surface (15) of the structure (1) such that at least one part of the portion (42) of the protruding strands of reinforcing wires is secured to the surface (15) of the structure (1) by bonding of said layer of fabric (5).

2. Method according to the previous claim also comprising a preliminary stage of creating a cavity (2), in particular by drilling, in the part (11, 12) of the structure (1) in order to at least partially house the anchoring element (3).

3. Method according to claim 1 characterized in that the strands of reinforcing wires comprise carbon fibres.

4. Method according to claim 1 characterized in that the strands of reinforcing wires are pre-impregnated with a resin.

5. Method according to claim 1 characterized in that the anchoring element (3) has an elongated shape, in particular approximately cylindrical.

6. Method according to claim 1 characterized in that the anchoring element (3) is made of metal, in particular steel, or a composite material, in particular comprising reinforcing fibres impregnated with a resin.

7. Method according to claim 1 characterized in that the strands of reinforcing wires are secured to the anchoring element (3) by threading said strands into a return portion (33) situated at one end of the anchoring element (3).

8. Method according to claim 1 characterized in that the anchoring element (3) is secured to the part (11, 12) of the structure with a masonry fixing, in particular with a cement or concrete grout, or with a resin.

9. Method according to claim 1 characterized in that the layer(s) of fabric bonded onto the surface (15) of the structure (1) connect two different parts of the structure.

10. Method according to claim 1 characterized in that the anchoring element (3) is placed in a first part (11) of the structure (1) and at least one portion of the portion (42) of the protruding strands of reinforcing wires is secured by bonding of a layer of fabric (5) to a surface of a second part (12) of the structure (1).

11. Structure, of which a part (11, 12) comprises an anchoring element (3) at least partially incorporated into and secured to said part (11, 12), strands of reinforcing wires secured to the anchoring element (3) where at least one portion (42) of the strands of reinforcing wires protrudes from said part (12), at least one layer of fabric (5) bonded with said part (42) of the strands of reinforcing wires onto a surface (15) of the structure (1).

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