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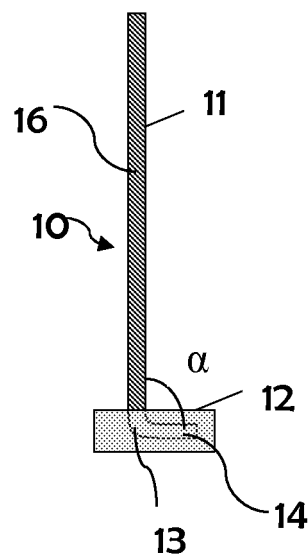
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(54) **Reinforcing element for concrete construction**

(57) A reinforcing element (10) for concrete construction comprising a rod-shaped member (11) having a cross-sectional enlargement on at least one end thereof. The rod shaped member (11) comprises an elbow portion (12) on said at least one end being embedded in a protection block (15), thereby forming said enlargement.

The method for producing the reinforcing element is also provided.



**Figure 2a**

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## Description

### FIELD OF THE INVENTION

**[0001]** The present invention relates to a reinforcing element for concrete construction comprising a rod-shaped member having a cross-sectional enlargement on at least one end thereof.

### BACKGROUND OF THE INVENTION

**[0002]** Reinforcement in structural concrete is placed to carry tensile forces due to the limited and unreliable tensile strength of concrete. In order to ensure an adequate performance and durability of the reinforcement, two aspects should be taken into account.

**[0003]** The bars require sufficient concrete cover to avoid rusting and corrosion problems. Typical values for this cover lay between 35 to 50 mm. Moreover, a minimum embedment length (or development length) has to be provided so that the reinforcement can develop its yield strength. Typical values for this length in ordinary concrete lay between 35 to 40 times the diameter of the bar.

**[0004]** The need for providing a minimal concrete cover for the reinforcement and thus leaving the outer layers of concrete without any reinforcement leads in some cases to premature spalling of the concrete cover. This leads to undesirable brittle failure modes. Spalling of the concrete cover is particularly significant with respect to some types of lightweight aggregate concrete (with a very brittle behaviour in compression) or for punching shear reinforcement close to support regions, where spalling of the concrete cover may develop prior to failure.

**[0005]** In addition to cover spalling, large development lengths lead sometimes to unpractical layouts of reinforcement, difficult to place or with reduced performance.

**[0006]** Various embodiments have been proposed in the past in order to avoid some of the aforementioned problems. For instance, the use of stainless steel allows providing reduced concrete cover. However, such steels are still very expensive compared to ordinary reinforcement.

**[0007]** The addition of fibres to the concrete provides a partial solution to the problem of cover spalling. However, this solution is also expensive and is only used in special cases such as complicated formworks or tunnel linings.

**[0008]** Reinforcements using T-headed bars or studs both of them presenting a metallic head or bolt at the ends of the bar allowing thus a suitable development of the bar have been introduced to reduce the required development length. Such solutions however do not solve the problem of the necessary concrete cover.

**[0009]** The document US 2006/0090416, Braasch et al. "Reinforcing element for concrete construction" describes the use of anchorage bolts cast in glass-fibre reinforced plastic. A reinforcing element for concrete con-

struction in the form of a set bolt is formed of a rod-shaped section with a cross-sectional enlargement provided on the end. The cross-sectional enlargement is formed of glass-fibre reinforced plastic and has an axial bore in its centre. The cross-sectional enlargement is provided as a separate part engaged in a form-locking manner with the rod-shaped section of the set bolt. The two components are connected by gluing, screwing, fusing, etc. In the disclosed document, the bar and bolts always lay inside the concrete. The disclosed embodiments do not allow introducing intermediate pieces as suspension points and the significant size of the bolts does not allow using them in all types of configuration, such as for instance thin slabs.

**[0010]** The document US 2007/0175127 A1, "Shearing force reinforced structure and member" discloses the use of a link member to reinforce an existing concrete member. The document discloses a shearing force reinforced structure for an existing reinforced concrete structure body. The structure is configured with a side wall of an existing reinforced concrete structure, shearing force reinforced members arranged inside reinforced member insertion holes with bottoms formed in a direction intersecting a major reinforcing bar of the side wall. Fillers are provided in the holes. Each of the shearing force reinforced members is configured with a shearing force reinforcing bar, a plate head and a ring head respectively fixed at a base end and top end of the reinforcing bar. This technique is exclusively to be post-installed by boring holes in an existing member.

**[0011]** EP 1 905 923, "Ankerstab und Anordnung zum Verstärken von bestehenden Bauteilen gegen Durchstanzen mit einem solchen Ankerstab" relates to an arrangement for reinforcing existing constructional components against punching shears with an anchor bar having an anchoring section and a threaded section to receive a tensioning nut and an intermediate section. The intermediate section has a coating and a sleeve that surrounds the anchor bar. The intermediate section is located between the anchoring section and the threaded section and has an anti-adhesive surface. This document also relates to a system exclusively to be post-installed by boring holes in an existing member.

**[0012]** Thus, there is a need for a reinforcing bar avoiding the above mentioned drawbacks. Such bars should be usable within new concrete constructions.

**[0013]** There is also a need for a low cost reinforcing bar that may be used in various configurations and avoiding corrosion.

**[0014]** There is also a need for a reinforcing bar allowing minimizing embedment length in concrete.

### SUMMARY OF THE INVENTION

**[0015]** According to the invention, these aims are achieved by means of a reinforcing element for concrete construction comprising:

- a rod-shaped member having a cross-sectional enlargement on at least one end thereof;
- said rod shaped member comprising an elbow portion on said at least one end;
- said elbow portion being embedded in a protection block thereby forming said enlargement.

**[0016]** This reinforcing element provides a single solution in order to solve at the same time the problems of minimum concrete cover, spalling of the concrete cover and development length.

**[0017]** Such reinforcing element allows developing the tensile forces of the reinforcing bar within a series of high-performance protection blocks that also protect the bar from corroding or rusting.

**[0018]** In a first embodiment, the protection block material is concrete and preferably high or ultra high performance concrete. In a second embodiment, the protection block material is selected from the list comprising ceramic, resin. Any of the above mentioned materials may be reinforced with fibers.

**[0019]** The protection block is preferably disk-shaped, but several variants, such as parallelepiped shapes may also be provided.

**[0020]** In an embodiment, the protection block material is substantially impermeable (watertight). In a variant, at least the outer portion of said protection block is provided with a substantially low permeability of low porosity material.

**[0021]** In a further embodiment, the protection block material provides high adhesion to said rod-shaped member. Optimization of embedment length may be obtained if the protection block surface interfacing with said rod-shaped member provides a substantially high adhesion to the rod-shaped member.

**[0022]** In a further embodiment, the reinforcing element comprises two protection blocks, one at each end thereof.

**[0023]** In a still further embodiment, the rod-shaped member is U-shaped with a connecting leg provided between the two axial portions and further comprises a protection block in which said connecting leg is at least partially embedded.

**[0024]** In a variant, the reinforcing element is further provided with a protection channel provided on one axial portion of the rod-shaped member, at the immediate proximity of said protection block. Such a channel may be helpful to provide extended impermeability along the main portion.

**[0025]** In a further embodiment, the elbow portion comprises an angled portion and a radial member extending substantially radially from adjacent axial portion.

**[0026]** In a preferred embodiment, the angle between the radial member and adjacent axial portion is substantially 90 degrees. Other values can be considered to enhance bond performance, in particular angles lower than 90 degrees.

**[0027]** The invention also provides a method for pro-

ducing a reinforcing element for concrete construction in the form of a rod-shaped member provided with a protection block at one end thereof, comprising the steps of producing said rod-shaped member, bending end portion of said rod member, covering said bent portion with a protection block.

**[0028]** The protection block may be provided by molding or by spraying.

## 10 BRIEF DESCRIPTION OF THE DRAWINGS

**[0029]** The invention will be better understood with the aid of the description of an embodiment given by way of example and illustrated by the figures, in which:

- 15 - Figure 1a illustrates known type reinforcement in concrete and the required concrete cover for such reinforcement;
- 20 - Figure 1b shows the standard development length for current reinforcements;
- Figure 1c shows spalling cracks on the compression face of a structural concrete member;
- 25 - Figure 1d presents a conventional T-headed bar and the corresponding concrete cover;
- 30 - Figure 2a is a schematic representation of a reinforcing member in accordance with the invention;
- Figure 2b is a first variant of the reinforcing member of figure 2a;
- 35 - Figure 2c is a schematic representation of a second embodiment of the reinforcing member of the invention;
- 40 - Figure 2d depicts a variant of the embodiment of figure 2c;
- Figure 3 illustrates the reduction of concrete cover that is due to the use of a reinforcement element of the invention;
- 45 - Figure 4 illustrates the reduction of development length that is due to the use of a reinforcement element of the invention;
- 50 - Figures 5 and 6 show applications as shear or punching shear reinforcing systems;
- Figure 7 represents an application as confinement reinforcement to avoid concrete cover spalling;
- 55 - Figure 8 shows a further use in an application as tension anchorage reinforcement;

- Figure 9 depicts an application as a link between two parts of a concrete member cast at different ages.

## DETAILED DESCRIPTION OF THE INVENTION

**[0030]** The present invention will now be described more fully hereinafter with reference to the accompanying drawings, in which embodiments of the invention are shown. This invention may, however, be embodied in many different forms and should not be construed as limited to the embodiments set forth herein; rather, these embodiments are provided so that this disclosure will be thorough and complete, and will fully convey the scope of the invention to those skilled in the art.

**[0031]** Figures 1a to 1d illustrates known type reinforcements embedded in concrete constructions. In figure 1a, the reinforcement 1 is configured such as to provide a concrete cover having a minimum thickness CC1. The bars require sufficient concrete cover to avoid rusting and corrosion problems. Typical values for this cover lay between 35 to 50 mm.

**[0032]** In figure 1d, the concrete cover is arranged such as to provide a minimum thickness CC1 between known type T-headed bar reinforcement and the concrete surface, for the same reasons as above.

**[0033]** Figure 1b shows the development length DL1 required in a known type installation. To sustain the traction efforts, the bar shall be embedded in the concrete. For important charges, DL1 may require significant embedment length. Depending on the specific construction configuration, such a length may sometimes not be provided.

**[0034]** Figure 1c illustrates the problem of cover spalling, after spalling cracks 22 have appeared in the reinforced concrete of prior art installations.

**[0035]** Figures 2a to 2d illustrate various embodiments of a reinforcing element 10 according to the invention. First, in Figure 2a, the reinforcing element 10 is provided with an extended rod-shape member 11. This rod-shaped member is preferably made with steel alloys. The axial portion 16 of the rod-shaped member 11 is substantially elongated, and generally substantially linear. At least one end of the rod-shaped member is provided with an elbow portion 12, having an angled portion 13 joining the axial portion 16 to a radial portion 14. In the illustrated examples, the angle  $\alpha$  between radial member 14 and adjacent axial portion 16 is substantially 90 degrees. Angles near 90 degrees provide high anchoring force between the rod-shaped member and the block. Other angle values may be provided depending on the mechanical requirements of the construction work.

**[0036]** The length of the axial and radial portions 16 and 14 depends on the application in which the reinforcing member shall be used. More particularly, the length of the radial portion 14 is defined as a function of the global resistance to be provided in the planned construction. For more convenience and in order to reduce manufacturing costs of the reinforcing elements 10, the most

usual standard dimensions may be provided on a large scale manufacturing basis.

**[0037]** The elbow portion 12 is embedded in a protection block 15. This protection block provides a very efficient protection against corrosion and rusting of the rod-shaped member 11. It also contributes to reduce the required embedment length. In order to perform these functions as efficiently as possible, the block 15 is preferably made with a material having low porosity or permeability. The material is to be such that protection to corrosion, considering the bar cover within the block (typically equal to the diameter of the bar), is the same as the protection with ordinary cover in traditional reinforced concrete members.

**[0038]** To comply with these criteria, the block 15 may be made with concrete, preferably high or ultra-high performance concrete or similar cementitious materials, preferably reinforced with fibers, such as Ductal, a well known UHPFRC (Ultra High Performance Fiber Reinforced Concrete). The block 15 may also be made with other materials, such as ceramic, resin or synthetic material.

**[0039]** The selected material should also preferably provide high adherence between the material and the rod-shaped member 11. Typical average values of bond strength measured in standard pull-out tests (according to RILEM/CEB/FIP - RC6 recommendations 1978) lay between 40 to 60 MPa.

**[0040]** Variants using more than one material may also be provided. In a first example, a block 15 comprises two materials, one for the outer surfaces, having very low permeability, and one for the inner volume of the block, offering less permeability protection, but allowing producing at lower global costs. In still another variant, the material providing the interfacing surface with the rod-shaped member 11 is specifically selected to provide high adherence with the latter.

**[0041]** The protection block 15 shape or profile may vary depending on the type of use, the mechanical properties, manufacturing costs, etc. In the illustrated examples, the blocks 15 have disk profiles. Other profiles such as parallelepiped may also be used. The block dimensions are determined in order to optimize the global mechanical properties of the construction work using the reinforcing elements. For best results, a minimum thickness of material covering the elbow portion 12 is provided.

**[0042]** In the illustrated examples, the elbow portions 12 are fully embedded in the blocks 15. However, variants in which the elbow portions are only partly embedded may also be provided. For instance, a protection block may entirely or partly embed the radial portion 14 only, while the angled portion 13 is not embedded. This would allow protecting the reduced embedded area against rusting and corrosion.

**[0043]** Figure 2b shows a variant of the embodiment of Figure 2a in which two protection blocks 15 are provided, one at each end, in an arrangement similar to the

previously described arrangement of Figure 2a, involving elbow portions 12 imbedded in protection blocks 15 at both ends of the reinforcing element 10.

**[0044]** Figure 2c and Figure 2d illustrate embodiments with U-shaped reinforcing elements 10 in which two axial portions 16 are provided on each side of a connecting leg 17. In the embodiment of figure 2c, the connecting leg 17 is not covered or embedded. Both free ends of the axial portions 16 are provided with embedded elbow arrangement similar to the previously described arrangement in relation with Figure 2a. The embodiment of Figure 2d differs from the latter in that the connecting leg 17 is at least partially embedded in a protection block 15. In the example shown in Figure 2d, the connecting leg 17 is entirely embedded.

**[0045]** The rod-shaped members 11 to be used can either be ordinary or high-strength reinforcing bars or pre-stressing bars or tendons to be fully or partly embedded in structural concrete members where at least one end is embedded in a protection block 15.

**[0046]** Figure 3 presents a comparison between the standard concrete cover required minimal thickness CC1 and minimal concrete cover CC2 resulting from the invention. The protection block of the reinforcement element may be placed into the CC1 zone of prior art installations, thus reducing considerably the concrete cover minimal thickness.

**[0047]** Figure 4 depicts a comparison between the standard embedment length required DL1 and embedment length DL2 resulting from the invention. The use of an elbow portion 15 embedded in a protection block allows to significantly reduce the embedment length from DL1 (prior art configuration) to DL2. Typical values of DL2 lay between 10% and 15% of DL1

**[0048]** In Figures 5 to 9, examples of uses of a reinforcing member 10 of the invention in structural applications are given.

**[0049]** As shown in Figures 5 and 6, the reinforcing element 10 can be used as a high performance shear and punching shear reinforcing system. The figures show that the compression face of the slab is suitably confined and that all reinforcements are suitably developed. In Figure 5, U-shaped reinforcing elements are used. An example of punching shear crack 21 is provided in the Figure. In Figure 6, U-shaped reinforcing elements in which the connecting legs 17 are provided with protection blocks are used. In a variant, inclined reinforcements can also be used.

**[0050]** Figure 7 shows a further application in which the confinement reinforcement for members cast with brittle (high strength or lightweight) concrete. The struts developing close to the compression face are suitably confined and premature spalling of the piece is avoided. Examples of cover spalling crack 22 are provided in the Figure. As shown in the Figure, the protection blocks 15 are not embedded in the concrete. Protection channels 20 are provided adjacent to protection blocks and provide further corrosion protection. The protection channels 20

are preferably made with the same material as the blocks. In such a case, they may be molded together with the blocks during manufacturing. Partial embedment of the blocks is also possible.

**[0051]** Figure 8 illustrates an application in which a reinforcing element 10 is used to provide anchorage points for structural concrete members. In this application, the reinforcing element configuration is designed to leave a portion of the element outside the structural concrete member, allowing using the free portion as tension anchorage reinforcement. As shown on the Figure, a protection block 15 is provided to protect the rod-shaped member 11 in order not to leave it in direct contact with the outer atmosphere.

**[0052]** Figure 9 shows that the reinforcing element 10 may further be used as a link member to connect two parts of a structural concrete member cast at different ages or two different concrete members 40 and 41.

**[0053]** The above detailed description with reference to the drawings illustrates rather than limit the invention. There are numerous alternatives, which fall within the scope of the appended claims. The word "comprising" does not exclude the presence of other elements or steps than those listed in a claim. The word "a" or "an" preceding an element or step does not exclude the presence of a plurality of such elements or steps. The mere fact that respective dependent claims define respective additional features, does not exclude a combination of additional features, which corresponds to a combination of dependent claims.

## Claims

1. A reinforcing element (10) for concrete construction comprising :
  - a rod-shaped member (11) having a cross-sectional enlargement on at least one end thereof;
  - **characterized in that** said rod shaped member (11) comprises an elbow portion (12) on said at least one end;
  - said elbow portion (12) being embedded in a protection block (15), thereby forming said enlargement.
2. The reinforcing element of claim 1, wherein the protection block (15) material is concrete and preferably high or ultra high performance concrete.
3. The reinforcing element of claim 1, wherein the protection block (15) material is selected from the list comprising ceramic and resin.
4. A reinforcing element according to any of claims 1 to 3, wherein the protection block (15) material is reinforced with fibers.

5. A reinforcing element according to any of preceding claims, wherein the protection block (15) is disk-shaped.
6. A reinforcing element according to any of preceding claims, wherein the protection block (15) material is substantially impermeable. 5
7. A reinforcing element according to any of preceding claims, wherein the protection block (15) material provides high adhesion to said rod-shaped member (11). 10
8. A reinforcing element according to any of proceeding claims, comprising two protection blocks (15), one at each end thereof. 15
9. A reinforcing element according to any of preceding claims, wherein the rod-shaped member (11) is U-shaped with a connecting leg (17) provided between the two axial portions (16) and further comprises a protection block (15) in which said connecting leg (17) is at least partially embedded. 20
10. A reinforcing element according to any of preceding claims, further provided with a protection channel (20) provided on one axial portion (16) of the rod-shaped member (11), at the immediate proximity of said protection block (15). 25  
30
11. A reinforcing element according to any of preceding claims, wherein the elbow portion (12) comprises an angled portion (13) and a radial member (14) extending substantially radially from adjacent axial portion (16). 35
12. A reinforcing element according to claim 11, wherein the angle ( $\alpha$ ) between radial member (14) and adjacent axial portion (16) is substantially 90 degrees. 40
13. A method for producing a reinforcing element (10) for concrete construction in the form of a rod shaped member (11) provided with a protection block (15) at one end thereof, comprising: 45
  - producing said rod-shaped member (11);
  - bending end portion of said rod member;
  - covering said bent portion with a protection block (15).
 50
14. A method for producing a reinforcing element (10) according to claim 13, wherein the protection block is provided by molding.
15. A method for producing a reinforcing element (10) according to claim 13, wherein the protection block is provided by spraying. 55

Fig 1a

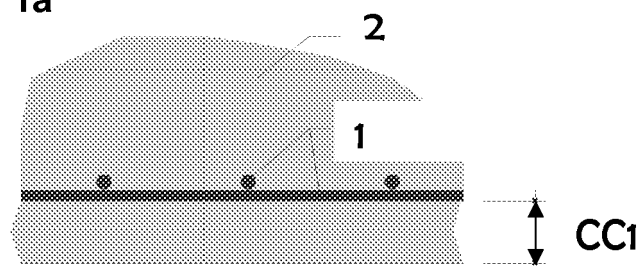


Fig 1b

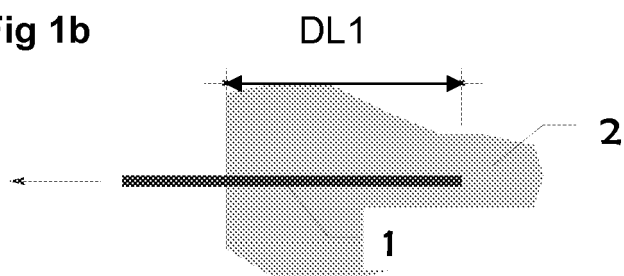


Fig 1c

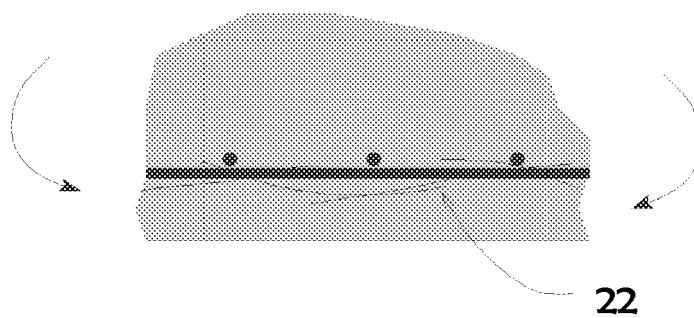
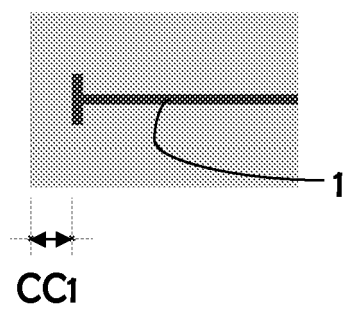
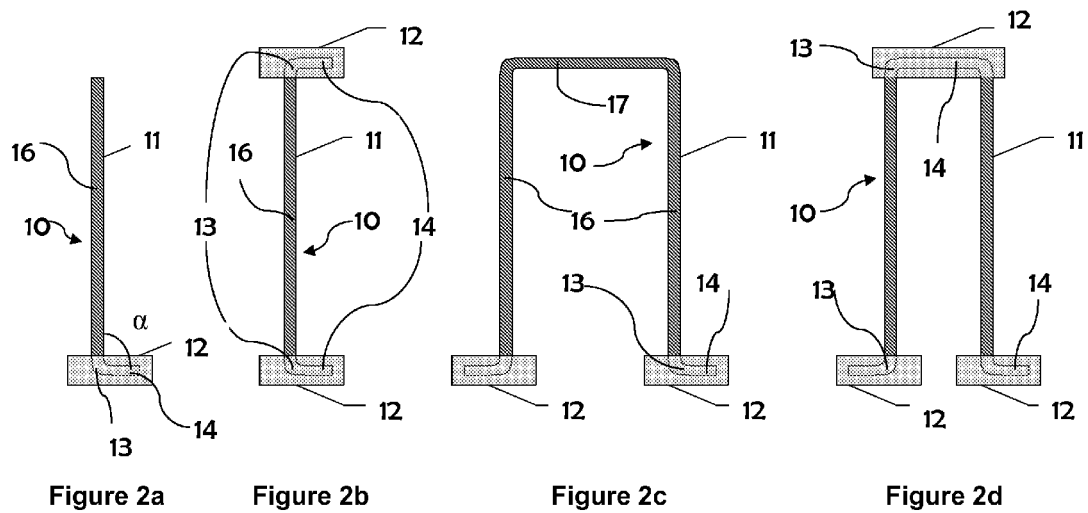


Fig 1d





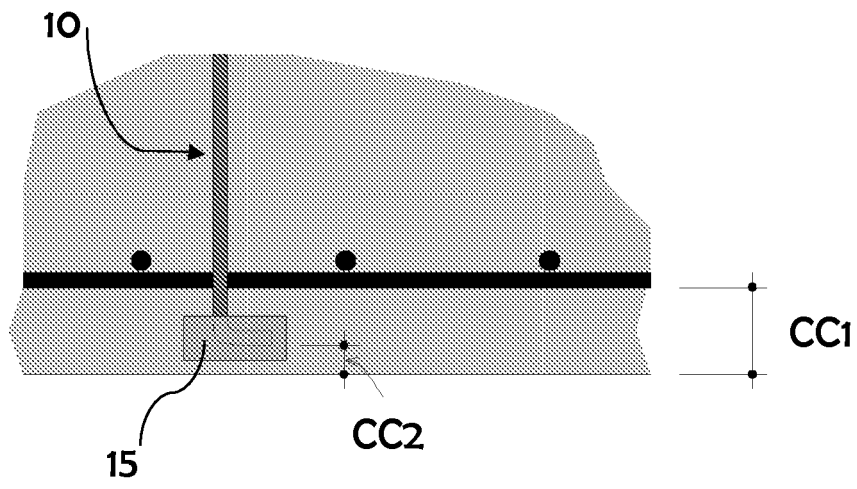


Figure 3

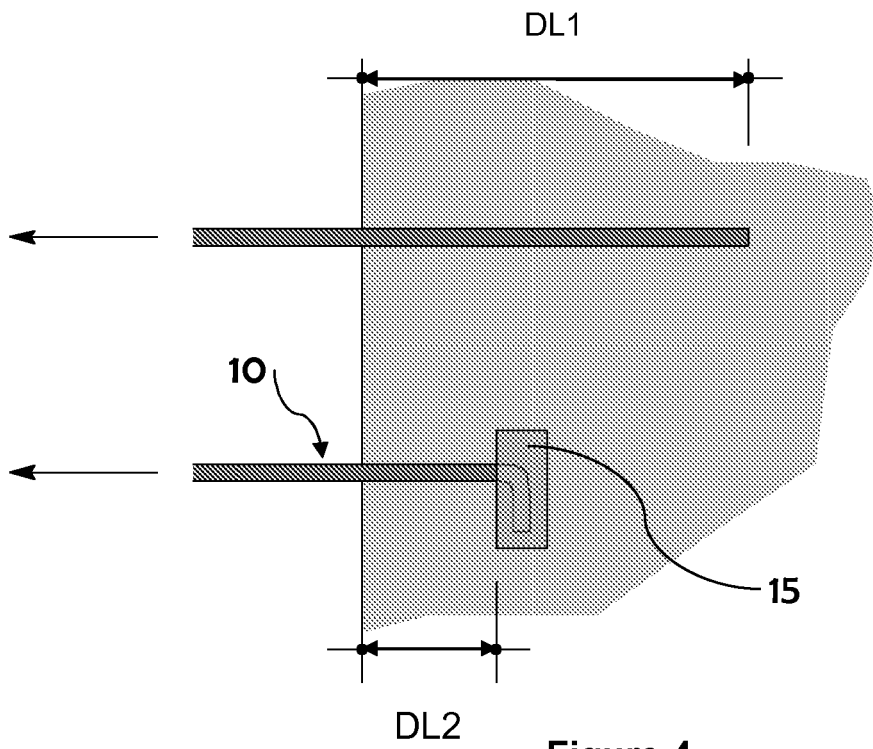
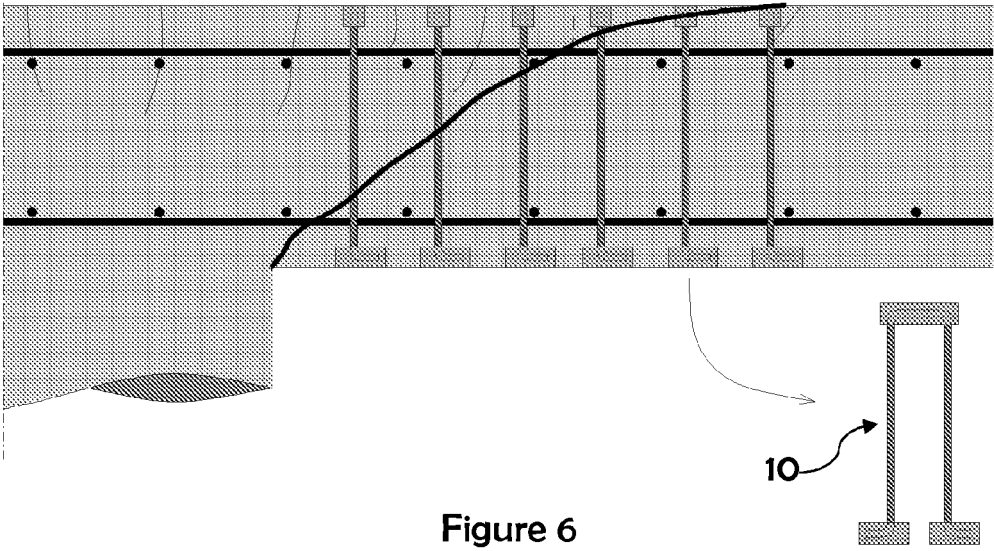
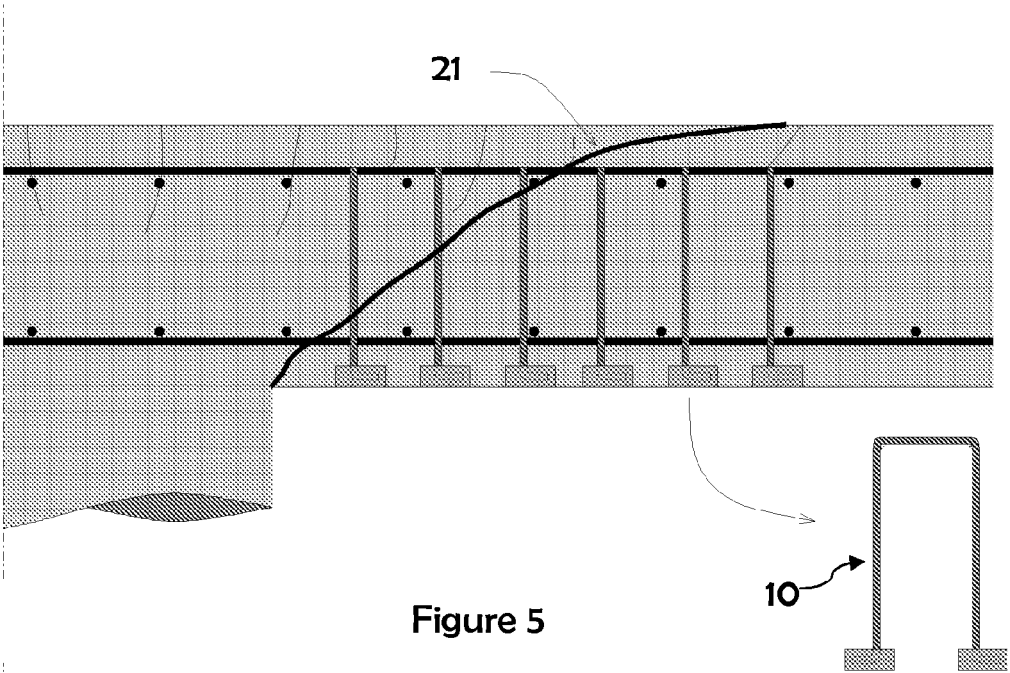


Figure 4



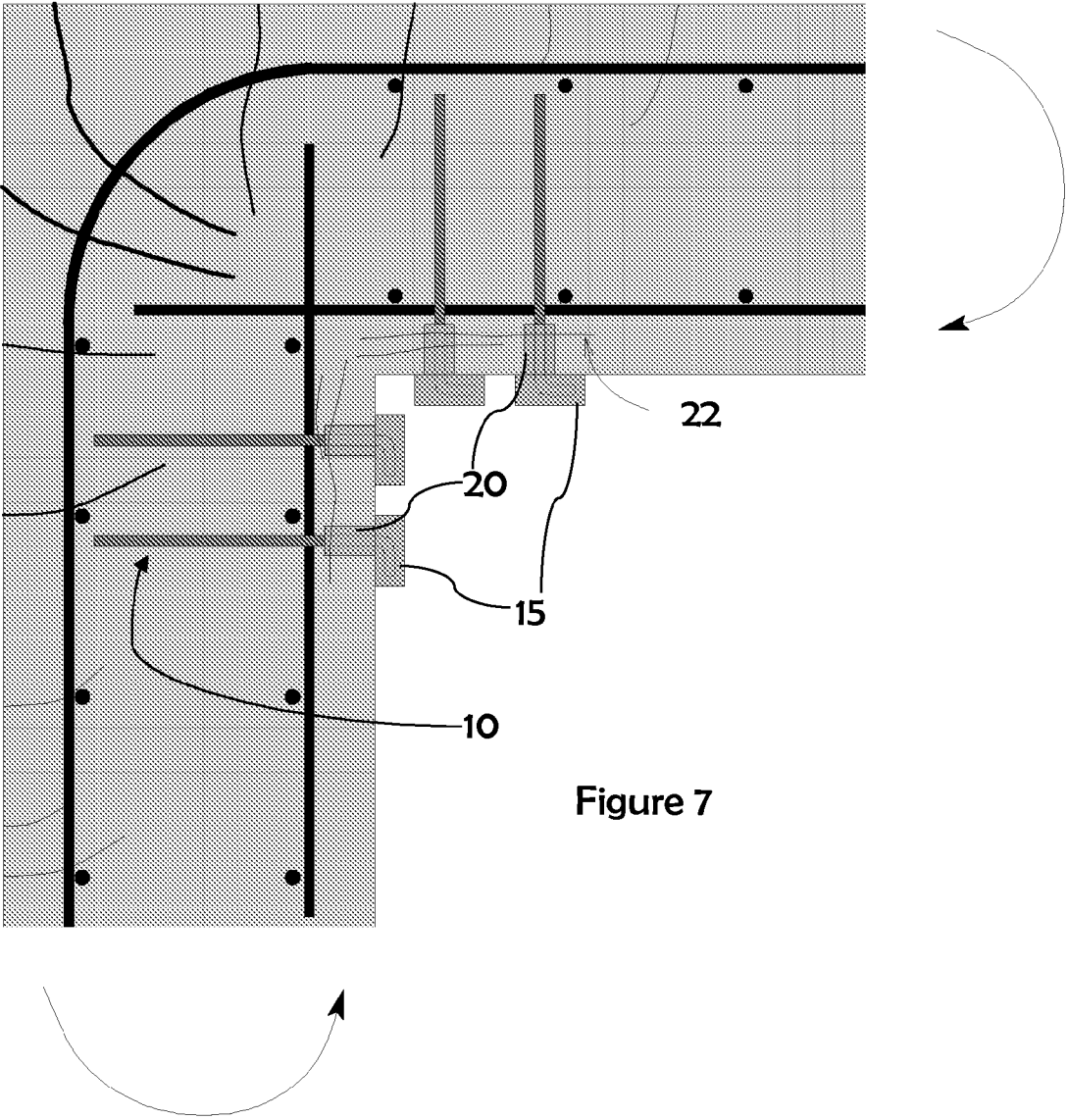
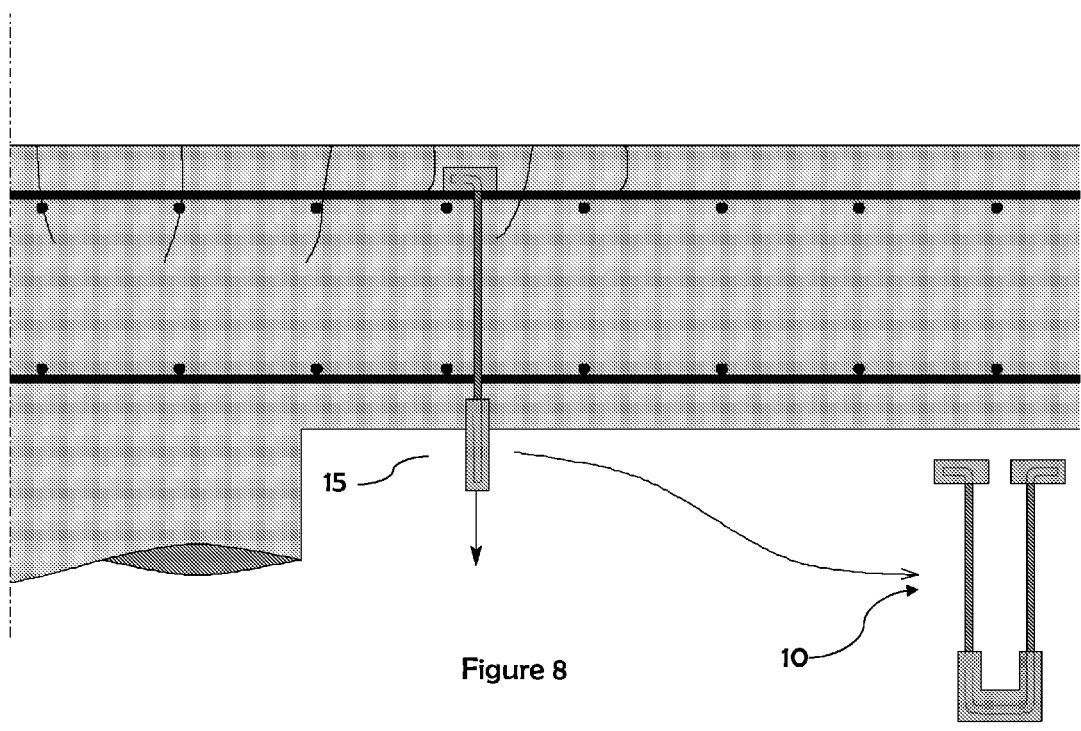


Figure 7



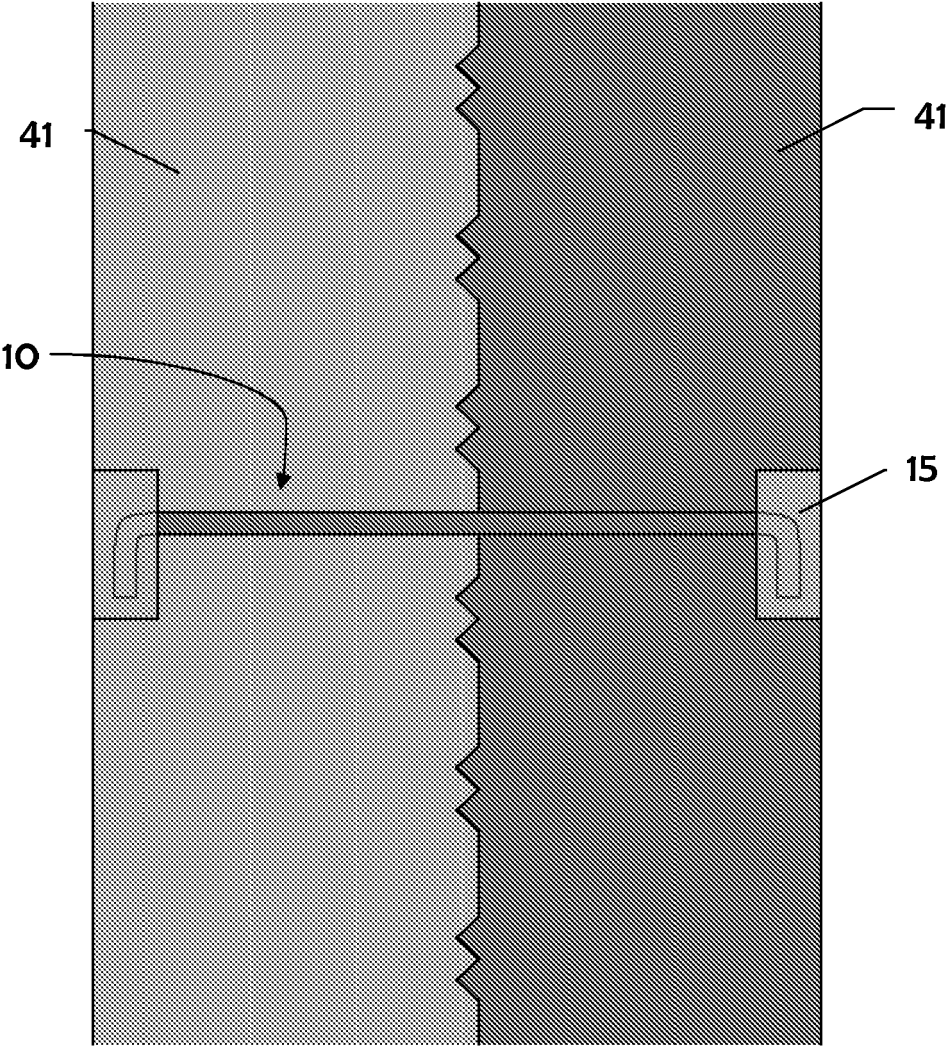


Figure 9



## EUROPEAN SEARCH REPORT

Application Number  
EP 09 15 7384

| DOCUMENTS CONSIDERED TO BE RELEVANT                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                  |                                                                                                                                                  |                                                      |                                         |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------------------------------------------------------------------------------------------------|------------------------------------------------------|-----------------------------------------|
| Category                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                             | Citation of document with indication, where appropriate, of relevant passages                                                                    | Relevant to claim                                    | CLASSIFICATION OF THE APPLICATION (IPC) |
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| The present search report has been drawn up for all claims                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                           |                                                                                                                                                  |                                                      |                                         |
| Place of search<br>Munich                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                            |                                                                                                                                                  | Date of completion of the search<br>2 September 2009 | Examiner<br>Vratsanou, Violandi         |
| <p>CATEGORY OF CITED DOCUMENTS</p> <p>X : particularly relevant if taken alone<br/>Y : particularly relevant if combined with another document of the same category<br/>A : technological background<br/>O : non-written disclosure<br/>P : intermediate document</p> <p>T : theory or principle underlying the invention<br/>E : earlier patent document, but published on, or after the filing date<br/>D : document cited in the application<br/>L : document cited for other reasons</p> <p>&amp; : member of the same patent family, corresponding document</p> |                                                                                                                                                  |                                                      |                                         |

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EPO FORM 1503 03.82 (P04C01)

**ANNEX TO THE EUROPEAN SEARCH REPORT  
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EP 09 15 7384

This annex lists the patent family members relating to the patent documents cited in the above-mentioned European search report.  
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