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(54) **Reinforcement of a retaining walls**

Verstärkung einer Rückhaltewand

Renforcement d'un mur de retention

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Description

Field of the invention

[0001] The present invention relates to the field of construction. More specifically it relates to a reinforcement profile for a retaining wall that can be recovered and optionally re-used, to the use of such reinforcement profile in a retaining wall, and to a method for recovering such reinforcement profile from a retaining wall such profile is generally known from US 6089793A.

Background of the invention

[0002] Concrete has good compression strength, but poor tensile strength or bending resistance. It is often mixed with fibers and other materials, in order to overcome these problems. Steel, for example, presents good tensile properties, so it is usually added to concrete, thus forming reinforced concrete. An advantage of steel over other metals is its thermal expansion coefficient, which is similar to that of concrete. This way, failure due to different volume changes is avoided. Nevertheless, besides steel, also other materials can be used to reinforce concrete.

[0003] Compression and tensile strength and resistance to vibration are desired properties in certain types of construction. In several cases, though, these properties are actually required only during particular stages of construction. Foundation pits, retaining walls, trenches and other structures are usually built with reinforced concrete. The concrete walls may be destroyed in order to recycle the relatively expensive reinforcement elements, when the useful life of the structures has expired. In other cases, after the highly straining construction stages, the reinforced concrete structures are usually left for supporting purposes, although reinforced concrete is often not necessary anymore.

[0004] In those cases in which the concrete structure can be demolished, when the structure is built with reinforced concrete, the steel can be recuperated using magnetic separators. Recycled steel cannot be readily used after separation from the concrete matrix, because the steel surface is often damaged and covered with rust. Document KR100380300B1 describes a process for recycling waste steel reinforcement, consisting in the steps of removing surface oxidation and rust, applying on the surface a solution comprising organic solvent and polymer (like PVC, ABS, PB and PS), and heating the steel in a dry furnace at a given temperature. This process improves the corrosion resistance property of recycled steel of increases its adhesive force to concrete. Nonetheless, it is costly, time consuming and it is only useful in case of steel-reinforced concrete after demolition. Other types of composite materials, like concrete reinforced with non-magnetic beams or with fibers, cannot benefit from a relatively easy recycling process.

Summary of the invention

[0005] It is an object of embodiments of the present invention to provide means for recovering a reinforcement profile from a retaining wall.

[0006] The above objective is accomplished by a method and a particular reinforcement profile according to the present invention.

[0007] In a first aspect, the present invention provides a reinforcement profile for a retaining wall made from a cementitious material or cementitious material comprising mixture, the reinforcement profile comprising an elongated profile element and a sleeve enveloping the profile element. It is an advantage of embodiments of the present invention that removal of the elongated profile element is facilitated by the presence of the sleeve.

[0008] A reinforcement profile according to embodiments of the present invention may further comprise a lubricant applied to the profile element, such that the lubricant is present in between the profile element and the sleeve. Both the profile element and the lubricant layer may be substantially enveloped by the sleeve. It is an advantage of embodiments of the present invention that removal of the elongated profile element from cementitious material is further facilitated by reduction of adhesion between the sleeve and the elongated profile element.

[0009] A reinforcement profile according to embodiments of the present invention may further comprise a releasing agent applied to the sleeve. This releasing agent can be the same material and/or have the same properties as the lubricant. Alternatively, the releasing agent can be a different material and/or have different properties compared to the lubricant. In particular embodiments, the releasing agent may be an oil based releasing agent. The releasing agent can be present without the lubricant between profile element and sleeve being present.

[0010] In embodiments of the present invention, the elongated profile element may be a steel profile element.

[0011] In certain embodiments of the present invention, the lubricant may be an oil or grease based type of lubricant. The lubricant may for instance be formwork removal oil, olive oil, rape seed oil.

[0012] In a reinforcement profile according to embodiments of the present invention, the sleeve may be fixedly attached to the elongated profile element.

[0013] In particular embodiments, the sleeve may be a textile sleeve. It is an advantage of embodiments of the present invention that inexpensive recycled material or geotextile can be used. The textile sleeve may be made of a geotextile material.

[0014] In a second aspect, the present invention provides the use of a reinforcement profile according to any of the embodiments of the first aspect of the present invention in a retaining wall. The retaining wall is typically built from a cementitious material comprising mixture. It is an advantage of embodiments of the present invention

that, by using a reinforcement profile according to embodiments of the present invention, a cementitious material containing mixture, e.g. concrete or grout, used for building the retaining wall may present the characteristics of reinforced cementitious material containing mixture. It is an advantage of embodiments of the present invention that the cementitious material containing mixture may have improved tensile properties. It is an additional advantage of embodiments of the present invention that the elongated profile elements are not necessarily permanently buried into elongated structural elements forming the retaining wall. It is an advantage of embodiments of the present invention that elongated structural elements provided with a reinforcement profile according to embodiments of the present invention can be used for manufacturing funding pits, flood contention, quaysides, etc.

[0015] In a third aspect, the present invention provides a method for preparing an elongated profile for being a reinforcement profile that can be recovered from a retaining wall. The method comprises obtaining the elongated profile and enveloping the elongated profile with a textile sleeve. It is an advantage of embodiments of the present invention that inexpensive recycled material or geotextile can be used.

[0016] A method according to embodiments of the present invention may furthermore comprise applying a lubricant to the elongated profile. Applying a lubricant to the elongated profile may be performed before enveloping the elongated profile with the sleeve.

[0017] A method according to embodiments of the present invention may furthermore comprise providing a releasing agent onto the textile sleeve, for instance impregnating the textile sleeve with releasing agent. This impregnation of the textile sleeve may take place before or after enveloping the elongated profile therewith.

[0018] A method according to embodiments of the present invention may furthermore comprise fixedly attaching the textile sleeve to the elongated profile.

[0019] In a method according to embodiments of the present invention, enveloping the elongated profile with a textile sleeve may leave an upper portion of the elongated profile uncovered. Enveloping the elongated profile with a textile sleeve preferably leaves an upper portion of at least 20 to 50 cm of the elongated profile uncovered.

[0020] In a fourth aspect, the present invention provides a method for recovering a reinforcement profile from a retaining wall made of cementitious material, the reinforcement profile comprising an elongated profile element and a sleeve enveloping the profile element, or alternatively an elongated profile element covered with a lubricant and a textile sleeve enveloping the lubricated profile element. The method comprises reducing the adhesion between the cementitious material and the reinforcement profile, and removing the profile element from the retaining wall. It is an advantage of embodiments of the present invention that by using a reinforcement profile according to embodiments of the present invention, the further step of removal of reinforcing elements is facilitated. It is a further advantage of embodiments of the present invention that recycling of the expensive materials after the main function expired is easy, with no need to destroy the whole structure.

[0021] In a method according to embodiments of the fourth aspect of the present invention, reducing the adhesion between the cementitious material and the reinforcement profile may comprise activating a vibrating block so as to apply vibrations to the reinforcement profile. It is an advantage of embodiments of the present invention that relatively simple devices can be used for enabling easy beam retrieval, like hydraulic hammers, jumping-jacks, compacting plates, and other vibratory rammers.

[0022] In a method according to embodiments of the present invention, reducing the adhesion between the cementitious material and the reinforcement profile may comprises using a clamp clamping the reinforcement profile, the clamp being mechanically moved away from the retaining wall, thus removing the elongated profile element. In particular embodiments of the present invention this clamping and removing action may be combined with application of vibration as in the previous embodiment. Using a clamp may include using a hydraulic clamp.

[0023] Particular and preferred aspects of the invention are set out in the accompanying independent and dependent claims. Features from the dependent claims may be combined with features of the independent claims and with features of other dependent claims as appropriate and not merely as explicitly set out in the claims.

[0024] These and other aspects of the invention will be apparent from and elucidated with reference to the embodiment(s) described hereinafter.

Brief description of the drawings

[0025]

FIG. 1 schematically shows a reinforcement profile comprising an elongated profile element partially covered with covering material according to particular embodiments of the present invention.

FIG. 2 schematically shows an example of an elongated structural element, comprising a reinforcement profile according to embodiments of the present invention encapsulated in a cementitious material comprising mixture.

FIG. 3 schematically shows a secant pile wall comprising regular elongated structural elements and elongated structural elements provided with reinforcement profiles according to embodiments of the present invention.

FIG. 4 schematically shows a soil mix wall comprising regular soil mix panels, and soil mix panels provided with reinforcement profiles according to embodiments of the present invention.

FIG. 5 schematically shows a soil mix wall comprising regular soil mix columns, and soil mix columns

provided with reinforcement profiles according to embodiments of the present invention, in a particular embodiment where two columns are manufactured simultaneously.

[0026] In the different drawings, the same reference signs refer to the same or analogous elements.

[0027] Any reference signs in the claims shall not be construed as limiting the scope.

Detailed description of illustrative embodiments

[0028] The present invention will be described with respect to particular embodiments and with reference to certain drawings but the invention is not limited thereto but only by the claims. The drawings described are only schematic and are non-limiting. In the drawings, the size of some of the elements may be exaggerated and not drawn on scale for illustrative purposes. The dimensions and the relative dimensions do not correspond to actual reductions to practice of the invention.

[0029] The terms first, second and the like in the description and in the claims, are used for distinguishing between similar elements and not necessarily for describing a sequence, either temporally, spatially, in ranking or in any other manner. It is to be understood that the terms so used are interchangeable under appropriate circumstances and that the embodiments of the invention described herein are capable of operation in other sequences than described or illustrated herein.

[0030] Moreover, the terms top, under and the like in the description and the claims are used for descriptive purposes and not necessarily for describing relative positions. It is to be understood that the terms so used are interchangeable under appropriate circumstances and that the embodiments of the invention described herein are capable of operation in other orientations than described or illustrated herein.

[0031] It is to be noticed that the term "comprising", used in the claims, should not be interpreted as being restricted to the means listed thereafter; it does not exclude other elements or steps. It is thus to be interpreted as specifying the presence of the stated features, integers, steps or components as referred to, but does not preclude the presence or addition of one or more other features, integers, steps or components, or groups thereof. Thus, the scope of the expression "a device comprising means A and B" should not be limited to devices consisting only of components A and B. It means that with respect to the present invention, the only relevant components of the device are A and B.

[0032] Reference throughout this specification to "one embodiment" or "an embodiment" means that a particular feature, structure or characteristic described in connection with the embodiment is included in at least one embodiment of the present invention. Thus, appearances of the phrases "in one embodiment" or "in an embodiment" in various places throughout this specification are not necessarily all referring to the same embodiment, but may. Furthermore, the particular features, structures or characteristics may be combined in any suitable manner, as would be apparent to one of ordinary skill in the art from this disclosure, in one or more embodiments.

[0033] Similarly it should be appreciated that in the description of exemplary embodiments of the invention, various features of the invention are sometimes grouped together in a single embodiment, figure, or description thereof for the purpose of streamlining the disclosure and aiding in the understanding of one or more of the various inventive aspects. This method of disclosure, however, is not to be interpreted as reflecting an intention that the claimed invention requires more features than are expressly recited in each claim. Rather, as the following claims reflect, inventive aspects lie in less than all features of a single foregoing disclosed embodiment. Thus, the claims following the detailed description are hereby expressly incorporated into this detailed description, with each claim standing on its own as a separate embodiment of this invention.

[0034] Furthermore, while some embodiments described herein include some but not other features included in other embodiments, combinations of features of different embodiments are meant to be within the scope of the invention, and form different embodiments, as would be understood by those in the art. For example, in the following claims, any of the claimed embodiments can be used in any combination.

[0035] In the description provided herein, numerous specific details are set forth. However, it is understood that embodiments of the invention may be practiced without these specific details. In other instances, well-known methods, structures and techniques have not been shown in detail in order not to obscure an understanding of this description.

[0036] Where in embodiments of the present invention reference is made to "profile element", reference is made to any beam with structural and/or reinforcing properties, or in general to any reinforcing elongated substrate which is to be embedded in cementitious material comprising mixture, for instance concrete. In particular embodiments this profile element is a steel element. The profile element may have any suitable shape in cross-section, for instance, but not limited thereto, circular, oval, square, rectangular, H-shaped. In accordance with embodiments of the present invention, the profile element is covered with a sleeve. The sleeve is a detachable layer or cloak like a textile sleeve, a geotextile layer, a cloth or any other covering material. The term "profile element" is not limiting to a particular type of element, e.g. beam, and the term "covering material" is not limiting to a clothing material, but includes material comprising fibers, nets, textile cloth, webs, geotextile layer not limited thereto, and in particular advantageous embodiments of the present invention, also comprising fluids, lubricants, oils or other substances.

[0037] In the context of the present invention, "a ce-

mentitious material comprising mixture" refers to a mixture of at least a liquid and a cementitious material forming construction material. Cementitious material is a binder that sets and hardens independently, and that can bind other materials together. One particular example of a cementitious material comprising mixture, the present invention not being limited thereto, is concrete, which is a mixture of cement, e.g. Portland cement, sand, coarse aggregate and water. One particularly suitable cementitious material is grout.

[0038] The present invention relates to a reinforcement profile, to the use of such reinforcement profile in a retaining wall, to a method of production and treatment of such reinforcement profile, and to a method for recovering a reinforcement profile from a retaining wall.

[0039] FIG. 1 shows schematically a reinforcement profile 100 according to particular embodiments of the present invention, comprising an elongated profile element 101, which may optionally be covered by a lubricant layer 102, and a covering material 103 in close contact with the optionally lubricated profile element. The covering material 103 envelopes the profile element 101. The covering material 103 may be temporarily attached to the profile element 101, for instance for preventing removal of the optional lubricant layer 102 when installing the reinforcement profile 100, for instance by nailing.

[0040] The profile element 101 shown in FIG. 1 has a rectangular cross-section, but it may have any other suitable cross-section, for instance, but not limited thereto, a circular or triangular cross-section, an elliptical cross-section, a channel cross-section, a T-shaped cross-section, rail profiles, a Z-shaped cross section, an L-shaped cross-section, or advantageously an H-shaped cross-section (wide flanged beams, like UC, UB, IPE, IPN, HEB, HEA, HEM, etc.), in which case the beam may have been produced for instance by rolling, or as plate girder. The present invention is not limited by the shape of the elongated profile element 101, nor by the production method of the elongated profile element 101 nor by the composition of the elongated profile element 101. For instance, the elongated profile element 101 may be made of an aluminum alloy, or it may comprise polymers. The material of the elongated profile element 101 may be any structural material which improves a chosen property of the cementitious material comprising mixture the elongated profile will be embedded in. The material of the elongated profile element 101 may for instance be selected so that its coefficient of thermal expansion is similar to, e.g. does not deviate more than 10% of the coefficient of thermal expansion of the cementitious material comprising mixture the elongated profile will be embedded in. In advantageous embodiments of the present invention, concrete may be used as cementitious material comprising mixture and steel may be used as material for the elongated profile element 101, so as to reinforce the concrete.

[0041] The optional lubricant 102 applied onto the elongated profile element 101 may comprise any suitable substance to reduce friction between moving surfaces, in particular between the profile element 101 and the sleeve 103 when removing the profile element from the retaining wall for recuperation. Examples are oils, fat, polymers, substances to prevent corrosion or oxidation, components to control adhesivity of the cementitious material to the profile. A particularly suitable lubricant is shuttering oil. Preferably the shuttering oil has a predetermined viscosity, for instance a viscosity between 0 Pa.s and 50 Pa.s. Instead of standard framework removal coating or oils, which are chemically aggressive to the environment, biological oils such as for instance rapeseed oil may be used in order to prevent pollution.

[0042] On top of the elongated profile element 101, or alternatively on top of the lubricant 102, a sleeve of covering material 103 is provided. The covering material 103 preferably has a tensile strength between 200 N/mm^2 and 2200N/mm^2 for it not to tear while introducing the reinforcing profile 100 into the environment. Moreover, the covering material 103 preferably has a mesh width of less than 300 μm in order to prevent cementitious material as much as possible from travelling through the meshes of the sleeve 103, so as to prevent physical contact between the cementitious material and the profile element 101. In particular embodiments of the present invention, the covering material 103 may comprise plastic material, such as for instance plastic foil, a cloth, a geotextile layer, or in general a textile layer. Textile material may advantageously be used, as it is less susceptible of damage than plastic material. Also when temporary nailing of the covering material 103 onto the profile element 101 will tear out less easy if the covering material 103 is textile material compared to when it is plastic material.

[0043] The covering material 103 may be impregnated, preferably up to saturation, either before or after enveloping the profile element 101, with a releasing agent such as a framework removal coating or oil. The impregnation limits or even prevents passage of cementitious material through the sleeve towards the profile element 101. Such impregnation may be performed before the covering material 103 is brought in close contact with the elongated profile element 101 and/or after enveloping the elongated profile element 101 with the covering material 103. The covering layer 103 may form a sleeve, completely encasing the length of the elongated profile element 101, or at least a substantial part thereof, for instance the elongated profile element 101 except for one of the ends 104. For instance, at most 150 cm and at least 20 cm may be left uncovered by the covering layer 103, for instance 50 cm may be left uncovered by the covering material 103.

[0044] A reinforcement profile 100 according to embodiments of the present invention is embedded in a cementitious material comprising mixture, so as to form an elongated structural element 200, an example of which is illustrated in FIG. 2. The elongated structural element 200 shown in FIG. 2 comprises a reinforcement profile 100 comprising an elongated profile element 101, optionally covered by a lubricant 102 (not shown in FIG. 2), and a covering material 103, encased in a body 203 of ce-

mentitious material comprising mixture except for a protruding extremity 204, which comprises at least the end 104 of the elongated profile element 101 not encased by the sleeve 103.

[0045] The elongated profile element 101 may advantageously be a wide-flange elongated profile element 101; the invention, however, not being limited thereto. The covering material 103 may completely cover the elongated profile element 101, or may advantageously leave uncovered one of the extremities 104 of the elongated profile element 101, as seen before. In this last case, the cementitious material comprising mixture 203 encasing the reinforcement profile 100 may be in contact only with at most the covered part of the reinforcement profile 100, hence leaving at least the uncovered part 104 of the elongated profile element 101 protruding out of the body of cementitious material comprising mixture, the part of the reinforcement profile 100 protruding out of the cementitious material comprising mixture being indicated in FIG. 2 by reference number 204. The protruding part 204 may consist of only the uncovered end 104 of the elongated profile element 101, or may consist of a larger portion of the reinforcement profile 100, i.e. also a portion of the sleeve 103 may protrude out of the cementitious material comprising mixture.

[0046] FIG. 3 schematically illustrates a part of a secant pile wall 300 formed by a plurality of elongated structural elements, of which at least some are as the elongated structural elements 200 illustrated in FIG.2, or similar. It can be seen that in the secant pile wall 300 illustrated in FIG. 3, two types of elongated structural elements are provided: a first type being the structural elements 310, 311, 312, and a second type being the elongated structural elements 301, 302 which are similar to the elongated structural element 200 illustrated in FIG. 2. The elongated structural elements 301, 302 comprise a core formed by a reinforcement profile 100 according to embodiments of the present invention, while thee elongated structural elements 310, 311, 312 either do not contain any reinforcement element, or contain a prior art reinforcement element which cannot be recovered after manufacturing of the building element, in the present case the secant pile wall 300. The It must be understood that the term "building element" is presented in a generic sense, and the present invention may also be applied to retaining walls, fences, contention dykes, weirs, trenches, foundation pits, railway walls, etc.

[0047] Although the invention is not limited to this shape, in the embodiment shown in FIG. 3, cylindrical elongated structural elements are depicted. They may have all the same diameter D and height H, or these values D and H may vary between different elements, in particular for instance between different types of elongated structural elements (prior art type elements or elongated structural elements according to embodiments of the present invention). In advantageous embodiments, for instance, not illustrated in the drawings, the prior art elongated structural elements 310, 311, 312 may be substantially shorter than the elongated structural elements 301, 302 as in accordance with the present invention. When forming a secant pile wall 300 as in FIG. 3, the elongated structural elements have a certain overlapping 307, for instance not larger than a fraction of the characteristic diameter D of the element, such as not larger than D/6, for instance they may be overlapping over a distance D/8. In particular embodiments of the present invention, the secant pile wall 300 may be built with prior art concrete structural elements and concrete elongated structural elements according to embodiments of the present invention, with an overlapping between the elongated elements which is smaller than D/8 or 6 cm, whatever is smaller, thus creating a solid wall.

[0048] In alternative embodiments, not illustrated, where the elongated structural elements form a tangent pile wall, the elongated structural elements do not overlap, but touch or even leave between the elements a gap smaller than D/10. In particular embodiments of the present invention, such wall may be built with a sequence of concrete elongated structural elements according to the prior art and according to embodiments of the present invention, and there may be a gap (for instance, if a certain flow of air or water is required through the wall) smaller than D/10. Other structures may be envisaged by those skilled in the art using reinforcement profiles according to embodiments of the present invention.

[0049] The cementitious material comprising mixture 203 may be cast in a cylinder shape as illustrated in FIG. 2, and the elongated structural element 200 may contain a single reinforcement profile 100 according to embodiments of the present invention, but the present invention is not limited thereto. Instead of a cylindrical shape, the cementitious material comprising mixture may be cast as a prism or a panel, for instance, and it may contain more than one reinforcement profile 100 according to embodiments of the present invention. For example, the embodiment schematically drawn in FIG. 4 shows a wall 400 formed by prismatic elements 401, each of which may comprise a prismatic body 402 of cementitious material comprising mixture. Some or all of these prismatic bodies may comprise one or more reinforcement profiles 100 according to embodiments of the present invention, for example two reinforcement profiles 100, as shown in FIG. 4. As before, the wall may consist of a sequence of prismatic bodies with and without reinforcement profiles 100 according to embodiments of the present invention. In the embodiment illustrated in FIG. 4, for instance, the wall 400 could be formed by a sequence of prismatic bodies 402, one according to the prior art, i.e. without reinforcement profile, or with some reinforcement means which cannot be recovered after having been put in place, at least not without destroying the prismatic body; and one with at least one reinforcement profile 100 according to embodiments of the present invention. Alternatively, a wall 400 may consist of only prismatic bodies provided with reinforcement profiles 100 according to embodiments of the present invention. In all embodiments, the

prismatic bodies may have a determined overlapping 404 or may have a gap between them, or some elements may overlap while others do not.

[0050] In one aspect, the present invention provides a method for preparing an elongated profile element 101, for example a steel profile element 101, for being a reinforcement profile 100 according to embodiments of the present invention that can be recovered from a retaining wall without destroying the wall. The method comprises obtaining the elongated profile element 101 and enveloping the elongated profile element with a covering material 103, for instance a sleeve such as a textile sleeve.

[0051] In certain embodiments, for instance but not exclusively in embodiments comprising long elongated profile elements, for instance but not limited thereto elongated profile elements having a length larger than 100 cm, a lubricant 102 may advantageously be applied to the elongated profile element 101. For instance, it may be applied before enveloping the elongated profile element with the covering material. Further steps of removal of the elongated profile element may be improved.

[0052] Before enveloping the elongated profile element 101 (or, optionally, before applying a lubricant 102 to the elongated profile element 101), this profile element 101 may be prepared, for instance the surface of this profile element 101 may be cleaned from polluting elements and adherent components.

[0053] The optional step of applying a lubricant 102 to the elongated profile 101 means applying an oil, fat, polymer, substance to prevent corrosion or oxidation, or a component to control adhesivity. The lubricant may be applied in any suitable way, for instance by smearing, spraying, brushing, dripping, submersion or suffusing. The layer of lubricant 102 has a limited thickness, for instance about 10 μm or more. The layer of lubricant should be thick enough to provide its lubricating action; applying more lubricant is not required and only increases the costs. This step of applying a lubricant 102 to the elongated profile 101, however, is not an essential step of the method according to embodiments of the present invention.

[0054] Just like the elongated profile element 101, also the covering material 103, e.g. the textile sleeve, may be prepared before applying it. The covering material 103 may be cut with a shape and surface so it can cover the required area of the elongated profile element 101, for instance all the elongated profile element 101, or most of the elongated profile element 101 except for at most 150 cm, for instance at most 50 cm. Additionally, the covering material 103 may be sewn, forming a sleeve, or it may be left as a layer of material for easy further attachment. Additionally, the covering material 103 may be covered or injected with releasing agent, for instance a releasing emulsion, coating or oil, for instance framework removal oil, the present invention not being limited thereto. In particular embodiments, the covering material 103 may be impregnated with releasing agent, but alternatively releasing agent may be applied to the covering material 103 in another way. This step of applying releasing agent during the preparation of the covering material 103, however, is not an essential step of the method according to embodiments of the present invention. Alternatively, releasing agent may be applied to the covering material 103 only after application of the covering material 103 to the elongated profile element 101.

[0055] Applying the covering material 103 to the elongated profile element 101 may include wrapping the covering material 103 around the profile element 101. In advantageous embodiments of the present invention, the covering material 103 is tightly attached to the elongated profile element 101. The attachment may be done by wrapping, by adhesion, or by wrapping and attaching the cloth to the substrate with nails, buttons or any other anchoring element, the attachment method not being limiting for the present invention. One of the extremities 104 of the elongated profile element 101 may be left uncovered.

[0056] Once the elongated profile element 101 is covered by the covering material 103, the latter may be temporarily fixedly attached to the profile element 101, for instance by means of nails or other suitable attachment means and techniques. This attachment of the covering material 103 onto the profile element 101 serves the purpose of having the covering material 103 follow the shape of the profile element 101. If lubricant 102 is applied on the elongated profile element before enveloping by covering material 103, the covering material 103 closely wrapped around the profile element 101 prevents the lubricant from being removed during installation of the reinforcement profile 100.

[0057] The reinforcement profiles 100 thus formed may either be manufactured onsite, i.e. at the building site where they will be used as a reinforcement profile in a retaining wall, or off-site, i.e. away from the building site where they will be used as a reinforcement profile in a retaining wall. In the latter case they have to be transported to the building site where they will be actually used. The covering materials 103, during manufacture, application to the elongated profile element 101, and storage at the building site, should be protected from environmental influences such as in particular rain and UV radiation if the covering material 103 was treated with framework removal oil, otherwise a further layer of framework removal oil may be required to be applied.

[0058] Once the reinforcement profiles 100 are available at the building site, they can be used for manufacturing at least temporarily reinforced retaining walls. Hereto, the reinforcement profiles 100 are embedded in the material from which the retaining wall is made, for instance in a cementitious material comprising mixture, such as for example concrete. Preferably, just before mounting the reinforcement profiles 100 into the cementitious material comprising mixture, it is again treated with the releasing agent. Application of such reinforcement profiles 100 according to embodiments of the present invention into the cementitious material comprising mix-

ture is not different from mounting prior art reinforcing structures in this material, except that the reinforcement profiles 100 according to embodiments of the present invention are placed such that they stick out of the cementitious material comprising mixture over a distance which will later allow to grab the reinforcement profiles 100 for recovering them from the hardened cementitious material comprising mixture, for instance by pulling or by vibration. In particular embodiments, the reinforcement profiles 100 stick out of the cementitious material comprising mixture for at least 50 cm.

[0059] The cementitious material comprising mixture may be formed at the same time as placing the reinforcement profiles 100, following the cast-in-place method which is suitable for building of walls, foundation pits, weir or in general any building structure with requirements of high compression and tensile strength. As an example of method of production, the reinforcement profiles 100 can be vertically placed in a mould. The verticality may be ensured with lasers, tiltmeters, etc. Then, the structure is encased in casting material, such as a cementitious material comprising mixture, for example in concrete, except one protruding extremity 204. For instance, the mould can be excavated in the ground with clamshell excavators or other techniques. Thus, the casting of the wall element may be done using the excavated ground as a mould. For instance, a structure like the secant pile wall depicted in FIG. 3 can be made by excavating cylindrical holes for the concrete elements 310, 312 of diameter D, and filling them with for instance concrete, then excavating intermediate holes suitable for the structural elements 311, and filling them with for instance concrete, letting the structural elements harden, and finally excavating holes, in between each of the previously filled holes, touching these or even overlapping therewith and thus removing previously applied material such as for instance concrete, suitable for formation of the elongated structural elements 301, 302. In these latter holes, in accordance with what is illustrated in FIG. 3, reinforcement profiles 100 according to embodiments of the present invention are placed vertically. Thereafter, the holes are filled with the cementitious material comprising mixture, for instance concrete, thus encasing the reinforcement profile 100 except for at least its uncovered extremity 104 (the extremity 104 of the elongated profile element 101 that is not covered by the covering material 103). The diameter D of the cylinders may be between 0.4 m and 1.5 m, for instance they may be between 0.4 m and 0.7 m for holes drilled with Auger screw blades, or between 0.6 m and 1.5 m for holes drilled with other systems. Alternatively or additionally, the known soil-mix technique of injecting concrete and mixing it with the ground may be used, instead of only excavating holes as moulds. The typical diameter of the obtained cylinder would be within the range of 0.4 m to 1.5 m, for instance between 0.6 m and 1.2 m, with a length H of maximum 20 m. The actual choice of diameter and length depends of factors like the quality of the ground, but embodiments of the present invention are applicable to any technique. For instance, all the elongated structural elements may be formed by soil-mix, or only the elongated structural elements according to the prior art, i.e. without a reinforcement profile according to embodiments of the present invention, may be formed by soil-mix, while the elongated structural elements provided with a reinforcement profile according to embodiments of the present invention may be formed by casting in an excavated hole. In particular embodiments of the present invention, concrete may be used as cementitious material comprising mixture, but alternatively other casting materials can also be used.

[0060] The cementitious material comprising mixture is then allowed to harden.

[0061] In any case, columns or pillars can be formed in such a way that a wall is created. All or some of the formed columns may overlap, creating a compact wall. In advantageous embodiments of the present invention, the columns may have an overlapping 307 not larger than D/6 (advantageously D/8 if the soil-mix method is used), D being the column diameter. The overlapping may for instance be in the range of 10 mm to 400 mm. In the same or other embodiments, the depth of the excavated holes is shorter for elongated structural elements without reinforcement profile according to embodiments of the present invention than for elongated structural elements with reinforcement profile according to embodiments of the present invention. In other embodiments, all formed elongated structural elements are provided with a reinforcement profile according to embodiments of the present invention, in which case a gap may advantageously be left between the elements, forming a fence-like wall instead of a compact wall. This can be done, for instance, for permeability reasons. As seen before, the present invention is not limited to the cylindrical shape and column formation, and other shapes are possible, like prismatic shapes, panels, etc. For instance, in other embodiments shown in FIG. 4, prismatic holes may be excavated, and more than one reinforcement profile may be encased in each hole. For instance, if the embodiment comprises panels, they may be formed by either excavating or by the soil-mix method. The panels may have a rectangular cross-section in the plane of the soil surface of between 2.0 m and 3.0 m by between 0.4 m and 0.8 m, for instance 2.2 m or 2.8 m by 0.55 m, with a depth of between 5 m and 25 m, for instance a depth of 14 m or 20 m. Of course, other sizes are possible. The overlapping 404 between neighbouring plates may advantageously be at least 0.1 m.

[0062] Other wall structures can be envisaged by those skilled in the art. For instance, the wall 500 shown in FIG. 5 comprises couples of elongated structural elements 501, 502, 503, 504, etc provided with reinforcement profiles according to embodiments of the present invention, alternating with concrete elements 505, 506, 507, 508 etc without reinforcement profiles according to embodiments of the present invention. Such couples can advan-

tageously be produced simultaneously, as known to a person skilled in the art.

[0063] The so-built retaining wall, wherein one or more elongated structural elements comprise a reinforcement profile 100 according to embodiments of the present invention, can fulfill its retaining function, requiring the tensile strength provided or supported by the reinforcement profile 100.

[0064] After the elongated structural elements are casted and hardened in the ground, the wall so formed can be partially excavated to form foundation pits, trenches, flood contention structures, weirs, quaysides, railway walls, etc., the present invention not being limited thereto.

[0065] Once the thus constructed retaining wall has fulfilled its ground and water retaining function, the excavation pit can be covered again, and recovery and recycling of the elongated profile elements 101 can be started, in accordance with embodiments of the present invention, without the need of destroying the structure. The recovery process is made possible because the adhesion between the profile elements 101 and the cementitious material comprising mixture (which encases the reinforcement profiles 100) can be reduced.

[0066] In one embodiment, this reduction in adhesion can be obtained by applying a strong vibration on the protruding extremity 204 of the reinforcement profile 100 (e.g. on the end 104 of the elongated profile element 101). The vibration may be provided by a jumping jack, a vibrating plate compactor, or in general a vibratory rammer or any other suitable means providing a strong enough vibration. The required vibration depends on the length and the mass of the profile element 101. The vibration may for instance provide a force of between 100 kN and 2000 kN. This vibration reduces the adhesion between the profile element 101 and the covering material 103. The adhesion may be further reduced if the lubricant layer 102 is applied on the elongated profile. Optionally or additionally, it may be further reduced if the covering material comprises, e.g. is covered or impregnated with, framework removal oil or another similar composition.

[0067] In another embodiment, the reduction in adhesion can be obtained by applying a strong enough pulling force in the longitudinal direction of the elongated profile element 101.

[0068] The extremity protruding out of the cementitious material comprising matrix of the elongated structural element can be clamped and pulled out using any suitable system, for instance a hydraulic system like a system of pistons or hydraulic cylinders. A crane, a power shovel, or other heavy lifting equipment may also be used.

[0069] This way, some of the elongated profile elements 101 may be recovered from the elongated structural elements when their tensile strength is not critical anymore. Typical problems stemming from the existence of elongated profile element 101 in the composite concrete are reduced or even completely avoided. For instance, in reinforced concrete (concrete with steel elongated profile elements 101), carbonation (caused by corrosion of elongated profile element 101, due to their proximity to the surface) or chloride attack (promoting corrosion of the elongated profile element 101) are typical problems that may be reduced if the unnecessary elongated profile elements 101 are removed. In those cases in which tensile strength is not required at some point in time (for instance, when works have finished), all elongated profile elements 101 may be removed. The recycling process reduces important costs in building structure, because the elongated profile element 101 may be readily re-used after cleaning. Environmental impact is also reduced. Additionally, removing the elongated profile element 101 from the cementitious material comprising mixture may increase structural stability due to the reduction of weight. Less anchoring may also be needed. After elongated profile element 101 removal, the holes in the cementitious material comprising mixture may be filled with more cementitious material comprising mixture, sand, liquid blocking means, etc.

Claims

1. A reinforcement profile (100) for a retaining wall (300; 400; 500), comprising:

   - an elongated profile element (101), and
   - a sleeve (103) enveloping the elongated profile element (101),

   characterized in that a lubricant (102) is provided between the elongated profile element (101) and the sleeve (103).

2. A reinforcement profile (100) according to claim 1, wherein the lubricant (102) is applied to the elongated profile element (101).

3. A reinforcement profile (100) according to any of the previous claims, further comprising a releasing agent applied to the sleeve (103).

4. A reinforcement profile (100) according to claim 3, wherein the releasing agent is an oil based releasing agent.

5. A reinforcement profile (100) according to any of the previous claims, wherein the lubricant is an oil or grease based type of lubricant.

6. A reinforcement profile (100) according to any of the previous claims, wherein the sleeve (103) is fixedly attached to the elongated profile element (101).

7. A reinforcement profile (100) according to any of the previous claims, wherein the sleeve (103) is a textile sleeve.

8. A building element (200; 301, 302; 402; 501, 502) comprising a reinforcement profile (100) according to any of the previous claims, the reinforcement profile (100) being encapsulated in a cementitious material comprising mixture cast around the reinforcement profile.

9. Use of a reinforcement profile (100) according to any of claims 1 to 8 in a retaining wall (300; 400; 500).

10. Method for preparing an elongated profile element (101) for being a reinforcement profile (100) that can be recovered from a retaining wall (300; 400; 500), the method comprising:

- obtaining the elongated profile element (101),
- enveloping the elongated profile element (101) with a sleeve (103), and
- applying a lubricant between the elongated profile element (101) and the sleeve (103).

11. Method according to claim 10, furthermore comprising providing a releasing agent onto the sleeve (103).

12. Method according to any of claims 10 to 11, furthermore comprising fixedly attaching the sleeve (103) to the elongated profile element (101).

13. Method for recovering a reinforcement profile (100) from a retaining wall (300; 400; 500) made of cementitious material, the reinforcement profile (100) comprising an elongated profile element (101), a sleeve (103) enveloping the profile element (101), and a lubricant (102) provided between the elongated profile element (101) and the sleeve (103), the method comprising:

- reducing adhesion between the cementitious material and the reinforcement profile (100), and
- removing the profile element (101) from the retaining wall (300; 400; 500).

14. Method according to claim 13, wherein reducing the adhesion between the cementitious material and the reinforcement profile (100) comprises activating a vibrating block so as to apply vibrations to the reinforcement profile (100).

15. Method according to claim 13 or 14, wherein reducing the adhesion between the cementitious material and the reinforcement profile (100) comprises using a clamp for clamping the reinforcement profile (100), the clamp being mechanically moved away from the retaining wall (300; 400; 500), thus removing the elongated profile element (101).

Patentansprüche

1. Verstärkungsprofil (100) für eine Rückhaltewand (300; 400; 500), umfassend:

- ein längliches Profilelement (101) und
- eine Hülse (103), die das längliche Profilelement (101) umgibt,

dadurch gekennzeichnet, dass ein Schmierstoff (102) zwischen dem länglichen Profilelement (101) und der Hülse (103) bereitgestellt ist.

2. Verstärkungsprofil (100) nach Anspruch 1, wobei der Schmierstoff (102) auf das längliche Profilelement (101) aufgetragen wird.

3. Verstärkungsprofil (100) nach einem der vorhergehenden Ansprüche, ferner umfassend ein Trennmittel, das auf die Hülse (103) aufgetragen wird.

4. Verstärkungsprofil (100) nach Anspruch 3, wobei das Trennmittel ein ölbasiertes Trennmittel ist.

5. Verstärkungsprofil (100) nach einem der vorhergehenden Ansprüche, wobei der Schmierstoff eine öl- oder fettbasierte Art von Schmierstoff ist.

6. Verstärkungsprofil (100) nach einem der vorhergehenden Ansprüche, wobei die Hülse (103) fest am länglichen Profilelement (101) angebracht ist.

7. Verstärkungsprofil (100) nach einem der vorhergehenden Ansprüche, wobei die Hülse (103) eine Textilhülse ist.

8. Bauelement (200; 301, 302; 402; 501, 502), umfassend ein Verstärkungsprofil (100) nach einem der vorhergehenden Ansprüche, wobei das Verstärkungsprofil (100) in einem zementartigen Material eingebettet ist, das ein Gemisch umfasst, welches um das Verstärkungsprofil herum gegossen wird.

9. Verwendung eines Verstärkungsprofils (100) nach einem der Ansprüche 1 bis 8 in einer Rückhaltewand (300; 400; 500).

10. Verfahren zum Vorbereiten eines länglichen Profilelements (101), um ein Verstärkungsprofil (100) zu werden, das aus einer Rückhaltewand (300; 400; 500) zurückgewonnen werden kann, wobei das Verfahren Folgendes umfasst:

- Erhalten des länglichen Profilelements (101),
- Umgeben des länglichen Profilelements (101) mit einer Hülse (103) und
- Auftragen eines Schmierstoffes zwischen dem länglichen Profilelement (101) und der Hülse

(103).

11. Verfahren nach Anspruch 10, ferner umfassend das Bereitstellen eines Trennmittels auf der Hülse (103).

12. Verfahren nach einem der Ansprüche 10 bis 11, ferner umfassend das feste Anbringen der Hülse (103) an dem länglichen Profilelement (101).

13. Verfahren zum Zurückgewinnen eines Verstärkungsprofils (100) aus einer Rückhaltewand (300; 400; 500), die aus einem zementartigen Material hergestellt ist, wobei das Verstärkungsprofil (100) ein längliches Profilelement (101), eine Hülse (103), die das Profilelement (101) umgibt, und einen Schmierstoff (102) umfasst, der zwischen dem länglichen Profilelement (101) und der Hülse (103) bereitgestellt ist, wobei das Verfahren Folgendes umfasst:

- Verringern der Adhäsion zwischen dem zementartigen Material und dem Verstärkungsprofil (100) und
- Entfernen des Profilelements (101) aus der Rückhaltewand (300; 400; 500).

14. Verfahren nach Anspruch 13, wobei das Verringern der Adhäsion zwischen dem zementartigen Material und dem Verstärkungsprofil (100) das Aktivieren eines Rüttelblocks umfasst, um Vibrationen auf das Verstärkungsprofil (100) anzuwenden.

15. Verfahren nach Anspruch 13 oder 14, wobei das Verringern der Adhäsion zwischen dem zementartigen Material und dem Verstärkungsprofil (100) das Verwenden einer Klemme zum Klemmen des Verstärkungsprofils (100) umfasst, wobei die Klemme mechanisch von der Rückhaltewand (300; 400; 500) weg bewegt wird, wodurch das längliche Profilelement (101) entfernt wird.

Revendications

1. Un profilé de renfort (100) destiné à un mur porteur (300, 400, 500), comprenant :

- un élément de profilé allongé (101), et
- un manchon (103) enveloppant l'élément de profilé allongé (101),

caractérisé en ce qu'un lubrifiant (102) est fourni entre l'élément de profilé allongé (101) et le manchon (103).

2. Un profilé de renfort (100) selon la Revendication 1, où le lubrifiant (102) est appliqué à l'élément de profilé allongé (101).

3. Un profilé de renfort (100) selon l'une quelconque des Revendications précédentes, comprenant en outre un agent de libération appliqué au manchon (103).

4. Un profilé de renfort (100) selon la Revendication 3, où l'agent de libération est un agent de libération à base d'huile.

5. Un profilé de renfort (100) selon l'une quelconque des Revendications précédentes, où le lubrifiant est un type de lubrifiant à base d'huile ou de graisse.

6. Un profilé de renfort (100) selon l'une quelconque des Revendications précédentes, où le manchon (103) est rattaché de manière fixe à l'élément de profilé allongé (101).

7. Un profilé de renfort (100) selon l'une quelconque des Revendications précédentes, où le manchon (103) est un manchon textile.

8. Un élément de construction (200, 301, 302, 402, 501, 502) comprenant un profilé de renfort (100) selon l'une quelconque des Revendications précédentes, le profilé de renfort (100) étant encapsulé dans un matériau cimentaire contenant un mélange coulé autour du profilé de renfort.

9. L'utilisation d'un profilé de renfort (100) selon l'une quelconque des Revendications 1 à 8 dans un mur porteur (300, 400, 500).

10. Un procédé de préparation d'un élément de profilé allongé (101) destiné à devenir un profilé de renfort (100) qui peut être récupéré à partir d'un mur porteur (300, 400, 500), le procédé comprenant :

- l'obtention de l'élément de profilé allongé (101),
- l'enveloppage de l'élément de profilé allongé (101) avec un manchon (103), et
- l'application d'un lubrifiant entre l'élément de profilé allongé (101) et le manchon (103).

11. Le procédé selon la Revendication 10, comprenant en outre la fourniture d'un agent de libération sur le manchon (103).

12. Le procédé selon l'une quelconque des Revendications 10 à 11, comprenant en outre la fixation de manière fixe du manchon (103) à l'élément de profilé allongé (101).

13. Le procédé de récupération d'un profilé de renfort (100) à partir d'un mur porteur (300, 400, 500) composé d'un matériau cimentaire, le profilé de renfort (100) comprenant un élément de profilé allongé (101), un manchon (103) enveloppant l'élément de

profilé (101) et un lubrifiant (102) fourni entre l'élément de profilé allongé (101) et le manchon (103), le procédé comprenant :

- la réduction d'une adhésion entre le matériau cimentaire et le profilé de renfort (100), et
- le retrait de l'élément de profilé (101) du mur porteur (300, 400, 500).

14. Le procédé selon la Revendication 13, où la réduction de l'adhésion entre le matériau cimentaire et le profilé de renfort (100) comprend l'activation d'un bloc vibreur destiné à l'application de vibrations au profilé de renfort (100).

15. Le procédé selon la Revendication 13 ou 14, où la réduction de l'adhésion entre le matériau cimentaire et le profilé de renfort (100) comprend l'utilisation d'une pince de serrage destinée à la fixation par serrage du profilé de renfort (100), la pince de serrage étant mécaniquement déplacé à l'écart du mur porteur (300, 400, 500), retirant ainsi l'élément de profilé allongé (101).

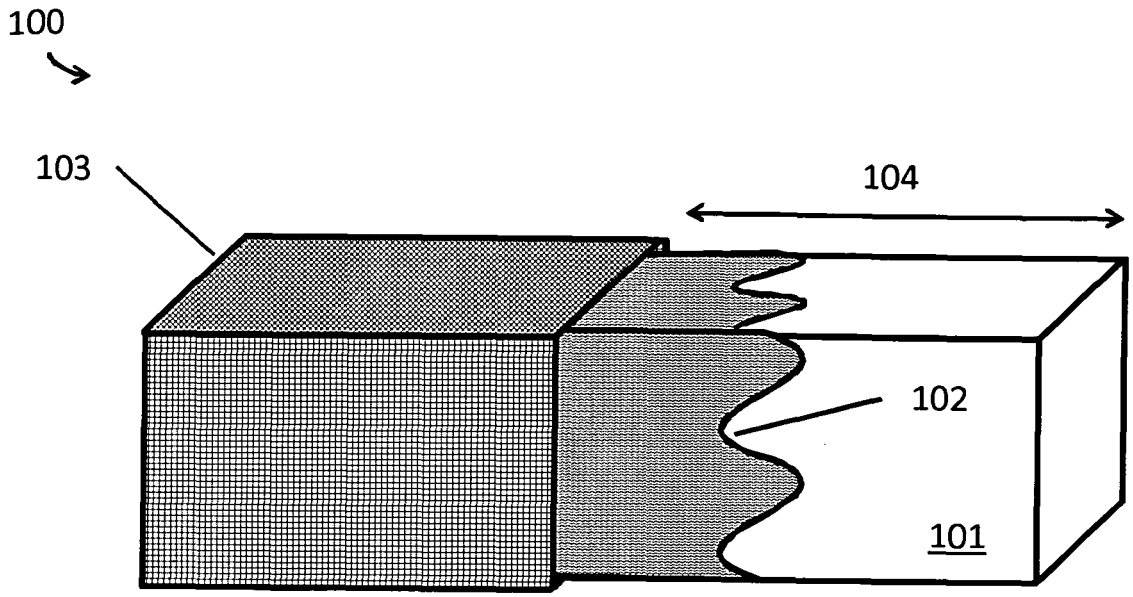


FIG. 1

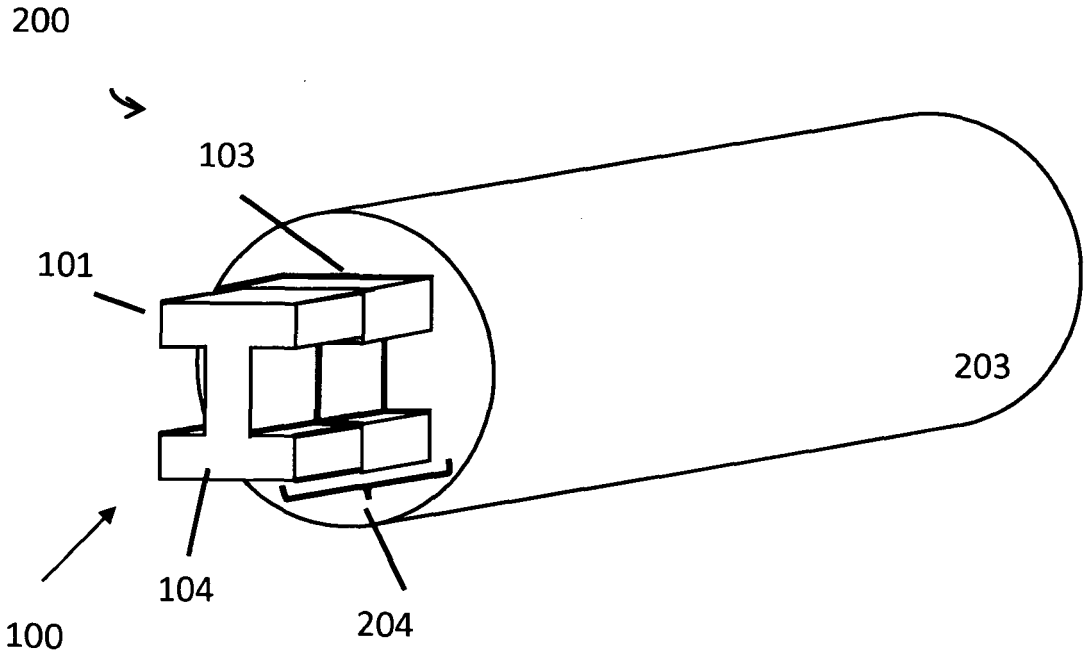


FIG. 2

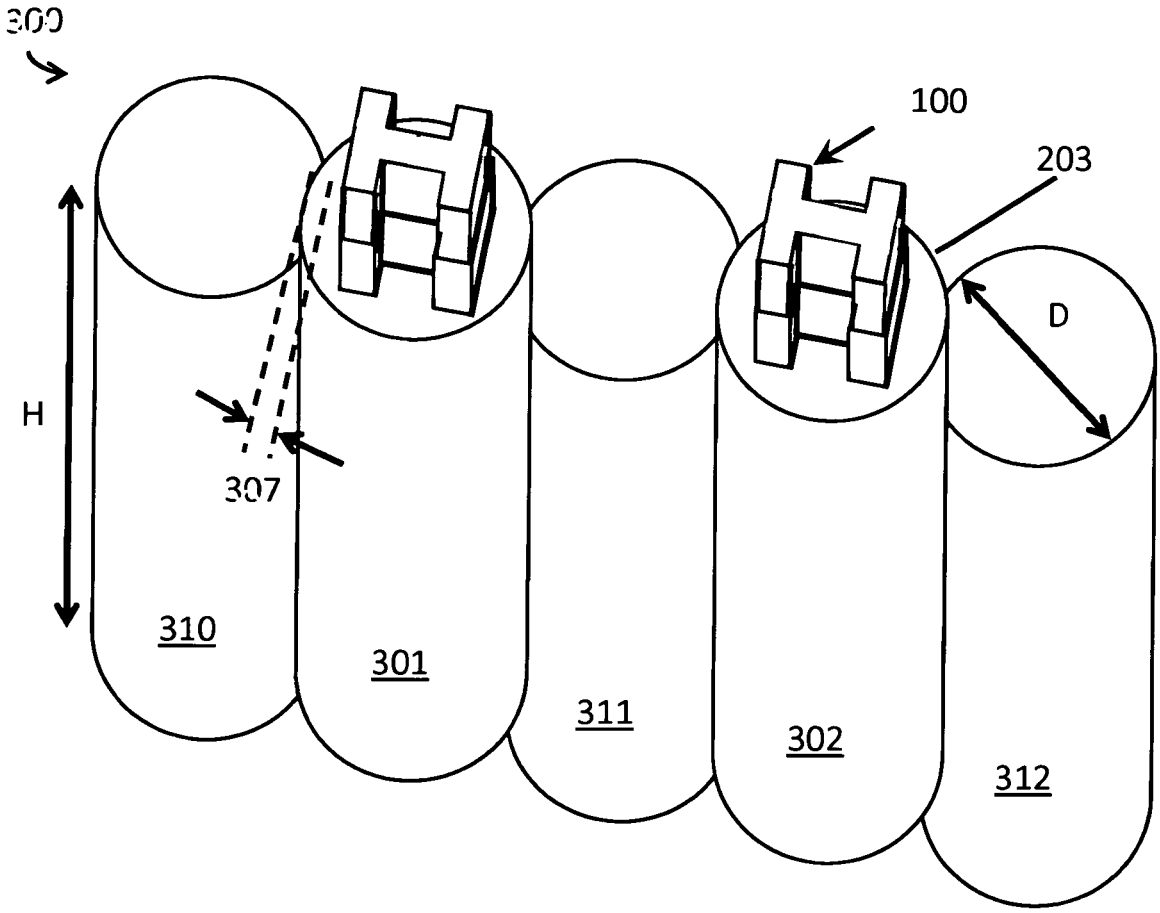


FIG. 3

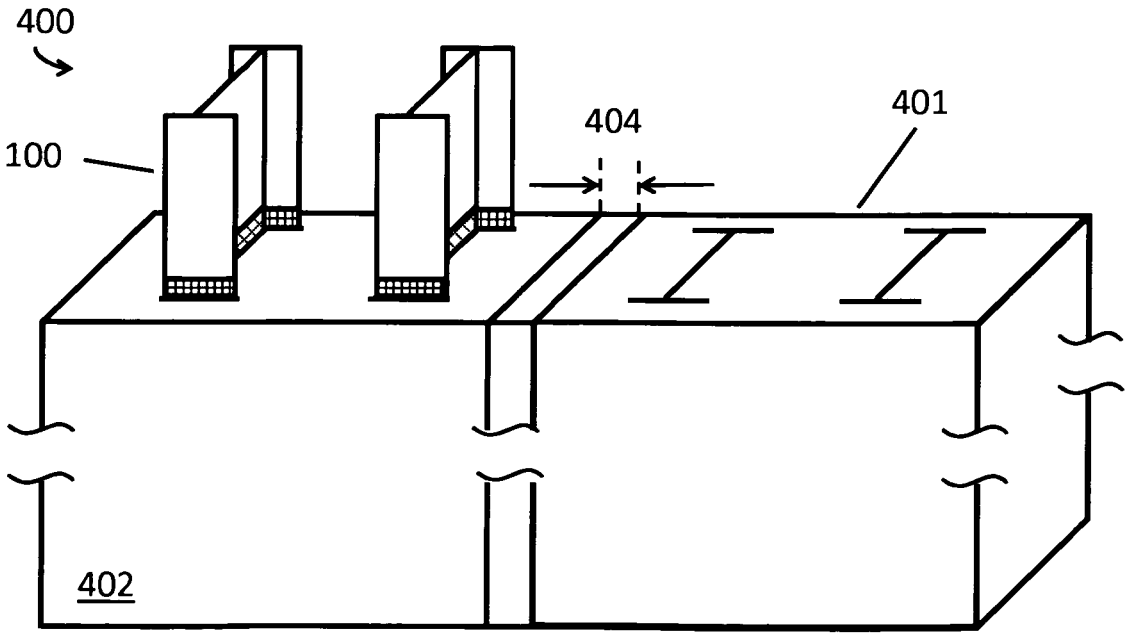


FIG. 4

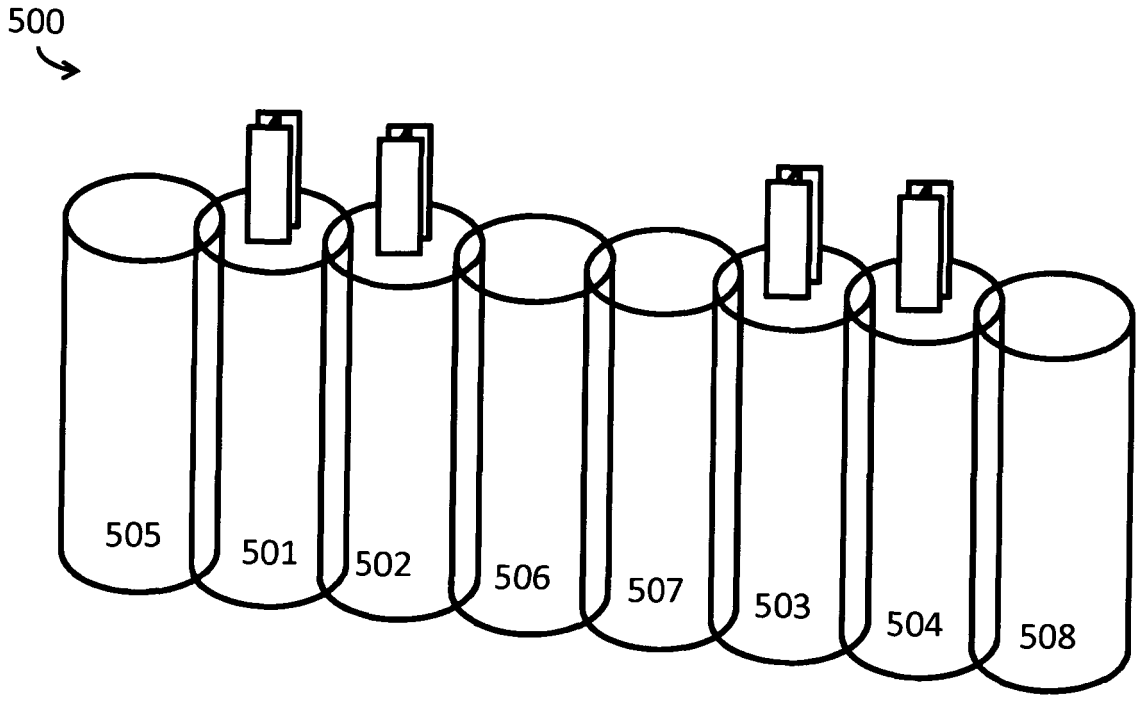


FIG. 5

REFERENCES CITED IN THE DESCRIPTION

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