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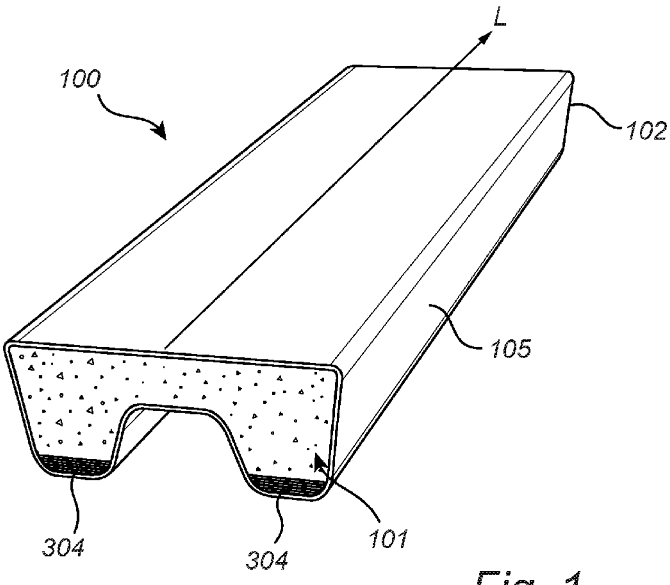

Fig. 1

(57) Abstract: The present invention relates to a construction element (100) for a bridge (600) comprising: a core structure (101) formed of porous concrete as a major component, and a load bearing shell (102) of composite material. The composite material comprising a matrix material and a reinforcing fiber material. The present invention also relates to a bridge (600) comprising a construction element (100) and a method (700)for fabricating a construction element (100).

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CONSTRUCTION ELEMENT, BRIDGE AND METHOD FOR FABRICATING A CONSTRUCTION ELEMENT

Technical Field

The present invention relates to a construction element for a bridge, and in particular to a construction element comprising composite material comprising a matrix material which is reinforced by fibers. The present invention also relates to a bridge comprising a construction element and a method for fabricating the construction element.

Background Art

Modern infrastructure, such as roads and railroads comprises numerous bridges, used to let the road or railroad in question cross e.g. waterways or roads. Today, bridges over waterways, roads or similar are commonly made of reinforced concrete or steel.

Concrete bridges commonly have to be manufactured on site due to the massive weight of the bridge being manufactured. Further, a lot of time is spent on manufacturing a form which is then used for molding the concrete. Also a lot of time is spent on positioning reinforcing irons in the form. The form is commonly made of wooden planks or plywood sheets which are cut and subsequently put together to constitute the form. During molding, the form has to be supported by shorings or posts in order to withstand the pressure and weight exerted by the concrete being molded. This process is time consuming and brings about that e.g. a road or a road section has to be closed for long periods of time, oftentimes even months.

In case of steel bridges, some off site preproduction is possible, but the bridge commonly at least has to be assembled on site.

Both concrete and steel bridges require a substantial amount of maintenance over time in order to withstand varying climate and weather conditions and substantial loads from traffic passing the bridges.

Concrete bridges suffer from rusting reinforcement irons which reduces the load bearing capacity of the bridges. Hence, regular repair and maintenance work is needed.

Iron bridges tend to rust and resulting in that they need to be painted, repainted and repaired on a regular basis.

Hence, common bridges suffer from large maintenance costs and large costs for society as roads and similar commonly has to be closed or at least partly closed. Typically a bride is maintained for more than 90 years as the lifetime for a bride is typically 100 years or more. The long life time brings about large accumulated maintenance costs. When salt is used as anti-skid treatment on roads, the salt will speed up any corrosion affecting e.g. reinforcing irons or steel bridges, resulting in even more costly and time consuming maintenance work.

Not only bridges, but any large construction element of e.g. concrete or steel which is not easily replaceable and being subjected to weather will suffer from undesired maintenance cost as described above. Examples of such large construction elements are sections of buildings, façades, beams and pillars.

In order to reduce maintenance costs and installation time it has been suggested to use bridges made of materials which are less sensitive to corrosion and which are lightweight.

US 6,557,201 B1 suggests using a modular composite bride of lightweight material. The suggested bridge addresses some of the above problems but do on the other hand suffer from an undesired instability and undesired acoustic properties.

Hence there is a need for an improved construction element, an improved bridge and a method for fabricating the construction element.

Summary

According to an aspect of the invention, the above is at least partly alleviated by a construction element for a bridge comprising: a core structure formed of porous concrete as a major component, and a load bearing shell of

composite material comprising a matrix material and a reinforcing fiber material.

The present invention is based on the realization that prior art composite material construction elements used for bridges and other large constructions, such as buildings, façades, parking garages or similar suffers from undesired wind sensitivity due to their light weight and generally large area exposed to the wind. Moreover, prior art composite material construction elements generally produce a significant undesired noise when for instance driven on by a vehicle. This is due to the fact that a generally hollow construction element of a rigid material may act as a sounding box. Moreover, composite material construction elements of the prior art tend to vibrate in an undesired manner when exposed to loads such as vehicles driving on the construction element.

Hence, by providing a core structure formed of porous concrete as a major component, it is possible to provide a construction element which is less sensitive to wind, less prone to undesired noise and undesired vibrations. At the same time, the construction element is not sensitive to corrosion, as it may not include any materials which may corrode. This means that the construction element will have a reduced need for maintenance throughout its lifetime.

It should be noted that within the context of this application the term “load bearing shell” may be any shell designed to carry the load of the construction element including the core structure and any load that the construction element is subjected to during normal use.

It should be noted that within the context of this application the term “porous concrete” may be any concrete or cement material comprising encapsulated gas bubbles or similar. The porous concrete may be for instance be referred to as gas concrete, lightconcrete, pumice concrete lightweight concrete, aerated concrete or air-entrained concrete. Examples of such materials are materials sold under the trade names of Siporex™ and Ytong™.

It should be noted that within the context of this application the term “composite material” may be any material where a plurality of materials are used in combination to form the composite material. According to the present invention, a matrix material may be used in combination with a reinforcing fiber material.

The load bearing shell may be wrapped around the core structure, which is advantageous in that the core structure may be used for shaping the load bearing shell. The load bearing shell may hence be completely filled by the core structure enhancing both mechanical properties and sound properties.

The load bearing shell may follow a contour of the core structure, which is advantageous in that the core structure may be used for shaping the load bearing shell.

75% by volume or more of the core structure may be made of porous concrete, which is advantageous in that the density of the core structure may be adjusted. Moreover, porous concrete is widely available.

The porous concrete may have a density of 1000 kg/m^3, or below, which is advantageous in that the density of the core structure may be adjusted to a desired level while keeping the total weight at a desired level

The matrix material and the reinforcing fiber material may be provided in form of a sandwich structure, which is advantageous in that a strong light weight structure may be achieved in well known manner. It should be noted that within the context of this application the term “sandwich structure” may be any structure comprising at least two material layers arranged on top of each other.

The sandwich structure may have different number of layers along a longitudinal direction of the construction element. By this arrangement, the strength of the construction element may be altered along the longitudinal direction thereof. For instance, when the construction element is used to span between to bearing points, a larger strength is generally needed in a central location of the construction element as compared to close to the bearing points.

The matrix material may be a thermoplastic material, a thermosetting plastic material, a cross-linked plastic material or a combination thereof, which is advantageous in that a strong composite material may be realized according to well established techniques.

The reinforcing fiber material may be selected from a group consisting of, carbon fiber, glass fiber, polymeric fiber, natural fiber, mineral fiber and metal fiber, which is advantageous in that a strong composite material may be realized according to well established techniques.

The reinforcing fiber material may be in the form of a woven web or a unidirectional web, which is advantageous in that the reinforcing fiber material may be provided in a conventional manner, where the web is cut to a desired size and shape. It should be noted that within the context of this application the term “unidirectional web” may be any web where the fibers are not woven, but provided side by side in a common direction. The unidirectional web may however, comprise a plurality of layers of fibers provided side by side in a common direction, where the fibers of the respective layers may be provided at different angles, e.g. 0 degrees and 30 degrees. This means that the fibers of the respective layers of the unidirectional web may be provided in any direction with respect to each other, in contrast to a woven web where the fibers generally are arranged at a 90 degree angle. The fibers of the unidirectional web are preferably sewn or stitched together so as to form a web.

A cross section of the construction element may vary along the longitudinal direction of the construction element, which is advantageous in that the strength of the construction element may be altered along the longitudinal direction thereof.

The core structure may be a self-supporting core structure, which is advantageous in that the core structure may be handled and stored without losing its shape. Moreover, the core structure may advantageously be used for shaping the load bearing shell.

The core structure may comprise a pipe, a tube, or a culvert, which is advantageous in that electrical wires, pipings or similar may be placed in or through the core structure in a simple manner. Moreover, the use of a pipe, a tube, or a culvert provides for that electrical wires, pipings or similar may be laid or exchanged after the fabrication of the core structure.

A length of the construction element in the longitudinal direction of the construction element may be between 4m and 100m.

According to another aspect of the invention, there is provided a bridge comprising at least one construction element of the above type. In general, features of this aspect of the invention provide similar advantages as discussed above in relation to the previous aspect of the invention. By utilizing at least one construction element of the above type in bridge, a bridge which is less sensitive to wind and corrosion may be provided. Moreover, the bridge may be less prone to generate undesired noise and vibrations when traveled upon. Further, the need for maintenance and the installation time required may be reduced.

The bridge may further comprise a road surface provided on top of the at least one construction element. By this arrangement, a wearing surface which also enhances the friction may be achieved. Hence, the bridge may handle excessive traffic with reduced wear to the construction element. Moreover, a desired friction may be achieved. The road surface may preferably comprise asphalt or concrete.

According to another aspect of the invention, there is provided a method for fabricating a construction element. It should be noted that the method may incorporate any of the features described above in association with the construction element, and has the same corresponding advantages.

A method for fabricating a construction element comprises the steps of: providing a core structure formed of porous concrete as a major component, arranging a reinforcing fiber material and a non-hardened matrix material in a sandwich arrangement on the core structure, hardening the matrix material, thereby forming, on the core structure, a load bearing shell comprising a composite material sandwich structure comprising the hardened matrix material and the reinforcing fiber material.

By the present method a construction element may be fabricated in an efficient way. A core structure formed of porous concrete as a major component is provided.

The reinforcing fiber material and the non-hardened matrix material are provided on the core structure in form of a sandwich arrangement. The matrix material and the reinforcing fiber material may be any of the materials discussed above in relation to the previous aspects of the invention.

The non-hardened matrix material is hardened thereby forming, on the core structure, a load bearing shell comprising a composite material sandwich structure comprising the hardened matrix material and the reinforcing fiber material.

It should be noted that within the context of this application the term “hardening” may be any process where the matrix material concerned is made harder and more rigid. The hardening may for instance be a cross-linking of a cross-linkable material, a heating of a thermosetting material or a lowering of a temperature of a melted material such as a thermoplastic material. Hence, the hardening of the matrix material may be irreversible or reversible.

The step of arranging may comprise wrapping the reinforcing fiber material and the non-hardened matrix material in a sandwich arrangement on the core structure.

The core structure may have a shape resembling a shape of the construction element.

The core structure may be provided in form of a plurality of attachable substructures. By this arrangement, core structures of various shapes and sizes may be realized in an efficient manner using a limited number of substructures. Moreover, transport and storage of the respective substructures may be simplified as compared to transporting and storing a complete core structure made of a single piece.

The matrix material may be provided by means of vacuum infusion, which is advantageous in that standard manufacturing processes for composite materials may be utilized when fabricating the construction element.

The step of hardening the matrix material may comprise; a first hardening step, and a second hardening step, wherein the matrix material is heated to a predetermined temperature for a predetermined time during the second hardening step, which is advantageous in that load bearing shell of the construction element may be given additional mechanical strength. The matrix material of the load bearing shell may be heated by incorporating hoses into the matrix material, in which hoses a heated fluid may be circulated. Further the matrix material of the load bearing shell may be heated by a forced flow of heated air. Furthermore, electrical heating cables may be incorporated in the matrix material or an electrical current may be applied to the reinforcing fibers of the reinforcing fiber material such that heat is generated in the reinforcing fibers.

The step of providing a core structure may be preceded by a step of pouring or casting the core structure, or shaping a block of porous concrete into the shape of the core structure by grinding, cutting, milling, or combinations thereof, which is advantageous in that conventional methods may be used to manufacture the core structure.

Further features of, and advantages with, the present invention will become apparent when studying the appended claims and the following description. The skilled person will realize that different features of the present invention may be combined to create embodiments other than those described in the following, without departing from the scope of the present invention.

Brief Description of the Drawings

Embodiments of the present invention will now be described, by way of example, with reference to the accompanying schematic drawings, in which

Fig. 1 is a perspective view of a construction element,

Fig. 2 is a perspective view of a core structure of the construction element of Fig. 1, Figs. 3a-c are perspective views schematically illustrating how reinforcing fiber materials are arranged on the core structure of Fig. 2,

Fig. 4 is a perspective view of a bridge comprising two construction elements, and

Fig. 5 is a flow chart of a method according to the invention.

Detailed description

The present invention will now be described more fully hereinafter with reference to the accompanying drawings, in which preferred 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 for thoroughness and completeness, and fully convey the scope of the invention to the skilled person.

Now referring to Fig.1, here is conceptually depicted a construction element 100. The construction element 100 comprises a load bearing shell 102 of composite material. The load bearing shell 102 is formed of a composite material sandwich structure 105. The composite material comprises a matrix material in form of polyester and reinforcing fiber materials in form of carbon fiber and glass fiber. The load bearing shell 102 is wrapped around a core structure 101 made of porous concrete. The core structure 101 is hence a self-supporting core structure 101.

The load bearing shell 102 is filled by the core structure 101 and follows the contour of the core structure 101. By this arrangement, the upper surface of the construction element 100 is backed by the core structure 101, resulting in that the upper surface of the construction element 100 becomes more rigid which result in that the construction element 100 becomes less prone to generate noise and vibrations. Further, the core structure 101 improves the strength of the construction element 100 due to the fact that the porous concrete used in the core structure 101 can handle compressive loads. However, the strength of the construction element 100 is mainly determined by the strength of the load bearing shell 102.

When designing a construction element 100 of the above kind, the properties of the load bearing shell 102 may be tailored to suit the needs of a particular application. For instance, the strength of the load bearing shell 102 may be tailored by adapting the amount and type of reinforcing fibers used. Also the directions in which the reinforcing fibers used extend may be adapted in order to adjust the strength of the load bearing shell 102. Further, the number of layers used in the composite material sandwich structure 105 may be adapted. Moreover, the number of layers used in the composite material sandwich structure 105 may vary along a longitudinal direction L of the load bearing shell102 and construction element 100. Yet another way of adapting the strength of the load bearing shell 102 may be to vary the cross section of the load bearing shell 102 and hence the construction element 100 along its longitudinal length L. Also the overall outer shape of the load bearing shell 102 and hence the construction element 100 may be varied to suit specific needs. For instance, the requirements relating to shape and strength may be very different when the construction element 100 is used in a bridge as compared to when being used as a façade portion of a building. Moreover the size of the construction element 100 may vary greatly depending on the current application.

It is to be noted that the construction element 100 of Fig. 1 is not drawn to scale, but is rather drawn in a simplified manner for illustrative purposes.

Other matrix materials may be used in the construction element 100. The matrix material may be a thermoplastic material, a thermosetting plastic material, a cross-linked plastic material or a combination thereof. Examples of other suitable matrix materials are vinyl ester, epoxy plastics, acrylic plastics and phenol plastics.

Other reinforcing fiber materials may be used in the construction element 100, such as polymeric fiber, natural fiber, mineral fiber and metal fiber. Further, examples of suitable fibers are cellulose, linen, hemp, jute and basalt. The reinforcing fiber material may be provided in form of a woven web or a unidirectional web.

An outer surface of the construction element 100 may be provided with a layer of gel-coat or paint. By this arrangement the construction element may be protected from weather conditions, such as UV-radiation and rain.

Trough openings (not shown) in form of a pipe, a tube, a culvert or similar may be provided through the core structure 101. By this arrangement, wires, pipes, cables or similar may be laid through the construction element 100 making use of the through openings.

The fabrication and the composition of the construction element 100 of Fig. 1 will now be described in more detail. In order to fabricate the construction element 100 the core structure 101 is provided first. The core structure 101 used for the construction element 100 is schematically depicted in Fig. 2. In the depicted embodiment of Figs. 1 and 2, the core structure 101 is formed of porous concrete. The core structure 101 is formed by pouring porous concrete into a mould (not shown). The porous concrete is then left to cure such that the core structure 101 is formed.

Alternatively, the core structure 101 may be formed by shaping a block of previously cured porous concrete. The shaping of the block may then for instance be performed using conventional shaping techniques, such as grinding, cutting, milling, or combinations thereof.

The core structure 101 may alternatively be provided in form of a plurality of attachable substructures (not shown) forming the core structure 101.

When the core structure 101 is provided, next reinforcing fibers are arranged on the core structure 101. Now referring to Figs. 3a-c, here is conceptually depicted how reinforcing fibers are arranged on the core structure 101.

Reinforcing fibers in form of pre-impregnated carbon fibers are provided in form of unidirectional webs or planks 304. The carbon fibers are provided as a plurality of layers of unidirectional fibers having a common fiber direction, as shown in Fig. 3a. The layers are sewn together, before being impregnated with a matrix material in form of polyester. Since the fibers of the unidirectional web 304 are pre-impregnated with polyester, the unidirectional web 304 will be rigid or semi-rigid and not as flexible as un-impregnated webs of fibers.

The unidirectional webs or planks 304 are arranged on an underside of the core structure 101 as two separate webs 304 which are arranged along two parallel longitudinal lines as shown in Fig. 3b.

Following this, reinforcing fibers in form of a unidirectional web 302 of glass fiber is arranged on the core structure 101 and the webs 304 as shown in Fig. 3c. The unidirectional web 302 of glass fiber is hence wrapped in a sandwich arrangement on the core structure 101.

The unidirectional web 302 of glass fiber comprises two layers of glass fibers. The fibers in each layer are arranged in a common direction while the two layers are arranged in a 90 degree angle with respect to each other. In the depicted embodiment the unidirectional web 302 of glass fibers is arranged such that the fibers of the respective layers are extending in a ± 45 degree angle with respect to the longitudinal direction L of the construction element 100 and core structure 101.

It is to be noted that any suitable technique may be used to arrange the reinforcing fibers on the core structure 101. The fibers may for instance be arranged manually on the core structure 101 or may be arranged automatically on the core structure 101, using a robot or similar.

After having arranged the unidirectional web 302 of fiber glass and the unidirectional webs 304 of carbon fibers on the core structure 101, the complete core structure 101 including the unidirectional web 302 of fiber glass and the unidirectional webs 304 of carbon fiber are inserted into a plastic vacuum bag or similar. Vacuum is applied to the vacuum bag while a plastic matrix material in form of polyester is infused under pressure through an inlet port or through several inlet ports as is known in the art. The polyester thus migrates through the plastic vacuum bag, infusing the un-impregnated fibers of the unidirectional web 302 and enclosing the pre-impregnated fibers of the unidirectional webs 304. After completion of the vacuum infusion, the infused polyester material will have been hardened by being polymerized as is known in the art, hence forming a load bearing shell 102 of composite material comprising a matrix material and a reinforcing fiber material.

Following the initial hardening of the infused polyester material the complete core structure 101 including the unidirectional web 302 of fiber glass, the unidirectional webs 304 of carbon fiber and the polyester matrix material may be heated to a predetermined temperature for a predetermined time in order to further harden the polyester matrix material. The duration and temperature of the hardening will be determined by the particular matrix material used. As an example, the hardening may take place at a temperature of about 120°C.

In order to heat the core structure 101 including the unidirectional web 302 of fiber glass and the unidirectional webs 304 of carbon fiber 104 to an elevated temperature, several techniques may be used. For instance, hoses or heating cables may be incorporated in the matrix material or an electrical current may be applied to the carbon fibers of the unidirectional web 304. Other suitable techniques known in the art may also be used.

The core structure 101 including the unidirectional web 302 of fiber glass and the unidirectional webs 304 of carbon fiber 104 may be removed from the vacuum plastic bag prior to or after the hardening at the elevated temperature.

It is to be noted that the core structure 101 may comprise other materials than porous concrete. Preferably 75% by volume or more of the core structure is made of porous concrete. Preferably, the porous concrete may have a bulk density which is lower than 1000 kg/m^3.

In addition to porous concrete, the core structure 101 may comprise cellular plastic, expanded plastic, air filled bellows, LECA™ or similar as a filling material. Preferably, the filling material may have a bulk density which is lower than 250 kg/m^3, more preferred a bulk density which is lower than 100 kg/m^3.

Now referring to Fig. 4, here is conceptually depicted a bridge 600 spanning over a waterway 602. The depicted bridge 600 is a road bridge used for letting a road 604 pass over the waterway 602. The bridge includes two construction elements 100 of the type depicted in Fig. 1. Each of the construction elements 100 spans the entire length of the bridge 600. The construction elements 100 are arranged side by side such that each construction element 100 carries one lane of the road 604. The construction elements 100 are provided with a road surface 606 on their respective top surfaces. The road surface reduces wear to the construction element 100 and increases the friction. The road surface is preferably made of asphalt or concrete.

The respective construction elements 100 may be fabricated in proximity to the location of the bridge 600, such that respective construction elements 100 may be lifted into their final positions using a mobile crane or similar.

The respective construction elements 100 may be fabricated in a location distant from the location of the bride 600 and subsequently moved to the location of the bridge 600 using a truck or similar.

The respective construction elements 100 may be handled and transported although typically having a length in the longitudinal direction L of 4 to 100 m. This is possible due to the fact that the respective construction elements 100 may be fabricated using a relatively speaking light material.

A 50 m construction elements 100 with a width of 6 m typically weighs about 25 tones. It is to be noted that a plurality of construction elements 100 may be arranged after each other thereby forming a bridge 600 being longer than the respective construction elements 100 used. When using this arrangement, each construction element 100 spans between two bearing points, such as foundations, pillars or similar. Hence, it is possible to build a bridge 600 of any length, by arranging a plurality of construction elements 100 after each other. Similarly, a bridge 600 of any width may be built by arranging a plurality of construction elements 100 side by side.

Moreover, a construction element 100 according to the invention may be used as a pillar for a bridge.

Furthermore, in addition to being used for bridges 600 or similar, the construction element 100 may be used in other relatively speaking large constructions. For example, the construction element 100 may be used in buildings, façades, beams, parking garages or similar.

In the following a method 700 fabricating a construction element 100 will be described with reference to Fig. 5 showing exemplifying steps for fabricating a construction element 100.

Now referring to Fig. 5, showing exemplifying steps of a method 700 for fabricating a construction element 100.

In a first step 702, a core structure 101 formed of porous concrete as a major component, is provided.

In a second step 704, a reinforcing fiber material and a non-hardened matrix material are arranged in a sandwich arrangement on the core structure 101. The reinforcing fiber material and the non-hardened matrix material may be arranged on the core structure 101 using any suitable techniques, including the techniques described above when describing how the construction element 100 of Fig. 1 may be fabricated.

In a third step 706, the matrix material is hardened, thereby forming a composite material sandwich structure 105 comprising the hardened matrix material and the reinforcing fiber material. The matrix material may be hardened using any suitable techniques, including the techniques described above when describing how the construction element 100 of Fig. 1 may be fabricated.

Although the figures may show a specific order of method steps, the order of the steps may differ from what is depicted. Also two or more steps may be performed concurrently or with partial concurrence. Such variation will depend on the systems chosen and on designer choice. All such variations are within the scope of the disclosure. Additionally, even though the invention has been described with reference to specific exemplifying embodiments thereof, many different alterations, modifications and the like will become apparent for those skilled in the art. Variations to the disclosed embodiments may be understood and effected by the skilled addressee in practicing the claimed invention, from a study of the drawings, the disclosure, and the appended claims. Furthermore, in the claims, the word "comprising" does not exclude other elements or steps, and the indefinite article "a" or "an" does not exclude a plurality.

CLAIMS

1. Construction element (100) for a bridge (600) comprising:

a core structure (101) formed of porous concrete as a major component, and

a load bearing shell (102) of composite material comprising a matrix material and a reinforcing fiber material.

2. Construction element (100) according to claim 1, wherein the load bearing shell (102) is wrapped around the core structure (101).

3. Construction element (100) according to claim 1 or 2, wherein the load bearing shell (102) follows a contour of the core structure (101).

4. Construction element (100) according to anyone of the previous claims, wherein 75% by volume or more of the core structure (101) is made of porous concrete.

5. Construction element (100) according to anyone of the previous claims, wherein the porous concrete has a density of 1000 kg/m^3, or below.

6. Construction element (100) according to any one of the preceding claims, wherein the matrix material and the reinforcing fiber material are provided in form of a sandwich structure (105).

7. Construction element (100) according to claim 6, wherein the sandwich structure (105) having different number of layers along a longitudinal direction (L) of the construction element (100).

8. Construction element (100) according to any one of the preceding claims, wherein the matrix material is a thermoplastic material, a

thermosetting plastic material, a cross-linked plastic material or a combination thereof.

9. Construction element (100) according to any one of the preceding claims, wherein the reinforcing fiber material is selected from a group consisting of, carbon fiber, glass fiber, polymeric fiber, natural fiber, mineral fiber and metal fiber.

10. Construction element (100) according to any one of the preceding claims, wherein the reinforcing fiber material is in the form of a woven web or a unidirectional web.

11. Construction element (100) according to any one of the preceding claims, wherein a cross section of the construction element (100) varies along the longitudinal direction (L) of the construction element (100).

12. Construction element (100) according to anyone of the previous claims, wherein the core structure (101) is a self-supporting core structure (101).

13. Construction element (100) according to anyone of the previous claims, wherein the core structure (101) comprises a pipe, a tube, or a culvert.

14. Construction element (100) according to any one of the preceding claims, wherein a length of the construction element in the longitudinal direction (L) of the construction element (100) is between 4m and 100m.

15. Bridge (600) comprising at least one construction element (100) according to any one of the previous claims.

16. Bridge (600) according to claim 15, further comprising a road surface (606) provided on top of the at least one construction element (100).

17. Method (700) for fabricating a construction element (100) comprising the steps of:

providing (702) a core structure (101) formed of porous concrete as a major component,

arranging (704) a reinforcing fiber material and a non-hardened matrix material in a sandwich arrangement on the core structure,

hardening (706) the matrix material, thereby forming, on the core structure (101), a load bearing shell (102) comprising a composite material sandwich structure (105) comprising the hardened matrix material and the reinforcing fiber material.

18. Method (700) according to claim 17, wherein the step of arranging (704) comprises wrapping the reinforcing fiber material and the non-hardened matrix material in a sandwich arrangement on the core structure (101).

19. Method (700) according to claim 17 or 18, wherein the core structure (101) having a shape resembling a shape of the construction element (100).

20. Method (700) according to anyone of claims 17 to 19, wherein the core structure (101) is provided in form of a plurality of attachable substructures.

21. Method (700) according to any one of claims 17 to 20, wherein the matrix material is provided by means of vacuum infusion.

22. Method (700) according to any one of claims 17 to 21, wherein the step of hardening (706) the matrix material comprises;

a first hardening step, and

a second hardening step, wherein the matrix material is heated to a predetermined temperature for a predetermined time during the second hardening step.

23. Method (700) according to anyone of claims 17 to 22, wherein the step of providing (702) a core structure (101), is preceded by a step of

pouring or casting the core structure (101), or

shaping a block of porous concrete into the shape of the core structure (101) by grinding, cutting, milling, or combinations thereof.

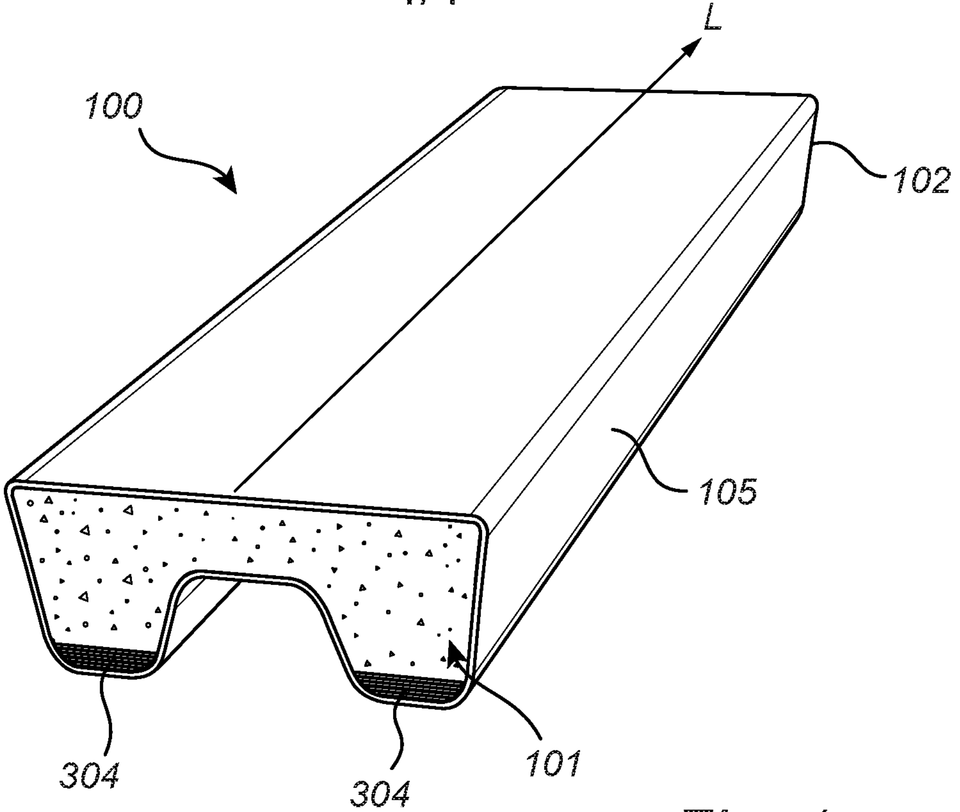

Fig. 1

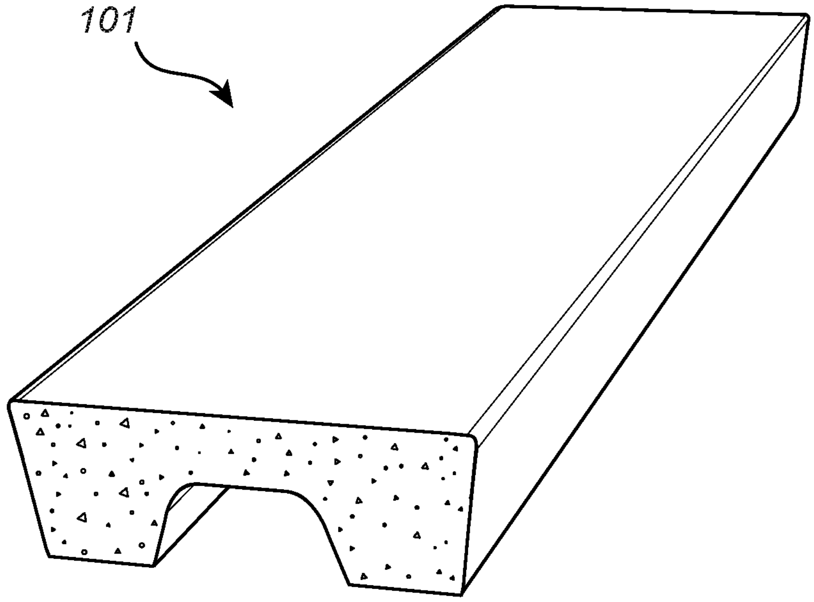

Fig. 2

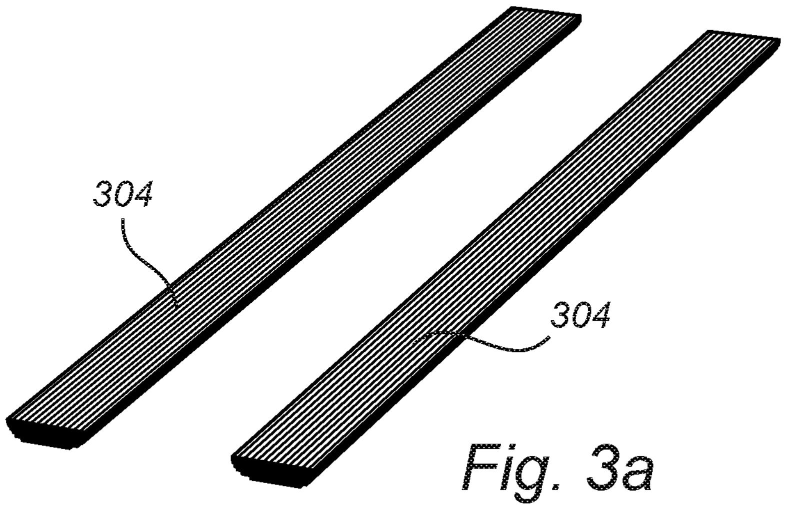

Fig. 3a

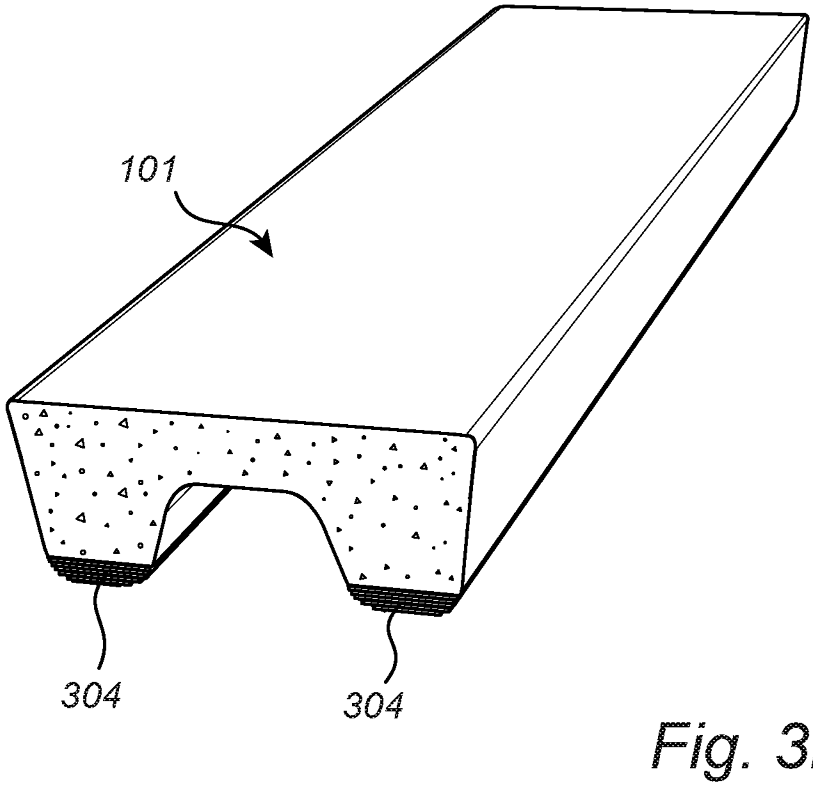

Fig. 3b

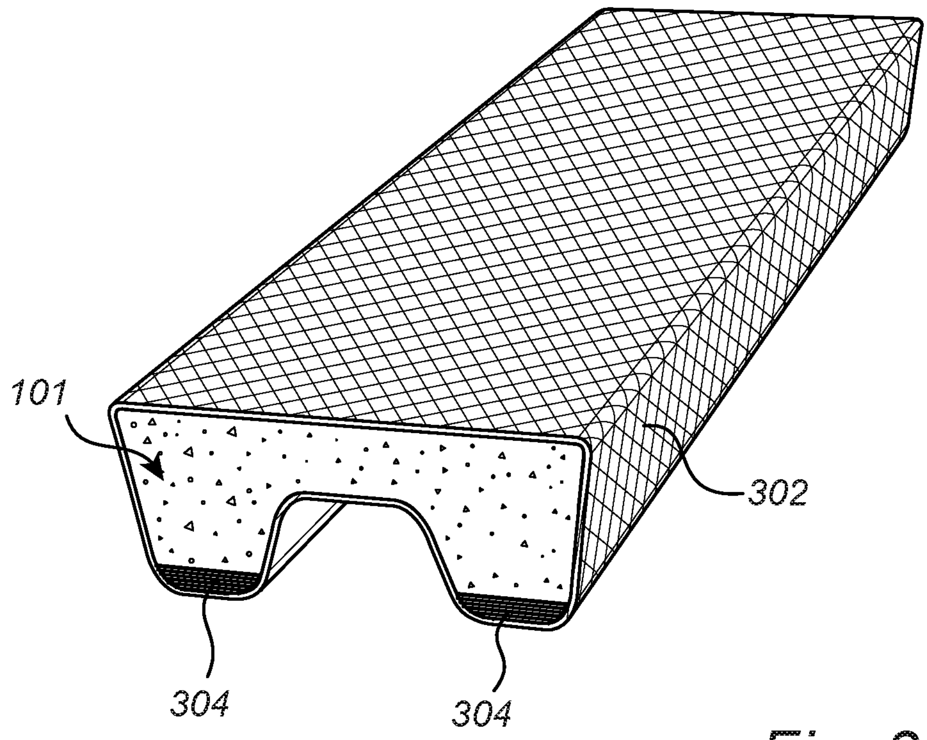

Fig. 3c

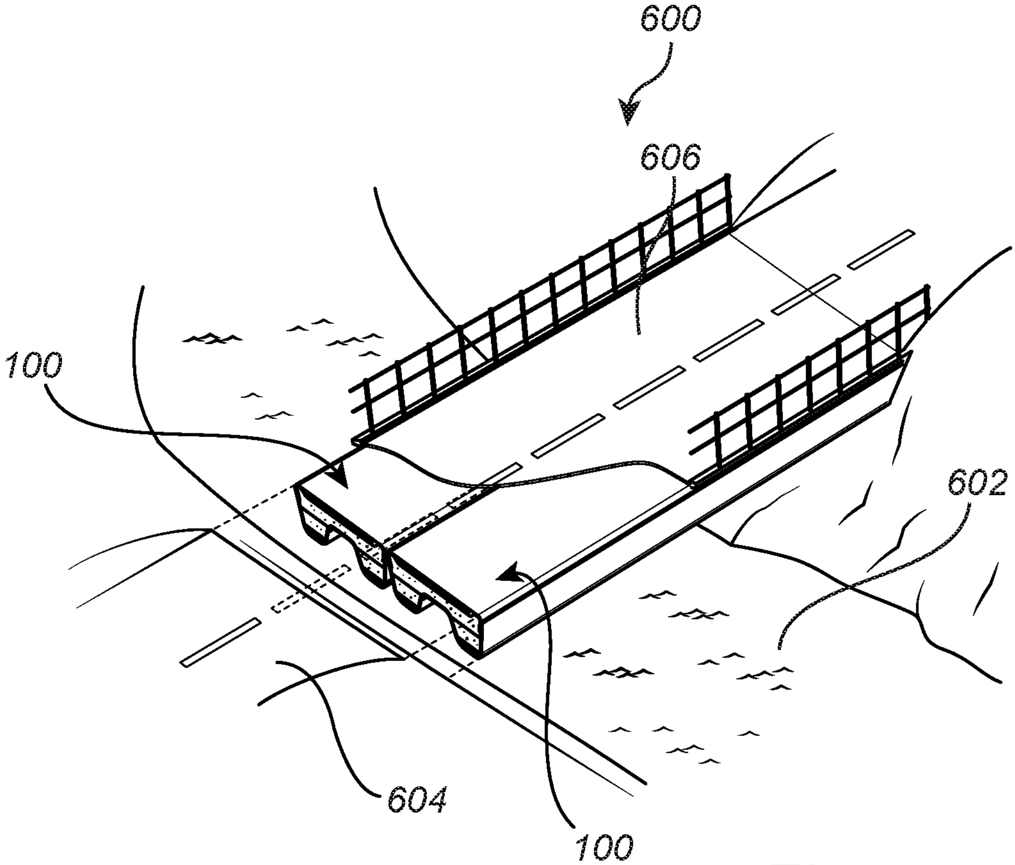
600
606
100
602
604
100

Fig. 4

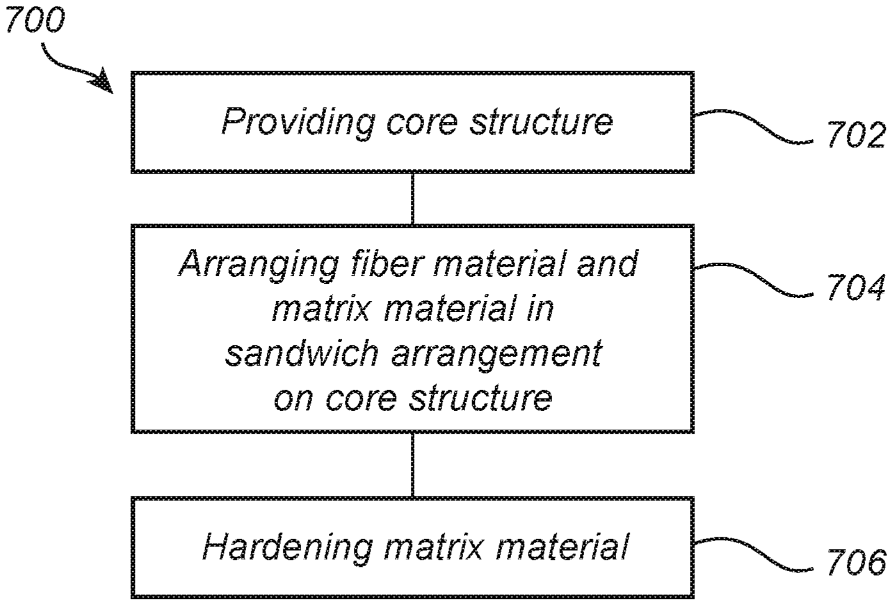
700
Providing core structure
702
Arranging fiber material and matrix material in sandwich arrangement on core structure
704
Hardening matrix material
706

Fig. 5

INTERNATIONAL SEARCH REPORT

International application No.
PCT/SE2017/050500

A. CLASSIFICATION OF SUBJECT MATTER

IPC: see extra sheet

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC: E01D, E04C, E04G

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

SE, DK, FI, NO classes as above

Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)

EPO-Internal, PAJ, WPI data

C. DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	WO 9853150 A1 (UNIV UTAH ET AL), 26 November 1998 (1998-11-26); abstract; page 2, line 8 - page 3, line 21; page 5, line 18 - line 28; page 6, line 5 - line 11; figures --	1-23
X	US 6189286 B1 (SEIBLE FRIEDER ET AL), 20 February 2001 (2001-02-20); abstract; figures --	1-23
X	US 5043033 A (FYFE EDWARD R), 27 August 1991 (1991-08-27); abstract; figures --	1-23

☒ Further documents are listed in the continuation of Box C. ☒ See patent family annex.

* Special categories of cited documents:

"A" document defining the general state of the art which is not considered to be of particular relevance

"E" earlier application or patent but published on or after the international filing date

"L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified)

"O" document referring to an oral disclosure, use, exhibition or other means

"P" document published prior to the international filing date but later than the priority date claimed

"T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention

"X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone

"Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art

"&" document member of the same patent family

Date of the actual completion of the international search	Date of mailing of the international search report
15-08-2017	15-08-2017

Name and mailing address of the ISA/SE	Authorized officer
Patent- och registreringsverket Box 5055 S-102 42 STOCKHOLM Facsimile No. + 46 8 666 02 86	Björn Lindkvist Telephone No. + 46 8 782 28 00

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
X	US 6832454 B1 (IYER SRINIVASA L), 21 December 2004 (2004-12-21); abstract; figures	1-4, 9, 12, 15, 16
A		5-8, 10, 11, 13, 14, 17-23
	--	
X	US 6138309 A (TADROS MAHER K ET AL), 31 October 2000 (2000-10-31); abstract; figures	1-16
A		17-23
	--	

Continuation of: second sheet

International Patent Classification (IPC)

E01D 19/08 (2006.01)
E04C 3/34 (2006.01)
E04C 5/07 (2006.01)
E04G 23/02 (2006.01)

WO	9853150	A1	26/11/1998	AU	7573298 A	11/12/1998
US	6189286	B1	20/02/2001	AT	248966 T	15/09/2003
				AU	723114 B2	17/08/2000
				AU	1859397 A	22/08/1997
				BR	9707488 A	04/01/2000
				CA	2244934 A1	07/08/1997
				CN	1105815 C	16/04/2003
				CN	1231712 A	13/10/1999
				DE	69724586 D1	09/10/2003
				EP	0879329 B1	03/09/2003
				HK	1023169 A1	03/10/2003
				JP	2007247401 A	27/09/2007
				JP	2001507769 A	12/06/2001
				WO	9728327 A1	07/08/1997
US	5043033	A	27/08/1991	CA	2108035 A1	29/07/1992
				EP	0606206 A1	20/07/1994
				MX	9200327 A	01/09/1992
				WO	9212858 A1	06/08/1992
US	6832454	B1	21/12/2004	NONE		
US	6138309	A	31/10/2000	AU	1807199 A	28/06/1999
				CA	2314218 C	14/10/2008
				WO	9929965 A1	17/06/1999