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(54) Title: METHOD FOR MANUFACTURING A BUILDING CONSTRUCTION ELEMENT AND BUILDING CONSTRUCTION ELEMENT

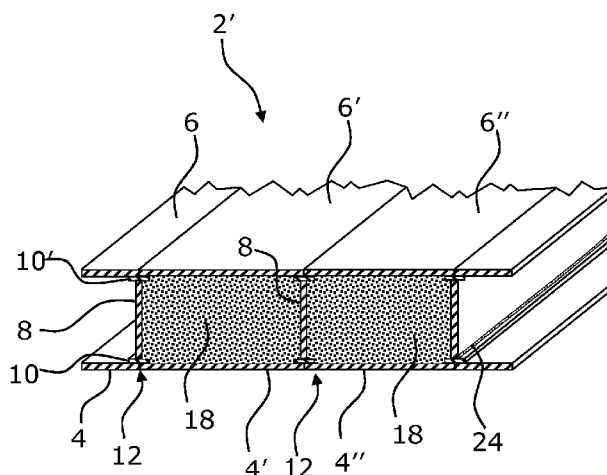


Fig. 1B

(57) Abstract: Method for manufacturing a building construction element (2'), the method comprising: forming each of a first and second wall structure (14; 16) from at least one first and second outer plate (4, 4', 4'') respectively; arranging a plurality of spaced apart intermediate structures (8) to extend between first and second flange members (10; 10') each extending along and covering an inside portion of the first and second wall structures respectively; filling polyurethane (PUR) foam or polyisocyanurate (PIR) foam (18) into the space between the first and second wall structures; determining the load bearing capacity of the PUR foam or PIR foam filled into the space; determining the required load bearing capacity of the intermediate structures to fulfil one or more predefined requirements related to the load bearing capacity of the building construction element; and selecting the dimension of the intermediate structures in dependency of the determined required load bearing capacity of the intermediate structures. By this method it is possible

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to reduce the dimensions of the intermediate structures and at the same time ensure that the overall strength of the building construction element fulfils the prescribed requirements.

Method for Manufacturing a Building Construction Element and Building Construction Element

Field of invention

5 The present invention relates to a building construction element comprising a sandwich structure comprising:

- one or more first outer plates forming a first wall structure of the building construction element, wherein the area between any adjacent first outer plates constitutes a joint;
- 10 - one or more second outer plates forming a second wall structure of the building construction element, wherein the area between any adjacent second outer plates constitutes a joint;
- optionally a number of flange members or joint cover plates extending along and covering the inside portion of the joints and
- 15 - a plurality of spaced apart intermediate structures each extending between:
 - a) a first flange member extending along and covering the inside portion of the first wall structure and a second flange member extending along and covering the inside portion of the second wall structure or
 - 20 b) the first wall structure and the second wall structure.

The present invention also relates to a method for manufacturing such building construction element.

Prior art

25 It is known to manufacture construction elements such as walls, floor elements, and horizontal divisions formed as sandwich structures comprising polyurethane (PUR) or polyisocyanurate (PIR).

30 In the field of building construction, these sandwich structures are typically produced by using a large block of foam, the block is cut into pieces of desired thicknesses. In order to provide the desired and required mechanical properties of the building construction element, intermedi-

ate structures made of wood are typically used. A building construction element is typically constructed in such a manner that the intermediate structures have sufficiently strength to ensure that the overall strength of the building construction element fulfils prescribed requirements.

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Even though the foam contributes to the overall strength of a building construction element, this is not taken into consideration in the prior art. Accordingly, the dimensions of the intermediate structures are typically larger than required.

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Accordingly, it would be advantageous to provide a method that reduces or even eliminates the above-mentioned disadvantages of the prior art.

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It is an object of the present invention to provide a method, by which it is possible to reduce the dimensions of the intermediate structures and at the same time ensure that the overall strength of the building construction element fulfils the prescribed requirements.

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Summary of the invention

The object of the present invention can be achieved by a method as defined in claim 1 and by a building construction element as defined in claim 13 and a building as defined in claim 14. Preferred embodiments are defined in the dependent subclaims, explained in the following description and illustrated in the accompanying drawings.

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The method is a method for manufacturing a building construction element, the method comprising:

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- forming a first wall structure of the building construction element from one or more (e.g. a plurality of) first outer plates, wherein the area between adjacent first outer plates (if any) constitutes a joint;
- forming a second wall structure of the building construction element

from one or more (e.g. a plurality of) second outer plates, wherein the area between adjacent second outer plates (if any) constitutes a joint;

- 5 - optionally arranging a number of flange members or joint cover plates along the inside portion of the joints and
 - arranging a plurality of spaced apart intermediate structures to extend between:
 - 10 a) a first flange member extending along and covering the inside portion of (e.g. a first joint of) the first wall structure and a second flange member extending along and covering the inside portion of (e.g. a second joint of) the second wall structure or
 - b) the first wall structure and the second wall structure,
 - 15 - filling polyurethane (PUR) foam or polyisocyanurate (PIR) foam into the space between the first wall structure and the second wall structure,
- wherein the method comprising:
- determining the load bearing capacity of the PUR foam or PIR foam filled into the space between the first wall structure and the second wall structure;
 - 20 - determining the required load bearing capacity of the intermediate structures of the building construction element in order to fulfil one or more predefined requirements related to the load bearing capacity of the building construction element and
 - selecting the dimension of the intermediate structures of the building construction element in dependency of the determined
 - 25 required load bearing capacity of the intermediate structures.

Hereby, it is possible to provide a method, by which it is possible to reduce the dimensions of the intermediate structures and at the same time ensure that the overall strength of the building construction element fulfils the prescribed requirements.

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In an embodiment, the intermediate structures are made of new PUR and/or PIR. In an embodiment, the intermediate structures are made of PUR and/or PIR comprising fibres (e.g. glass fibres, carbon fibres or aramid fibres). In an embodiment, the intermediate structures are made of PUR and/or PIR comprising recircled PUR and/or PIR material.

In an embodiment, fibres (e.g. glass fibres, carbon fibres or aramid fibres) and/or recircled PUR and/or PIR material is added before or during PUR or PIR into the space between the wall structures.

The method is a method for manufacturing a building construction element.

In an embodiment, the building construction element is a wall. In an embodiment, the building construction element is a horizontal division. In an embodiment, the building construction element is a floor element.

The method comprising:

- forming a first wall structure of the building construction element from one or more (e.g. a plurality of) first outer plates, wherein the area between adjacent first outer plates (if any) constitutes a joint.

In an embodiment, the method comprising:

- forming a first wall structure of the building construction element from a single first outer plate.

In an embodiment, the method comprising:

- forming a first wall structure of the building construction element from a plurality of first outer plates, wherein the area between adjacent first outer plates constitutes a joint.

The method comprising:

- forming a second wall structure of the building construction element from one or more (e.g. a plurality of) second outer plates, wherein the area between adjacent second outer plates (if any) constitutes a joint.

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In an embodiment, the method comprising:

- forming a second wall structure of the building construction element from a single second outer plate.

In an embodiment, the method comprising:

- 10
- forming a second wall structure of the building construction element from a plurality of second outer plates, wherein the area between adjacent second outer plates constitutes a joint.

In an embodiment, the method comprising:

- 15
- arranging a number of flange members or joint cover plates along the inside portion of the joints or the first wall structure.

In an embodiment, the method comprising:

- 20
- arranging a number of flange members along the inside portion of the joints or the second wall structure.

In an embodiment, the method comprising:

- 25
- arranging a number of joint cover plates along the inside portion of the joints or the first wall structure.

In an embodiment, the method comprising:

- 30
- arranging a number of joint cover plates along the inside portion of the joints or the second wall structure.

In an embodiment, the method comprising:

- 30
- arranging a plurality of spaced apart intermediate structures to extend between:

- a) a first flange member extending along and covering the inside portion of the first wall structure and;
- b) a second flange member extending along and covering the inside portion of the second wall structure,
- 5 - filling PUR foam or PIR foam into the space between the first wall structure and the second wall structure.

In an embodiment, the method comprising:

- arranging a plurality of spaced apart intermediate structures to extend between:
- 10 - the first wall structure and the second wall structure,
- filling PUR foam or PIR foam into the space between the first wall structure and the second wall structure.

In an embodiment, the method comprising:

- 15 - arranging a plurality of spaced apart intermediate structures to extend between:
- a) a first flange member extending along and covering the inside portion of a first joint the first wall structure and;
- b) a second flange member extending along and covering the inside
- 20 portion of a second joint the second wall structure,
- filling PUR foam or PIR foam into the space between the first wall structure and the second wall structure.

The method comprising:

- 25 - determining the load bearing capacity of the PUR foam or PIR foam filled into the space between the first wall structure and the second wall structure.

In an embodiment, the load bearing capacity of the PUR foam or PIR foam filled into the space between the first wall structure and the second wall structure is determined by:

- 30 a) detecting the density of the PUR foam or PIR foam filled into the

space between the first wall structure and the second wall structure and

- b) using one or more predefined mechanical values related to the PUR foam or PIR foam.

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In an embodiment, said predefined mechanical values are the maximum load-carrying capacity.

In an embodiment, the maximum load-carrying capacity is at least 3000 kg/m².

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In an embodiment, the maximum load-carrying capacity is at least 4000 kg/m².

In an embodiment, the maximum load-carrying capacity is at least 5000 kg/m².

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In general, the maximum load-carrying capacity of the PUR or PIR depends on the density. Accordingly, the density of the PUR or PIR can be selected in order to achieve a predefined the maximum load-carrying capacity (e.g. 5000 kg/m²).

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In an embodiment, the density of the PUR or PIR is in the range 20-80 kg/m³.

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In an embodiment, the density of the PUR or PIR is in the range 30-70 kg/m³.

In an embodiment, the density of the PUR or PIR is in the range 40-60 kg/m³.

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In an embodiment, the density of the PUR or PIR is in the range 45-55 kg/m³.

The method comprising:

- determining the required load bearing capacity of the intermediate structures of the building construction element in order to fulfil one or more predefined requirements related to the load bearing capacity of the building construction element.

In an embodiment, the required load bearing capacity of the intermediate structures of the building construction element in order to fulfil one or more predefined requirements related to the load bearing capacity of the building construction element may be determined by performing a pre-test of the intermediate structures or the wind turbine, from which the intermediate structures are taken.

In an embodiment, the required load bearing capacity of the intermediate structures of the building construction element in order to fulfil one or more predefined requirements related to the load bearing capacity of the building construction element may be determined by using predefined values and measuring the thickness of the intermediate structures.

In an embodiment, a predefined requirement related to the load bearing capacity of the building construction element is the required minimum load bearing capacity of the building construction element.

In an embodiment, a predefined requirement related to the load bearing capacity of the building construction element is the required minimum compressive strength of the building construction element.

In an embodiment, the minimum compressive strength of the building construction element is 10 MPa.

In an embodiment, the minimum compressive strength of the building

construction element is 15 MPa.

In an embodiment, the minimum compressive strength of the building construction element is 20 MPa.

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The method comprising:

- selecting the dimension of the intermediate structures of the building construction element in dependency of the determined required load bearing capacity of the intermediate structures.

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In an embodiment, the width of the intermediate structures of the building construction element is determined in dependency of the determined required load bearing capacity of the intermediate structures.

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In an embodiment, the method comprising:

- prior to construction of the building construction element conducting a mechanical test of the wind turbine blade and/or the suitable intermediate structures to be used in the building construction element.

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In an embodiment, the method comprising:

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- determining the force with which the PUR foam or PIR foam filled into the space between the first wall structure and the second wall structure exerts toward the intermediate structures placed adjacent to the PUR foam or PIR foam when an external force is exerted towards the intermediate structures along the length of the intermediate structures.

In an embodiment, the method comprising:

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- determining the maximum allowable distance between the intermediate structures to fulfil the one or more predefined requirements in dependency of the determined required load bearing capacity of the intermediate structures.

In an embodiment, each intermediate structure is a continuous section from a wind turbine blade.

In an embodiment, the method comprising:

- 5 - prior to construction of the building construction element defining a plurality of different types of construction elements having different predefined minimum required load capacity;
- determining the thickness of a group of suitable intermediate structures to be used in the building construction element and
- 10 - selecting among said types of construction elements one single type having a load capacity above its predefined minimum required load capacity when the suitable intermediate structures are used in the building construction element.

- 15 In an embodiment, determining the thickness of the intermediate structure corresponds to determining the load capacity of the intermediate structure.

- 20 The blade has different thicknesses. The idea is to use thicker parts for roof and floor separation and thinner for wall construction.

In an embodiment, the first wall structure extends parallel to the second wall structure.

- 25 In an embodiment, the intermediate structure extends perpendicular to the first wall structure and to the second wall structure.

In an embodiment, the flange members are made of a fire-resistant material.

- 30 In an embodiment, the flange members are made of concrete.
- In an embodiment, the flange members are made of plaster.

In an embodiment, the intermediate structure is at least partly covered by a fire-resistant material.

5 In an embodiment, the intermediate structure is fully covered by a fire-resistant material.

In an embodiment, the method comprising:

- gluing each intermediate structure to the flange members or wall structures between which the intermediate structure extends.

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In an embodiment, the method comprising:

- removing the wall structures;
- grinding the intermediate structure and PUR or PIR of the building construction element into smaller pieces of the building construction element;
- 15 - molding a new element by using the smaller pieces of the building construction element.

20 In an embodiment, the new element is a pillar or column.

In an embodiment, the new element is manufactured by adding a suitable type of resin e.g. a polyurethane resin comprising copolymers made up of polyol and isocyanate components.

25 In an embodiment, the resin is a polyurethane resin.

The building construction element according to the invention is a building construction element manufactured by using a method according to the invention.

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In an embodiment, the building construction element comprising a sandwich structure comprising:

- one or more first outer plates forming a first wall structure of the building construction element, wherein the area (if any) between adjacent first outer plates constitutes a joint;
 - one or more second outer plates forming a second wall structure of the building construction element, wherein the area (if any) between adjacent second outer plates constitutes a joint;
 - optionally a number of flange members extending along and covering the inside portion of the joints and
 - a plurality of spaced apart intermediate structures each extending between:
 - a) a first flange member extending along and covering the inside portion of the first wall structure and a second flange member extending along and covering the inside portion of the second wall structure or
 - b) the first wall structure and the second wall structure,
- wherein each intermediate structure is a continuous section from a wind turbine blade.

- In an embodiment, the sandwich structure comprising:
- a plurality of first outer plates forming a first wall structure of the building construction element, wherein the area between adjacent first outer plates constitutes a joint;
 - a plurality of second outer plates forming a second wall structure of the building construction element, wherein the area between adjacent second outer plates constitutes a joint.

In an embodiment, outer plates are planar plates. A planar outer plate is lying in a single plane.

- In an embodiment, a plurality of spaced apart intermediate structures each extending between:
- a) a first flange member extending along and covering the inside portion of a first joint the first wall structure and;

b) a second flange member extending along and covering the inside portion of the second wall structure.

5 In an embodiment, a plurality of spaced apart intermediate structures each extending between the first wall structure and the second wall structure.

In an embodiment, a plurality of spaced apart intermediate structures each extending between:

10 a) a first flange member extending along and covering the inside portion of the first wall structure and;

b) a second flange member extending along and covering the inside portion of a second joint the second wall structure.

15 In an embodiment, a plurality of spaced apart intermediate structures each extending between:

a) a first flange member extending along and covering the inside portion of a first joint the first wall structure and;

b) a second flange member extending along and covering the inside

20 portion of a second joint the second wall structure.

In an embodiment, a joint cover plate extends along and covering the inside portion of one or more first joints the first wall structure.

25 In an embodiment, a joint cover plate extends along and covering the inside portion of one or more first joint the second wall structure.

30 In an embodiment, the first wall structure extends parallel to the second wall structure.

In an embodiment, the flange members are made of a fire-resistant material.

In an embodiment, the flange members are made of concrete.

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In an embodiment, the flange members are made of plaster.

In an embodiment, the intermediate structure is at least partly covered by a fire-resistant material.

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In an embodiment, the intermediate structure is fully covered by a fire-resistant material.

In an embodiment, each intermediate structure extends perpendicular to the first wall structure and to the second wall structure.

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In an embodiment, each intermediate structure is glued to the flange members or wall structures between which the intermediate structure extends.

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In an embodiment, the glue is a PUR adhesive. In an embodiment, the glue is a PIR adhesive.

In an embodiment, the glue is a PUR hot melt adhesive.

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In an embodiment, the glue is an is inflammable, one-component adhesive.

In an embodiment, the glue is an is inflammable, two-component adhesive.

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In an embodiment, each intermediate structure is mechanically attached to the flange members or wall structures between which the in-

intermediate structure extends. The mechanical attachment may be carried out by using various attachment types including one or more nails and/or one or more screws and/or one or more wedges.

5 In an embodiment, polyurethane (PUR) foam or polyisocyanurate (PIR) foam is filled into the space between the first wall structure and the second wall structure.

In an embodiment, the building construction element is a wall or a horizontal division.

10 The building according to the invention is a building comprising a building construction element according to the invention.

By using intermediate structures formed as a continuous section from a wind turbine blade, it is possible to achieve strong and reliable building components and thus to achieve a strong and reliable building construction element.

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In an embodiment, the sandwich structure comprising:

- a plurality of first outer plates forming a first wall structure of the building construction element, wherein the area between adjacent first outer plates constitutes a joint;
 - a plurality of second outer plates forming a second wall structure of the building construction element, wherein the area between adjacent second outer plates constitutes a joint.
- 20

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In an embodiment, a plurality of spaced apart intermediate structures each extending between:

- a) a first flange member extending along and covering the inside portion of a first joint the first wall structure and;
- 30 b) a second flange member extending along and covering the inside portion of the second wall structure.

In an embodiment, a plurality of spaced apart intermediate structures each extending between:

- a) a first flange member extending along and covering the inside portion of the first wall structure and;
- 5 b) a second flange member extending along and covering the inside portion of a second joint the second wall structure.

In an embodiment, a plurality of spaced apart intermediate structures each extending between:

- 10 a) a first flange member extending along and covering the inside portion of (e.g. a first joint of) the first wall structure and;
- b) a second flange member extending along and covering the inside portion of (e.g. a second joint of) the second wall structure.

- 15 In an embodiment, a plurality of spaced apart intermediate structures each extending between the first wall structure and the second wall structure.

- 20 In an embodiment, a joint cover plate extends along and covering the inside portion of one or more first joints the first wall structure.

In an embodiment, a joint cover plate extends along and covering the inside portion of one or more first joint the second wall structure.

- 25 In an embodiment, the first wall structure extends parallel to the second wall structure.

In an embodiment, the flange members are made of a fire-resistant material.

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In an embodiment, the flange members are made of concrete.

In an embodiment, the flange members are made of plaster.

5 In an embodiment, the intermediate structure is at least partly covered by a fire-resistant material. Hereby, it is possible to approve a fire rated building construction element.

In an embodiment, the intermediate structure is fully covered by a fire-resistant material. Hereby, it is possible to approve a fire rated building construction element.

10 In an embodiment, each intermediate structure extends perpendicular to the first wall structure and to the second wall structure.

In an embodiment, each intermediate structure is glued to the flange members between which the intermediate structure extends.

15 In an embodiment, PUR foam or PIR foam is filled into the space between the first wall structure and the second wall structure.

20 In an embodiment, PUR foam or PIR foam is filled into the space between adjacent intermediate structures.

The building according to the invention is a building comprising a building construction element according to the invention.

25 The method comprising using a number of intermediate structures, wherein each intermediate structure is a continuous section from a wind turbine blade.

30 Hereby, it is possible to provide an alternative method for manufacturing a building construction element. It is possible to recircle wind turbine blade and use them in new construction.

In an embodiment, the method comprising:

- prior to construction of the building construction element defining a plurality of different types of construction elements having different predefined minimum required load capacity;
- 5 - determining the thickness of a group of suitable intermediate structures to be used in the building construction element and
- selecting among said types of construction elements one single type having a load capacity above its predefined minimum required load capacity when the suitable intermediate structures are used in the building construction element.
- 10

In an embodiment, determining the thickness of the intermediate structure corresponds to determining the load capacity of the intermediate structure.

- 15 The blade has different thicknesses. In an embodiment, the thicker parts are used for roof and floor separation. In an embodiment, the thinner parts of the wind turbine blades are used for wall construction.

In an embodiment, the method comprising:

- 20 - prior to construction of the building construction element conducting a mechanical test of the wind turbine blade and/or the suitable intermediate structures to be used in the building construction element.

- 25 In an embodiment, the first wall structure extends parallel to the second wall structure.

In an embodiment, the intermediate structure extends perpendicular to the first wall structure and to the second wall structure.

- 30 In an embodiment, the flange members are made of a fire-resistant material.

In an embodiment, the flange members comprise concrete.

In an embodiment, the flange members are made of concrete.

5 In an embodiment, the flange members comprise plaster.

In an embodiment, the flange members are made of plaster.

In an embodiment, the intermediate structure is at least partly covered by a fire-resistant material.

10 In an embodiment, the intermediate structure is fully covered by a fire-resistant material.

In an embodiment, the method comprising:

15 - gluing each intermediate structure to the flange members between which the intermediate structure extends.

Description of the Drawings

The invention will become more fully understood from the detailed description given herein below. The accompanying drawings are given by way of illustration only, and thus, they are not limitative of the present invention. In the accompanying drawings:

- 20 Fig. 1A shows a perspective view of a building construction element according to the invention;
- 25 Fig. 1B shows another view of the building construction element shown in Fig. 1A;
- Fig. 2A shows a perspective view of a building construction element according to the invention;
- Fig. 2B shows another view of the building construction element shown in Fig. 2A;
- 30 Fig. 3A shows a perspective view of a building construction element according to the invention;
- Fig. 3B shows a close-up view of at portion a building construction

- element according to the invention;
- Fig. 4A shows a cross-sectional view of a building construction element according to the invention;
- Fig. 4B shows a cross-sectional view of a building construction element arranged in a mold;
- 5 Fig. 4C shows a cross-sectional view of a building construction element arranged in a mold in a configuration in which PUR has been filled into the space between the first wall structure and the second wall structure of the building construction element;
- 10 Fig. 5A shows how an intermediate structure is made of a continuous section from a wind turbine blade;
- Fig. 5B shows another view of how an intermediate structure is made of a continuous section from a wind turbine blade;
- 15 Fig. 6A shows a prior art building construction element;
- Fig. 6B shows a building construction element according to the invention;
- Fig 6C shows a flow chart illustrating steps of a method according to the invention;
- 20 Fig. 7A shows internal and external forces exerted to structures of a building construction element according to the invention;
- Fig. 7B shows internal and external forces exerted to structures of another building construction element according to the invention;
- 25 Fig. 8A shows a cross-sectional view of a building construction element according to the invention;
- Fig. 8B shows a schematic perspective top view of the building construction element shown in Fig. 8A;
- Fig. 8C shows another view of a building construction element according to the invention;
- 30 Fig. 9A shows a cross-sectional view of a building construction element according to the invention;

- Fig. 9B shows a schematic view of the building construction element shown in Fig. 9A;
- Fig. 9C shows a cross-sectional view of another building construction element according to the invention;
- 5 Fig. 10A shows a cross-sectional view of two building construction elements according to the invention;
- Fig. 10B shows a cross-sectional view of the building construction elements shown in Fig. 10A in an assembled configuration and
- 10 Fig. 10C shows a perspective of a floor comprising a plurality of building construction elements according to the invention.

Detailed description of the invention

Referring now in detail to the drawings for the purpose of illustrating preferred embodiments of the present invention, a building construction element 2 of the present invention is illustrated in Fig. 1.

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Fig. 1A illustrates a perspective view of a building construction element 2 according to the invention. The building construction element 2 comprises a sandwich structure comprising:

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- a) a plurality of first outer plates 4, 4', 4'' forming a first wall structure 14 of the building construction element 2 and
- b) a plurality of second outer plates 6, 6', 6'' forming a second wall structure 16 of the building construction element 2.

Each area between adjacent first outer plates 4, 4', 4'' constitutes a joint 12. Likewise, each area between adjacent second outer plates 4, 4', 4'' constitutes a joint 12.

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In an embodiment, the first outer plates 4, 4', 4'' and/or the second outer plates 6, 6', 6'' are made of a fire resistant material.

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In an embodiment, the first outer plates 4, 4', 4'' and/or the second outer plates 6, 6', 6'' are made of a material that contains concrete.

In an embodiment, the first outer plates 4, 4', 4'' and/or the second outer plates 6, 6', 6'' are made of concrete.

5 In an embodiment, the first outer plates 4, 4', 4'' and/or the second outer plates 6, 6', 6'' are made of a material that contains plaster.

In an embodiment, the first outer plates 4, 4', 4'' and/or the second outer plates 6, 6', 6'' are made of plaster.

10 In an embodiment, the first outer plates 4, 4', 4'' and/or the second outer plates 6, 6', 6'' are made of a material that contains bricks.

In an embodiment, the first outer plates 4, 4', 4'' and/or the second outer plates 6, 6', 6'' are made of bricks.

The sandwich structure comprises:

15 a) a number of flange members 10, 10' extending along and covering the inside portion of the joints 12 of the first wall structure 14 and
b) a number of flange members 10, 10' extending along and covering the inside portion of the joints 12 of the second wall structure 16.

20 The sandwich structure further comprises a plurality of spaced apart intermediate structures 8 each extending between:

- a first flange member 10 extending along and covering the inside portion of a first joint 12 the first wall structure 14 and
- a second flange member 10' extending along and covering
25 the inside portion of a second joint 12 the second wall structure 16.

Each intermediate structure 8 is a continuous section from a wind turbine blade as shown in and explained with reference to Fig. 5A and Fig. 5B.

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The first wall structure 14 and the second wall structure 16 extend parallel to each other. Each intermediate structure 8 extends perpendicu-

lar to the first wall structure 14 and the second wall structure 16. The first flange members 10 bear against and extends parallel to the first wall structure 14. Likewise, the second flange members 10' bear against and extends parallel to the second wall structure 16.

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In an embodiment, each intermediate structure 8 is attached to a first flange member 10 and a second flange member 10'. Accordingly, each intermediate structure 8 and extends between a first flange member 10 and a second flange member 10'. In an embodiment, each intermediate structure 8 is attached to a first flange member 10 and a second flange member 10' by means of glue 24.

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In an embodiment, a first flange member 10 and a second flange member 10' extends between the first wall structure 14 and second wall structure 16 without covering any joint 12, 12'.

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Fig. 1B illustrates another view of the building construction element 2 shown in Fig. 1A. The space between the first wall structure 14 and second wall structure 16 has been filed with a polyurethane (PUR) foam 18 or polyisocyanurate (PIR) foam 18. The PUR foam or PIR foam 18 supports the intermediate structure 8 and hereby prevents the intermediate structure 8 from bending. When the PUR foam or PIR foam 18 is filled (injected) into the space provides a between the first wall structure 14 and second wall structure 16, the PUR foam or PIR foam 18 will exert a pressure towards the intermediate structure 8 from both sides of the intermediate structure 8. Accordingly, the intermediate structure 8 will be held in place by the PUR foam or PIR foam 18. When the PUR foam or PIR foam 18 has cured, a firm stabilizing support structure is build-up against the intermediate structure 8.

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The PUR foam or PIR foam 18 have very good properties concerning insulation. Accordingly, these types of insulation are suitable for being

used in the construction industry.

5 The low lambda value of PUR (less than $0.028 \text{ W/m}\cdot\text{K}^\circ$) means that large amounts of energy can be saved when using PUR. Therefore, the use of PUR can improve a building's energy efficiency and reduces heat and cold waste. This can in the long-run have a positive impact on climate change due to the low emission of carbon dioxide.

10 Fig. 1B, however, only illustrates a portion of a building construction element 2 according to the invention. In an embodiment, all spaces between the first wall structure 14 and second wall structure 16 has been filed with PUR or PIR foam 18.

15 Fig. 2A illustrates a perspective view of a building construction element 2 according to the invention. The building construction element 2 basically corresponds to the one shown in and explained with reference to Fig. 1A. Several surfaces of the intermediate structure 8, however is covered by a fire-resistant material 28. In an embodiment, the fire-resistant material 28 is plate-formed and fits a surface of the intermediate structure 8. In an embodiment, the fire-resistant material 28 is
20 made of a material that contains concrete.

In an embodiment, the fire-resistant material 28 is made of concrete.

25 In an embodiment, the fire-resistant material 28 is made of a material that contains plaster.

In an embodiment, the fire-resistant material 28 is made of plaster.

30 In an embodiment, the fire-resistant material 28 is made of a material that contains bricks.

In an embodiment, the fire-resistant material 28 is made of bricks.

In an embodiment, all surfaces of the intermediate structure 8 that are not covered by flange members 10, 10' is covered by a fire-resistant material 28.

By covering surfaces of the intermediate structure 8 by a fire-resistant material 28, it is possible to provide a building construction element that can be fire rated.

Fig. 2B illustrates another view of the building construction element shown in Fig. 2A. The space between the first wall structure 14 and second wall structure 16 has been filled with PUR or PIR foam 18. The PUR foam or PIR foam 18 supports the intermediate structure 8 and hereby prevents the intermediate structure 8 from bending. When the PUR foam or PIR foam 18 is filled (injected) into the space provides between the first wall structure 14 and second wall structure 16, the PUR foam or PIR foam 18 will exert a pressure towards the intermediate structure 8 from both sides of the intermediate structure 8. Accordingly, the intermediate structure 8 will be held in place by the PUR foam or PIR foam 18. When the PUR foam or PIR foam 18 has cured, a firm stabilizing support structure is build-up against the intermediate structure 8.

Fig. 3A illustrates a perspective view of a building construction element 2 according to the invention. The building construction element 2 basically corresponds to the one shown in and explained with reference to Fig. 1A. The first outer plates 4, 4', 4'' forming part of the first wall structure 14 of the building construction element 2, however, have a different shape (width) than the one shown in and explained with reference to Fig. 1A). It can be seen that a joint cover plate 30 covers the inside portion of the joint between the first outer plates 4, 4' and that a

joint cover plate 30 covers the inside portion of the joint between the first outer plates 4', 4''. In Fig. 3A none of the joints 12 in the first wall structure 14 are covered by a flange member. In Fig. 3A the joints 12 in the first wall structure 14 are covered by a joint cover plate 30.

5

Fig. 3B illustrates a close-up view of at portion a building construction element 2 according to the invention. The building construction element 2 comprises a second wall structure 16 comprises two adjacent first outer plates 6, 6' arranged bearing against each other along a joint 12.

10

Likewise, the building construction element 2 comprises a first wall structure 14 comprises two adjacent first outer plates 4, 4' arranged bearing against each other along a joint.

15

Several surfaces of the intermediate structure 8 extends between flange members 10, 10' bearing against the inside surface of the first wall structure 14 and the second wall structure 16, respectfully.

20

PUR foam or PIR foam 18 has been filled into the space provided between the first wall structure 14 and second wall structure 16. The width D_1 of the intermediate structure 8 is smaller than the distance D_2 between adjacent intermediate structures 8. The width of the flanges 10, 10' is larger than the width D_1 of the intermediate structures 8.

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Fig. 4A illustrates a cross-sectional view of a building construction element 2 according to the invention. The building construction element 2 comprises a sandwich structure comprising:

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- a) a first outer plate 4 forming a first wall structure of the building construction element 2 and
- b) a second outer plate 6 forming a second wall structure of the building construction element 2.

Even though is not illustrated in Fig. 4A, the first wall structure of the

building construction element 2 may comprise several first outer plates 4. Likewise, the second wall structure of the building construction element 2 may comprise several second outer plates 6.

- 5 In an embodiment, the one or more first outer plates 4 and/or the one or more second outer plates 6 are made of a fire resistant material. The fire resistant material may contain concrete or be made of concrete, contain plaster or be made of plaster.
- 10 Fig. 4B illustrates a cross-sectional view of the building construction element 2 shown in Fig. 4A arranged in a mold 32.

The mold 32 comprises a top member 38 extending parallel to a bottom member 38'. The mold 32 comprises two spaced apart end
15 press members 36 that are moveably arranged so that the distance between the end press members 36 can be changed in order to make the mold 32 fit the length of the building construction element 2.

Each of the end press members 36 are connected to a connection
20 member 34 that is attached to an actuator 32. An actuator 32 is arranged and configured to displace a connection member 34 and the end portion 36 along a longitudinal axis of the mold 32. Accordingly, it is possible to fixate the building construction element 2 in the mold 32 and hereafter inject PUR or PIR into the spaces between the first wall
25 structure and the second wall structure of building construction element 2.

Fig. 4C illustrates a cross-sectional view of the building construction element 2 arranged in the mold 32 shown in and explained with reference
30 to Fig. 4B, in a configuration in which PUR or PIR 18 has been filled into the spaces between the first wall structure and the second wall structure of building construction element 2.

Fig. 5A illustrates how an intermediate structure 8 is made of a continuous section from a wind turbine blade 20 of a wind turbine 22. The wind turbine 22 comprises several blades 20 that eventually needs to be replaced. When this happens, a wind turbine blade 20 is removed. The longitudinal axis X of the wind turbine blade 20 is indicated.

A number of intermediate structures 8 can be cut out of the wind turbine blade 20. In an embodiment, several intermediate structures 8 are be cut out of the wind turbine blade 20, wherein the longitudinal axis of the intermediate structures 8 extend parallel to the longitudinal axis X of the wind turbine blade 20. In an embodiment, the intermediate structures 8 are rectangular.

Fig. 5B illustrates another view of how an intermediate structure 8 is made of a continuous section from a wind turbine blade 20.

In an embodiment, the wind turbine blade 20 is cut into several sections 26, 26'. When this is done, a number of intermediate structures 8 are cut from each of the sections 26, 26'.

By providing intermediate structures 8 made of a continuous section from a wind turbine blade 20, it is possible to achieve a strong and reliable building support structure and thus to provide a strong and reliable building construction element 2.

The term "cut" should be interpreted as any suitable process, by which a number of intermediate structures 8 can be provided from each of the sections 26, 26'. In an embodiment, the intermediate structures 8 are cut from each of the sections 26, 26' by using a knife. In an embodiment, the intermediate structures 8 are cut from each of the sections 26, 26' by using a saw. In an embodiment, the intermediate structures 8 are cut from each of the sections 26, 26' by using a laser cutter. In an embodiment, the intermediate structures 8 are cut from each of the

sections 26, 26' by using a water jet cutter. In an embodiment, the intermediate structures 8 are cut from each of the sections 26, 26' by using a heat cutter (hot cutting tool).

- 5 Fig. 6A illustrates a portion of a prior art building construction element 102, while Fig. 6B illustrates a portion of a building construction element 2 according to the invention.

10 The prior art building construction element 102 and the building construction element 2 according to the invention comprises a first outer plate 4, a second outer plate 6 and a plurality of spaced apart intermediate structures 8 each extending between:

- a) a first flange member 10 extending along and covering an inside portion of a first outer plate 4 and;
15 b) a second flange member 10' extending along and covering an inside portion of the second outer plate 6.

PUR foam or PIR foam 18 has been filled into the space between the first outer plate 4 and the second outer plate 6.

20 When comparing the prior art building construction element 102 and the building construction element 2 according to the invention it can be seen that width W_1 of the building construction element 2 according to the invention is smaller than the width W_2 of the prior art building construction element 102 because when constructing the prior art building
25 construction element 102 it is not taken into consideration that the foam 18 contributes to the overall strength of a building construction element 102. Accordingly, the width W_2 of the intermediate structures 8 is larger than required.

30 Fig 6C illustrates a flow chart illustrating steps of a method according to the invention.

The first step is: "Determining the load bearing capacity of the PUR foam or PIR foam 18 filled into the space between the first wall structure 14 and the second wall structure 16".

5 The second step is:

"Determining the required load bearing capacity of the intermediate structures of the building construction element 2 in order to fulfil predefined requirements"

10 The third step is:

"Selecting the dimension of the intermediate structures 8 of the building construction element 2 in dependency of the determined required load bearing capacity of the intermediate structures 8"

15 Fig. 7A illustrates internal forces F_P and external forces F_E exerted to structures of a building construction element 2 according to the invention. The building construction element 2 corresponds to the one shown in and explained with reference to Fig. 6B.

20 An external load causes an external force F_E to be exerted to structures of a building construction element 2. The external force F_E is transferred to the intermediate structures 8 that are load bearing structures. If the surrounding PUR or PIR 18 was very soft, the external force F_E could cause the intermediate structures 8 to bend. Since the PUR or PIR provides internal forces F_P towards both sides of the intermediate structures 8, the PUR or PIR 18 is stabilizing the intermediate structures 8 and preventing them to bend. Moreover, the PUR or PIR 18 provides a reaction force F_R due to the external force F_E .

25

30 Fig. 7B illustrates internal forces F_P and external forces F_E exerted to structures of a building construction element 2 according to the invention. The building construction element 2 differs from the one shown in

and explained with reference to Fig. 7A in that the intermediate structures 8 are in contact with and extend between the wall structures 14, 16 because the building construction element 2 comprises no flanges.

- 5 By filling PUR or PIR 18 into the space between the wall structures 14, 16, it is possible to support the intermediate structures 8 and hereby increase their load bearing capacity significantly.

10 The compressive load at which a slender column will suddenly bend or buckle is called Euler's critical load, which is given by the following formula:

$$(1) \quad P_{cr} = \frac{\pi^2 EI}{(KL)^2}$$

15 Where:

P_{cr} is Euler's critical load (longitudinal compression load on column),

E is Young's modulus of the column material,

I is the minimum second moment of area of the cross section of the column (area moment of inertia),

20 L is the unsupported length of column and

K is the column effective length factor

When PUR or PIR 18 is filled into the space between the wall structures 14, 16 I is increased and hereby the load bearing capacity of the intermediate structures 8 is increased significantly. The higher density of the PUR or PIR 18 the more support (and thus a higher force F_p) will provided by the PUR or PIR 18 towards the intermediate structures 8.

Fig. 8A illustrates a cross-sectional view of a building construction element 2 according to the invention. The building construction element 2 is a floor element (e.g. a prefabricated floor element) intended for building constructions.

The building construction element 2 comprises a sandwich structure comprising:

- a) several first outer plates 4 (only one is indicated) forming a first wall structure of the building construction element 2,
- 5 b) several second outer plates 6 (only one is indicated) forming a second wall structure of the building construction element 2 and
- c) several partition plates 42 (only one is indicated) forming a third wall structure of the building construction element 2.

10 In an embodiment, the first, second and partition plates 4, 6, 42 are made of a fire resistant material (e.g. a material that contains concrete or is made of concrete. Alternatively, the material may contain plaster or be made of plaster).

The sandwich structure comprises

- 15 a) a number of reinforcement members 52 constituting flange members extending along the inside portion of a first wall structure and
- b) a number of and reinforcement structures 54 constituting flange members extending along the inside portion of a second wall structure.

20 The reinforcement members 52 will typically cover the inside portion of the joints (not shown) of the first and third wall structure. Likewise, the reinforcement structures 54 will typically cover the inside portion of the joints (not shown) of the second and third wall structure.

25 The reinforcement members 52 and the reinforcement structures 54 constitutes a plurality of spaced apart intermediate structures.

30 It may be an advantage that each of the reinforcement members 52 and the reinforcement structures 54 is a continuous section from a wind turbine blade as shown in and explained with reference to Fig. 5A and Fig. 5B.

The building construction element 2 comprises a floor portion 50. The

floor portion 50 comprises a heating portion 44 (e.g. comprising under-floor heating pipes) arranged on the top of the second outer plates 6. The floor portion 50 comprises a flooring 48 constituting the uppermost layer. The floor portion 50 comprises an intermediate portion 46 arranged between the flooring 48 and the heating portion 44.

The height H_1 of the building construction element 2 is lower than the total height H_2 of the building construction element 2 and the floor portion 50.

The space between the first wall structure and second wall structure has been filled with a polyurethane (PUR) foam 18, 18' or polyisocyanurate (PIR) foam 18, 18'. The PUR foam or PIR foam 18, 18' supports the intermediate structure 52, 54 and hereby prevents the intermediate structure 52, 54 from bending. The intermediate structure 52, 54 are pairwise aligned (and thus extend along the same line).

It may be an advantage to glue adjacent parts together since glue is typically stronger than stronger than the PUR foam or PIR foam 18, 18'. During the production process, the largest components are typically produced first. After shrinkages, the smaller components will typically be produced.

The density of the intermediate structures 52, 54 typically in the range 400-600g/l. In an embodiment, the density of the intermediate structures 52, 54 is about 500 g/l. This resin will be available for screws do to fire classification. In an embodiment, the mechanical properties of the intermediate structures 52, 54 are given by the following table.

Test	Standard	UoM	A - 535kg/m ³	B - 535kg/m ³	C - 495kg/m ³
Shore D	ISO 868		67	67	
Compression strength	ISO 844	[MPa]	18.1	19.7	15.1
Compression Modulus	ISO 844	[MPa]	325	311	353
Flexural strength	ISO 1209-2	[N/mm ²]	28.0	27.2	
Youngs modulus	ISO 1209-2	[N/mm ²]	625	626	
Tensile strength	ISO 527-2	[N/mm ²]	9.5		
Thermal expansion coefficient *	TMA-analyse	[µm/m*K]	54		
Tg. **	TMA-analyse	[°C]	95		

(*) = as measured between 25°C and 50°C

(**) = as measured by the onset of sample expansion due to Tg by DMA

The PUR foam or PIR foam 18, 18' will typically have a density in the range 35-50 g/l. In an embodiment, the PUR foam or PIR foam 18, 18' has a density in the range 40-44 g/l. In an embodiment, the PUR foam or PIR foam 18, 18' has a density of 41-43 g/l. In an embodiment, the PUR foam or PIR foam 18, 18' has a density of 42 g/l.

Fig. 8B illustrates a schematic perspective top view of the building construction element 2 shown in Fig. 8A. The foam 18, 18' is not indicated in Fig. 8B.

Fig. 8C illustrates another view of a building construction element 2 corresponding to the one shown in Fig. 8A and Fig. 8B. It can be seen that the first outer plate 4 is attached to the reinforcement member 52 by using screws 56. Moreover, the partition plate 42 is attached to the reinforcement member 52 by using screws 56. Likewise, the second outer plate 6 is attached to the reinforcement structure 54 by using screws 56.

In an embodiment, the first outer plate 4 is attached to the reinforcement member 52 by using glue. In an embodiment, the partition plate 42 is attached to the reinforcement member 52 by using glue. In an

embodiment, the second outer plate 6 is attached to the reinforcement structure 54 by using glue.

Fig. 9A illustrates a cross-sectional view of a building construction element 2 according to the invention. The building construction element 2 is a wall. The building construction element 2 comprises a sandwich structure comprising:

- a) several first outer plates 4 (only one is indicated) forming a first wall structure of the building construction element 2,
- b) several second outer plates 6 (only one is indicated) forming a second wall structure of the building construction element 2,
- c) several first partition plates 42 (only one is indicated) forming a third wall structure of the building construction element 2 and
- d) several second partition plates 42' (only one is indicated) forming a third wall structure of the building construction element 2.

The reinforcement members 52 will typically cover the inside portion of the joints (not shown) of the first and third wall structure. Likewise, the reinforcement structures 54 will typically cover the inside portion of the joints (not shown) of the second and third wall structure.

The reinforcement members 52 and the reinforcement structures 54 constitutes a plurality of spaced apart intermediate structures.

It may be an advantage that each of the reinforcement members 52 and the reinforcement structures 54 is a continuous section from a wind turbine blade as shown in and explained with reference to Fig. 5A and Fig. 5B.

The space between the wall structures has been filled with a polyurethane (PUR) foam 18, 18', 18''' or polyisocyanurate (PIR) foam 18, 18', 18'''. The PUR foam or PIR foam 18, 18' supports the intermediate

structure 52, 54 and hereby prevents the intermediate structure 52, 54 from bending. The intermediate structure 52, 54 are pairwise aligned and are extending along the same line extending perpendicular to the plane of the outer plates 4, 6. A wall material 58 is provided on the first
5 outer plate 4.

Fig. 9B illustrates a schematic view of the building construction element shown in Fig. 9A. The first outer plate 4 is attached to the reinforcement member 52 by using screws 56. Moreover, the partition plates 42,
10 42' are attached to the reinforcement member 52 by using screws 56. Likewise, the second outer plate 6 is attached to the reinforcement structure 54 by using screws 56.

In an embodiment, the first outer plate 4 is attached to the reinforcement member 52 by using glue. In an embodiment, the partition plates
15 42, 42' are attached to the reinforcement member 52 by using glue. In an embodiment, the second outer plate 6 is attached to the reinforcement structure 54 by using glue.

Fig. 9C illustrates a cross-sectional view of another building construction element 2 according to the invention. The building construction element
20 2 comprises a building construction element forming a wall as shown in Fig. 8A and a building construction element forming a floor element 80 that basically corresponds to the one shown in Fig. 9A.

The building construction element as shown in Fig. 8A is fixed to the ground 68 by using several screw pile foundations 62 that are screwed
25 into the ground 68. Accordingly, a ventilated portion 70 is provided under the floor element 80. Therefore, infiltration of water into the building can be avoided. Moreover, the floor element 80 is resistant to water and moisture.
30

Each screw pile foundation 62 comprises a top part provided with a

base plate. A plinth (e.g. made of composite) 72 is placed and rests on the baseplate of the pile foundation 62. A cover member 66 extends along the lateral side of the screw pile foundation 62. In an embodiment, the cover member 66 comprises or is made of cement. In an embodiment, the cover member 66 comprises or is made of concrete.

As an option, reinforcement members 74 may be provided at the end portion of the floor element 80. An outer structure 60 is attached to the end portion of the floor element 80. In an embodiment, the reinforcement members 74 are made of composite material.

The wall is placed on reinforcement members 76. In an embodiment, these reinforcement members 76 are made of composite material. It may be advantageous that an elastic joint material 78 is used as a joint between the wall and the floor element 80.

Fig. 10A illustrates a cross-sectional view of two building construction elements 2 according to the invention. The leftmost building construction element 2 is a flooring element comprising a first outer plate 4 and a second outer plate 6 made of a fire-resistant material.

The space between the first outer plate 4 and a second outer plate 6 has been filled with a polyurethane (PUR) foam 18 or polyisocyanurate (PIR) foam 18. The leftmost and the rightmost building construction element 2 comprises an end member 84 made of PUR or PIR having a density large enough to allow screws 56 to be screwed into and hereby be lockingly received by the end member 84. The leftmost building construction element 2 comprises an angled attachment member 82 designed to receive a corresponding angled attachment member 82' of the adjacent rightmost building construction element 2.

The rightmost building construction element 2 comprises an end member 84' made of PUR or PIR having a density large enough to allow

screws 56 to be screwed into and hereby be lockingly received by the end member 84'.

5 Fig. 10B illustrates a cross-sectional view of the building construction elements shown in Fig. 10A in an assembled configuration. A closing plate 86, 86' made of a fire-resistant material closes the joint portion between adjacent building construction elements.

10 Fig. 10C illustrates a perspective of a floor comprising a plurality of building construction elements 2 according to the invention.

List of reference numerals

	2	Building construction element
	4, 4', 4''	First outer plate
5	6, 6', 6''	Second outer plate
	8	Section from a wind turbine blade
	10, 10'	Flange -
	12	Joint
	14	First wall structure
10	16	Second wall structure
	18, 18', 18''	Insulation material
	20	Wind turbine blade
	22	Wind turbine
	24	Glue
15	26, 26'	Section of a wind turbine blade
	28	Fire-resistant material
	30	Joint cover plate
	32	Mold
	34	Connection member
20	36	End press member
	38	Top member
	38'	Bottom member
	40	Actuator
	42, 42'	Partition plate (e.g. cement board)
25	44	Heating portion
	46	Intermediate portion
	48	Flooring
	50	Floor portion
	52	Reinforcement member
30	54	Reinforcement structure
	56	Screw
	58	Wall material

	60	Outer structure
	62	Screw pile foundation
	64	Top layer
	66	Cover member
5	68	Ground
	70	Ventilated portion
	72	Plinth (e.g. of composite)
	74	Reinforcement member
	76	Reinforcement member
10	78	Elastic joint material
	80	Floor element
	82, 82'	Angled attachment member
	84, 84'	End member
	86, 86'	Closing plate
15	102	Prior art building construction element
	X	Longitudinal axis
	D ₁	Width
	D ₂	Distance
	W ₁ , W ₂	Width
20	H ₁ , H ₂	Height
	F _P	Force
	F _E	Force

Claims

1. Method for manufacturing a building construction element (2, 2', 2''), the method comprising:
- 5 - forming a first wall structure (14) of the building construction element (2) from one or more first outer plates (4, 4', 4''), wherein the area between adjacent first outer plates (4, 4', 4'') (if any) constitutes a joint (12);
- 10 - forming a second wall structure (16) of the building construction element (2) from one or more second outer plates (6, 6', 6'') (if any), wherein the area between adjacent second outer plates (6, 6', 6'') constitutes a joint (12);
- arranging a number of flange members (10, 10') or joint cover plates (30) along an inside portion of the joints (12) and
- 15 - arranging a plurality of spaced apart intermediate structures (8) to extend between:
- a) a first flange member (10) extending along and covering an inside portion of (e.g. a first joint (12) of) the first wall structure (14) and;
- b) a second flange member (10') extending along and covering an in-
- 20 side portion of (e.g. a second joint (12) of) the second wall structure (16),
- filling polyurethane (PUR) foam or polyisocyanurate (PIR) foam into the space between the first wall structure (14) and the second wall structure (16),
- 25 **characterised in** that the method comprising:
- determining the load bearing capacity of the PUR foam or PIR foam (18) filled into the space between the first wall structure (14) and the second wall structure (16);
- determining the required load bearing capacity of the intermediate structures (8) of the building construction element (2, 2', 2'')
- 30 in order to fulfil one or more predefined requirements related to the load bearing capacity of the building construction element (2,

2', 2'') and

- selecting the dimension of the intermediate structures (8) of the building construction element (2, 2', 2'') in dependency of the determined required load bearing capacity of the intermediate structures (8).

5

2. Method according to claim 1, wherein the width (D_1) of the intermediate structures (8) of the building construction element (2, 2', 2'') is determined in dependency of the determined required load bearing capacity of the intermediate structures (8).

10

3. Method according to claim 1 or 2 comprising:
- prior to construction of the building construction element (2, 2', 2'') conducting a mechanical test of the wind turbine blade (20) and/or the suitable intermediate structures (8) to be used in the building construction element (2, 2', 2'').

15

4. Method according to one of the preceding claims comprising:
- determining the force (F_P) with which the PUR foam or PIR foam (18) filled into the space between the first wall structure (14) and the second wall structure (16) exerts toward the intermediate structures (8) placed adjacent to the PUR foam or PIR foam (18) when an external force (F_E) is exerted towards the intermediate structures (8) along the length of the intermediate structures (8).

25

5. Method according to one of the preceding claims comprising:
- determining the maximum allowable distance (D_2) between the intermediate structures (8) to fulfil the one or more predefined requirements in dependency of the determined required load bearing capacity of the intermediate structures (8).

30

6. Method according to one of the preceding claims, wherein each intermediate structure (8) is a continuous section from a wind turbine blade (20).
- 5 7. Method according to one of the preceding claims, wherein the method comprising:
- prior to construction of the building construction element (2, 2', 2'') defining a plurality of different types of construction elements (2, 2', 2'') having different predefined minimum required load capacity;
 - 10 - determining the thickness of a group of suitable intermediate structures (8) to be used in the building construction element (2, 2', 2'') and
 - selecting among said types of construction elements (2, 2', 2'') one single type having a load capacity above its predefined minimum
 - 15 required load capacity when the suitable intermediate structures (8) are used in the building construction element (2, 2', 2'').
8. Method according to one of the preceding claims, wherein the first wall structure (14) extends parallel to the second wall structure (16).
- 20 9. Method according to one of the preceding claims, wherein the flange members (10, 10') are made of a fire-resistant material.
- 25 10. Method according to one of the preceding claims, wherein the intermediate structure (8) is at least partly covered by a fire-resistant material.
- 30 11. Method according to one of the preceding claims, wherein the method comprising:
- gluing or mechanically attaching each intermediate structure (8) to the flange members (10, 10') or wall structures (14, 16) between which the intermediate structure (8) extends.

12. Method according to one of the preceding claims 10-16, wherein the building construction element (2, 2', 2'') is a wall or a horizontal division.

5

13. Building construction element (2) being manufactured by using a method according to one of the preceding claims.

14. A building comprising a building construction element (2, 2', 2'') according to claim 13.

10

1/10

Fig. 1A

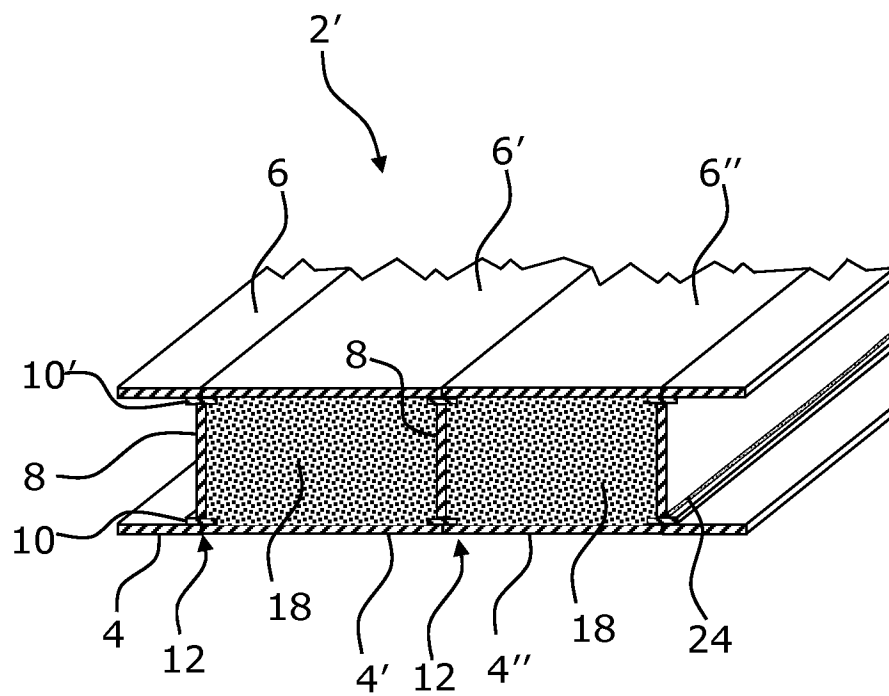
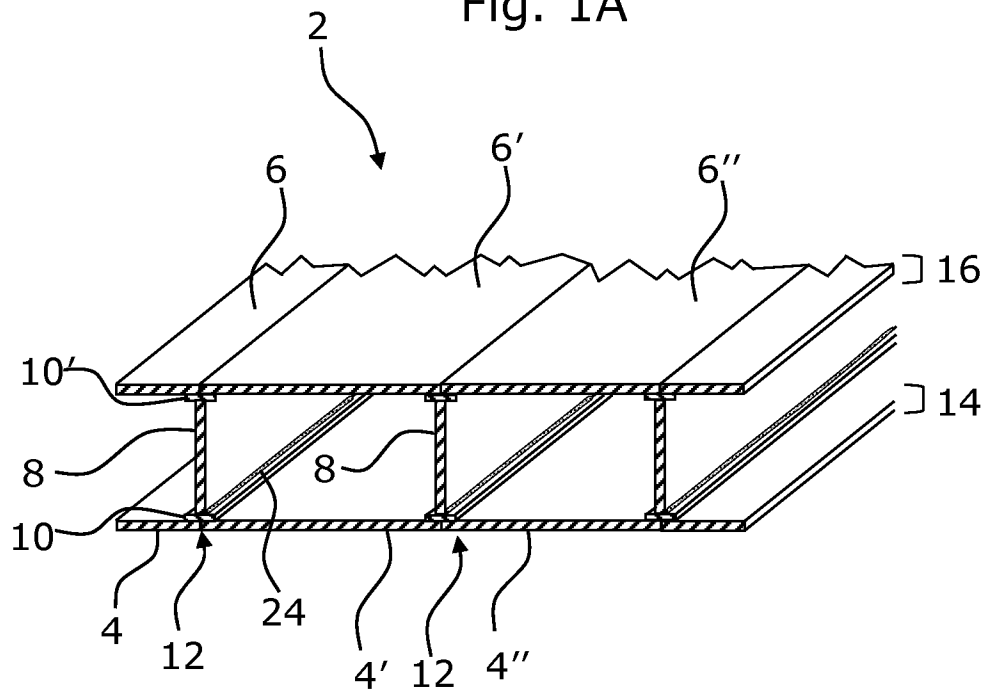


Fig. 1B

Fig. 2A

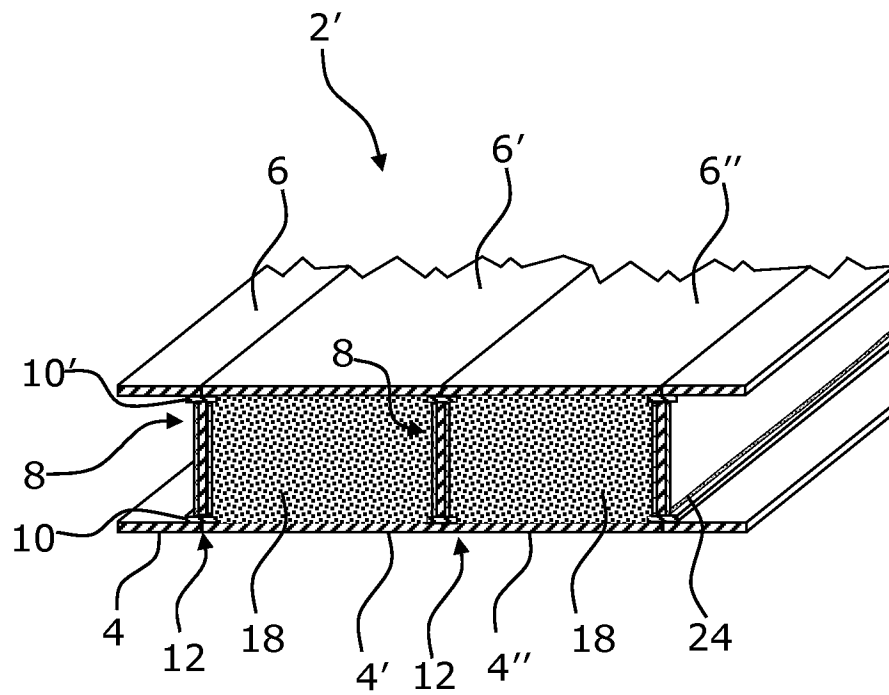
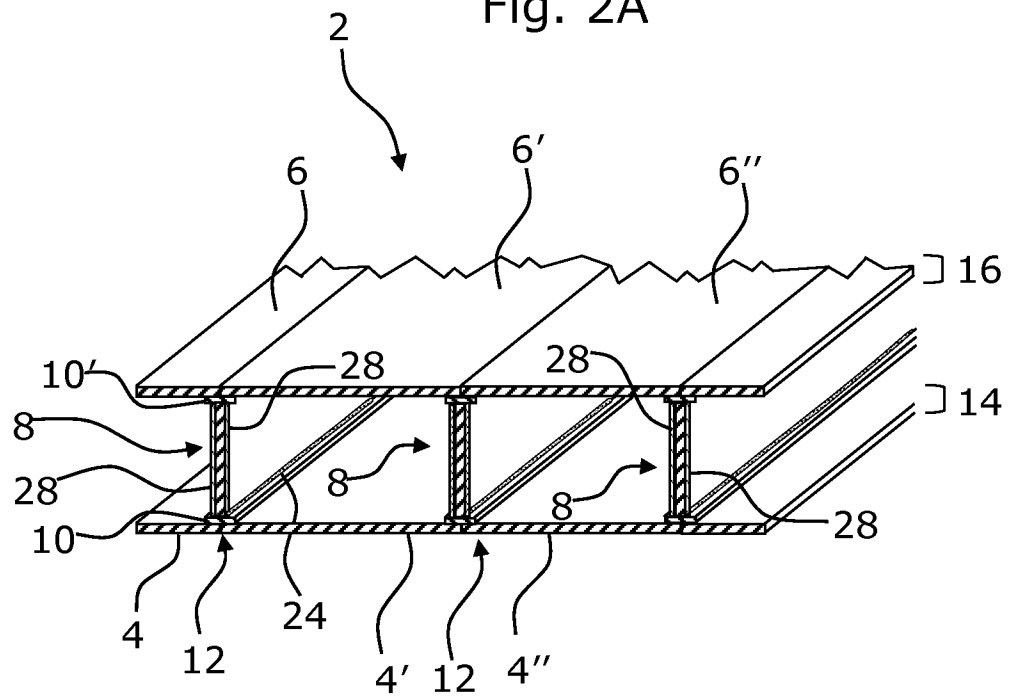


Fig. 2B

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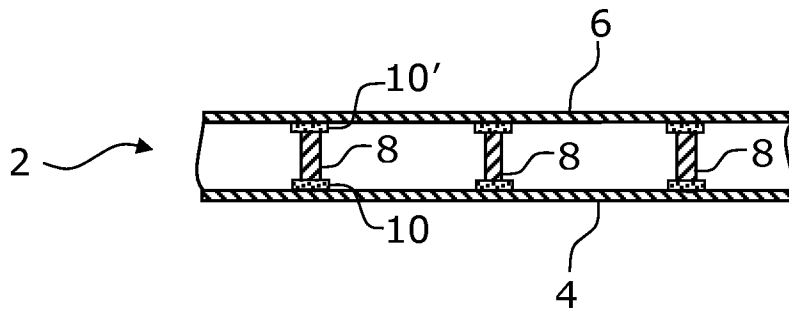


Fig. 4A

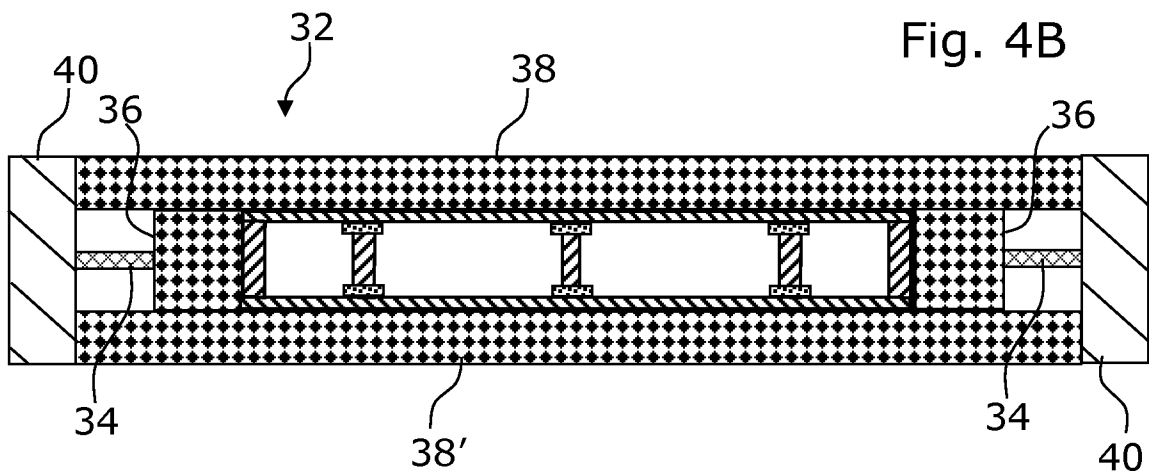


Fig. 4B

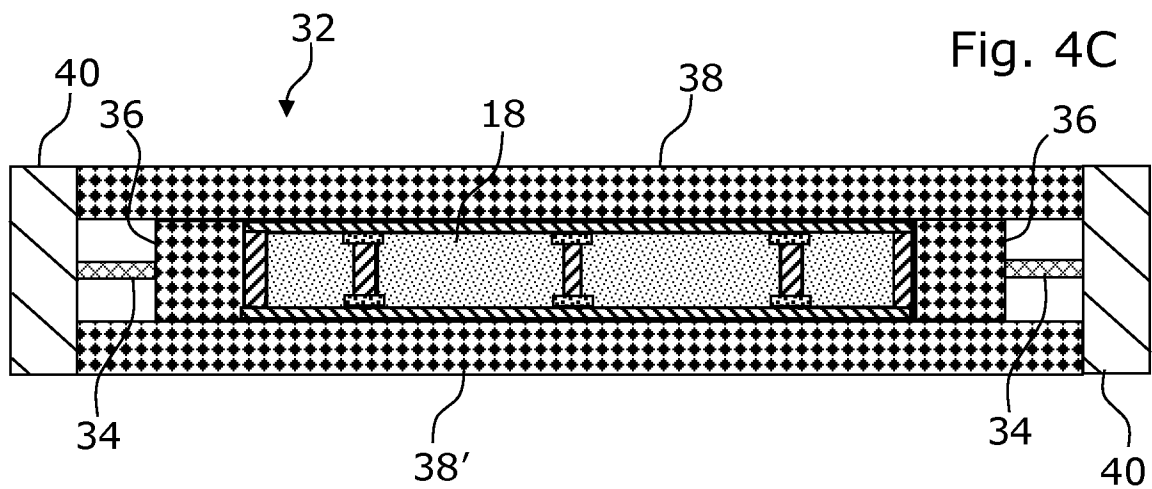


Fig. 4C

Fig. 5A

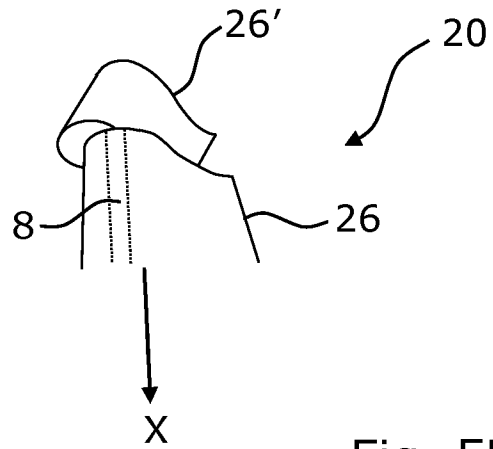
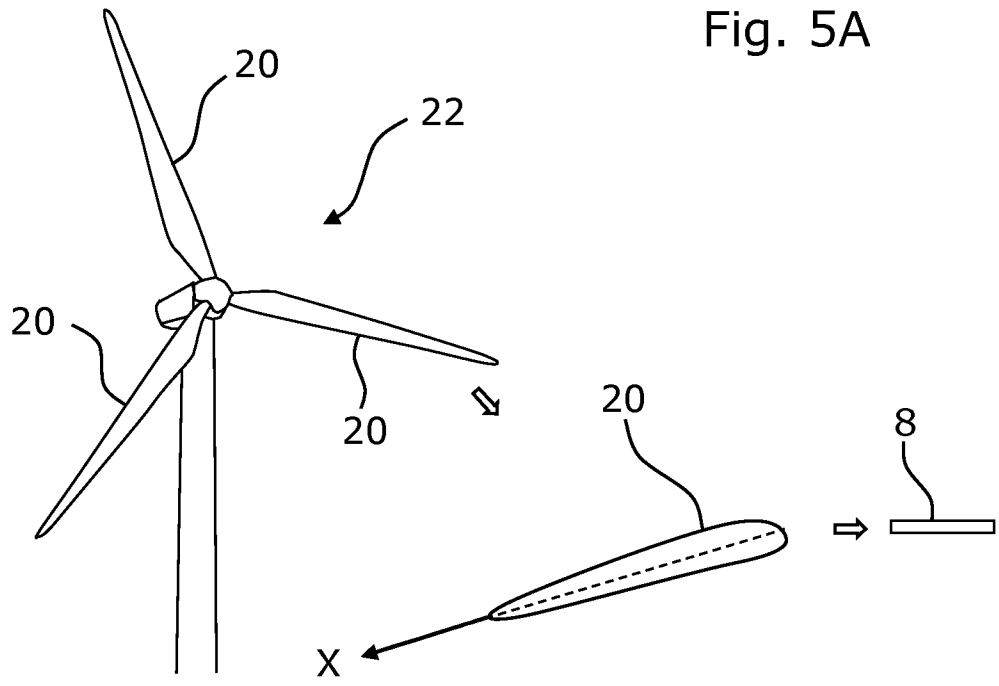


Fig. 5B

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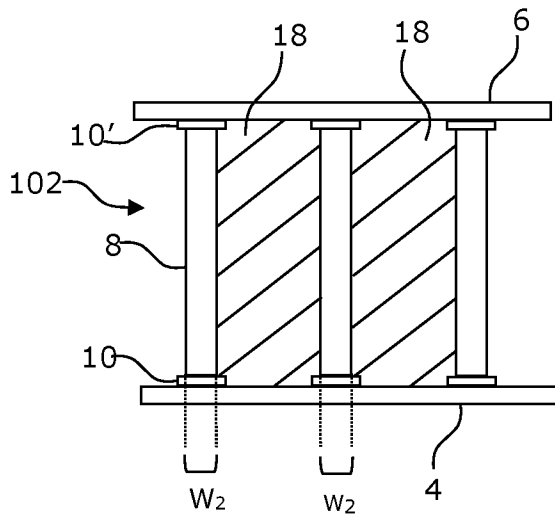


Fig. 6A

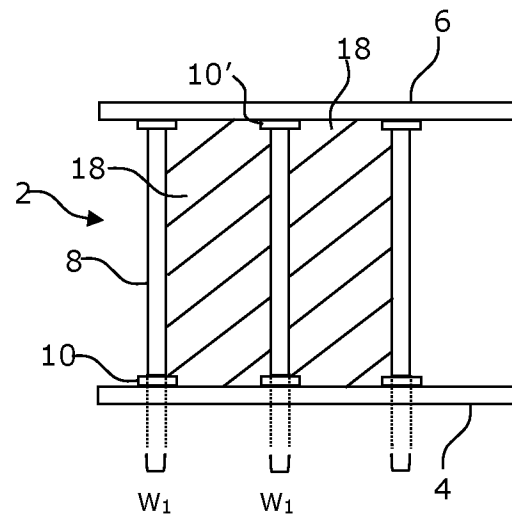


Fig. 6B

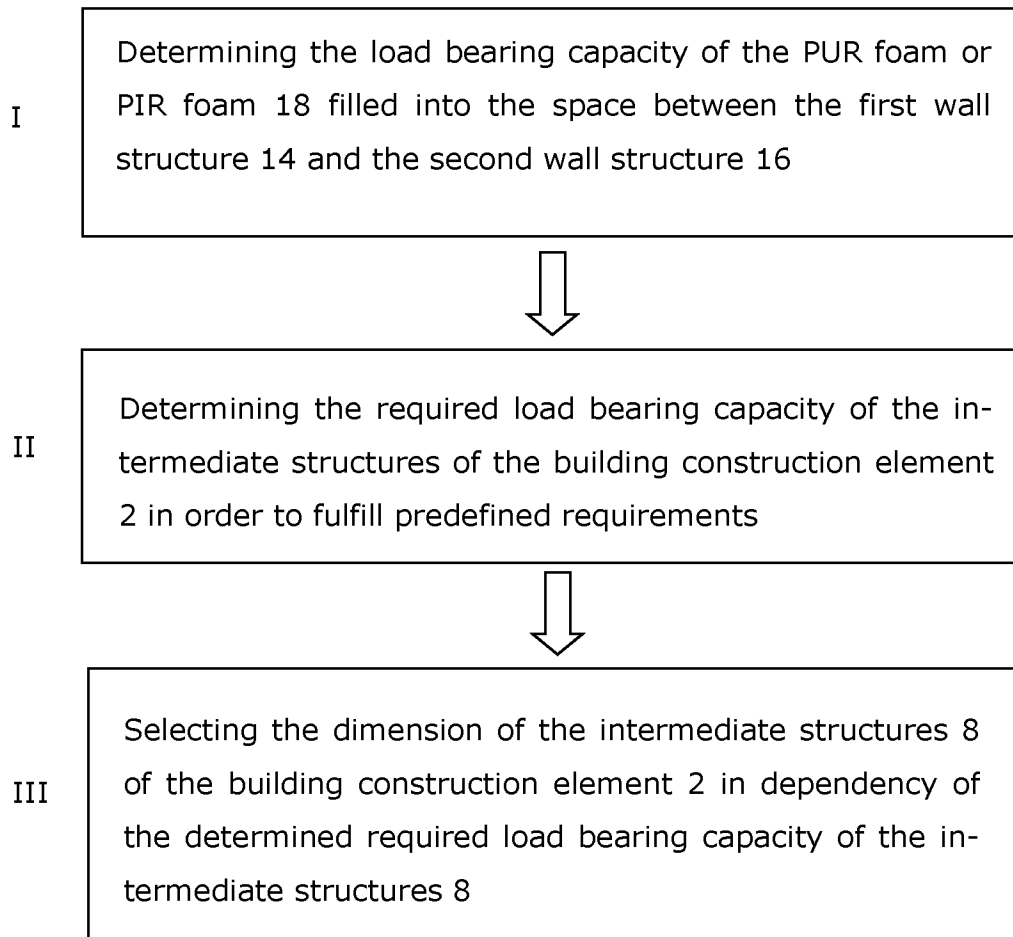


Fig. 6C

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Fig. 7A

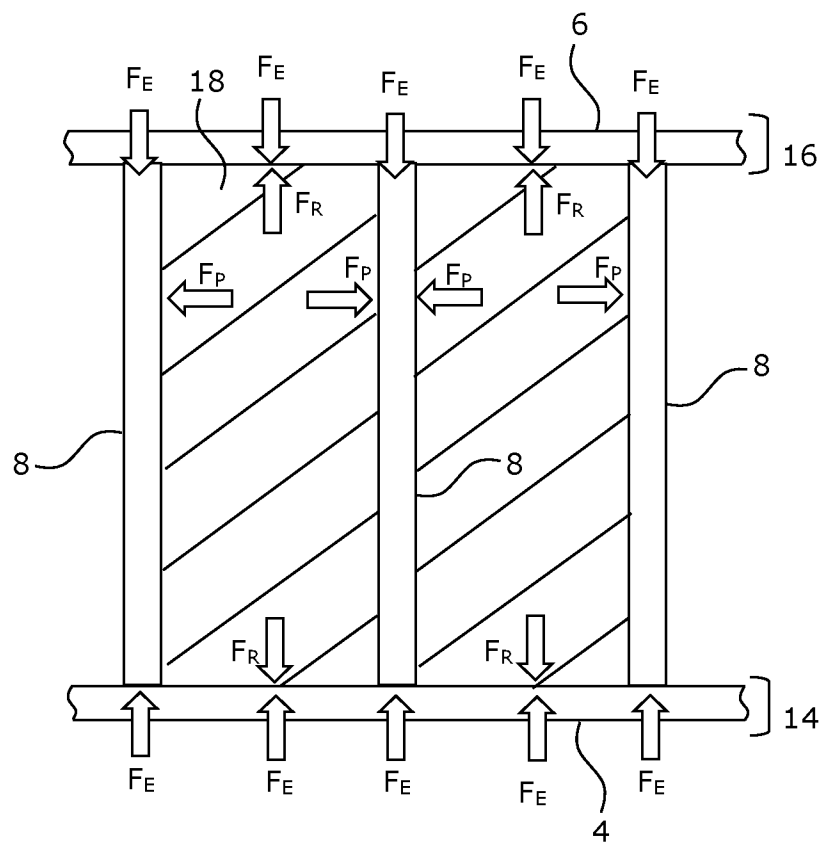
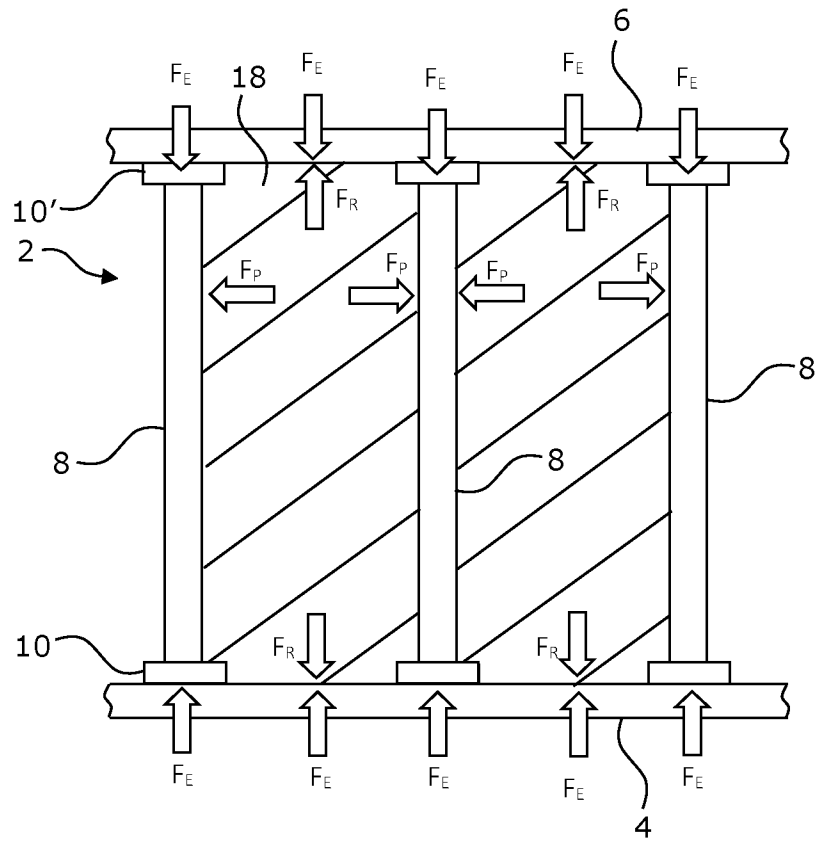


Fig. 7B

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Fig. 8A

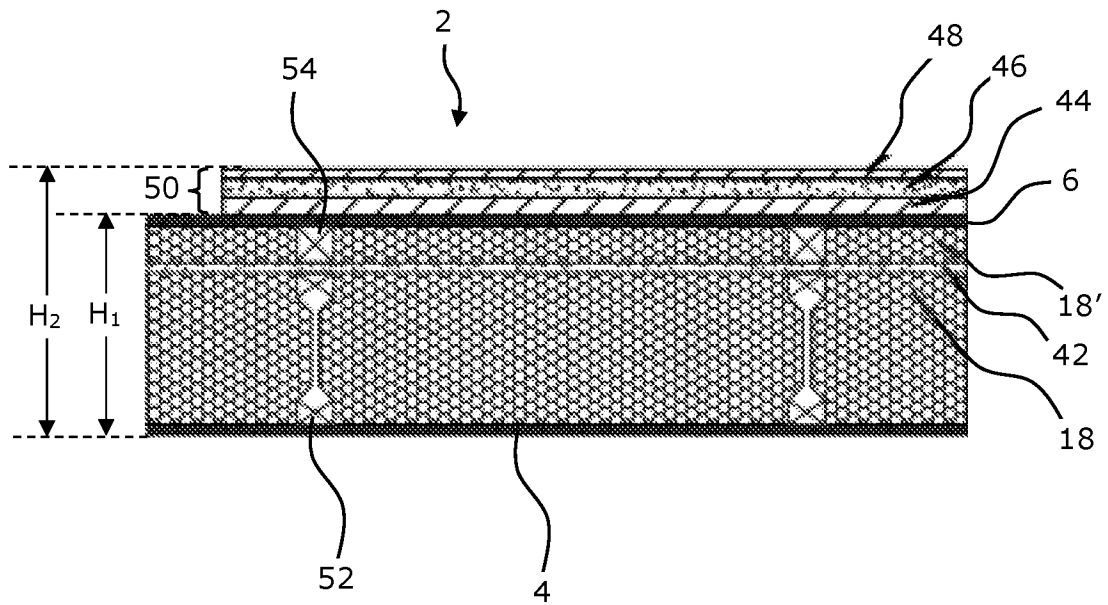


Fig. 8B

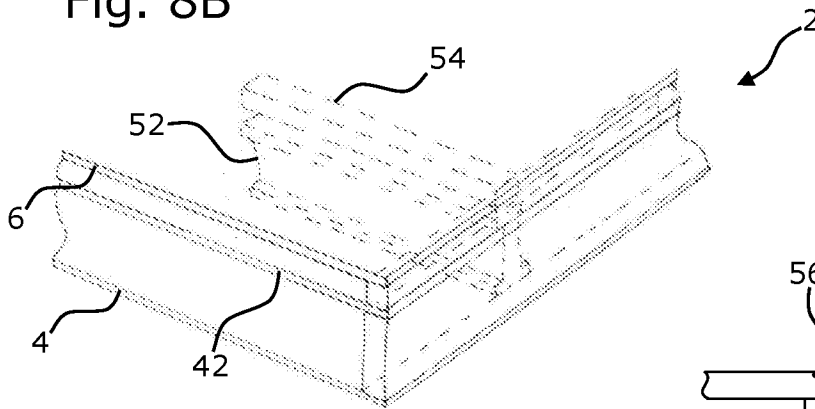
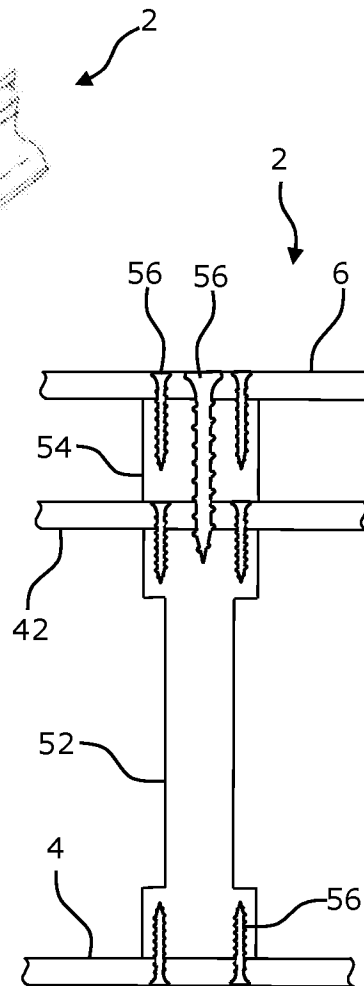


Fig. 8C



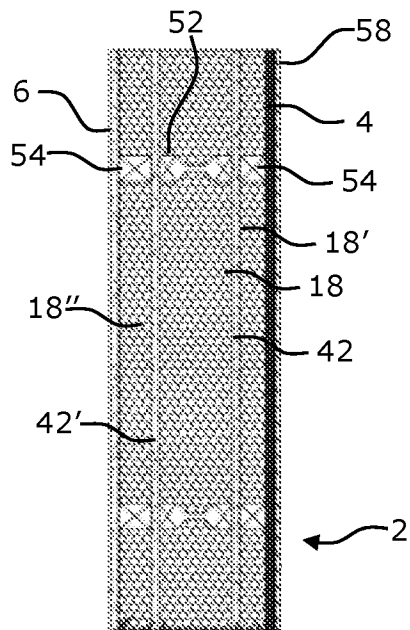


Fig. 9A

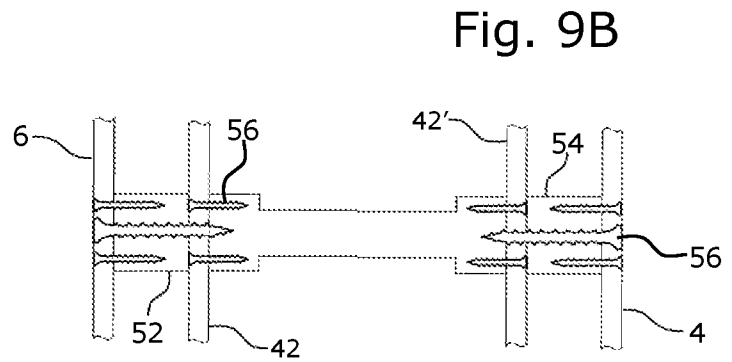


Fig. 9B

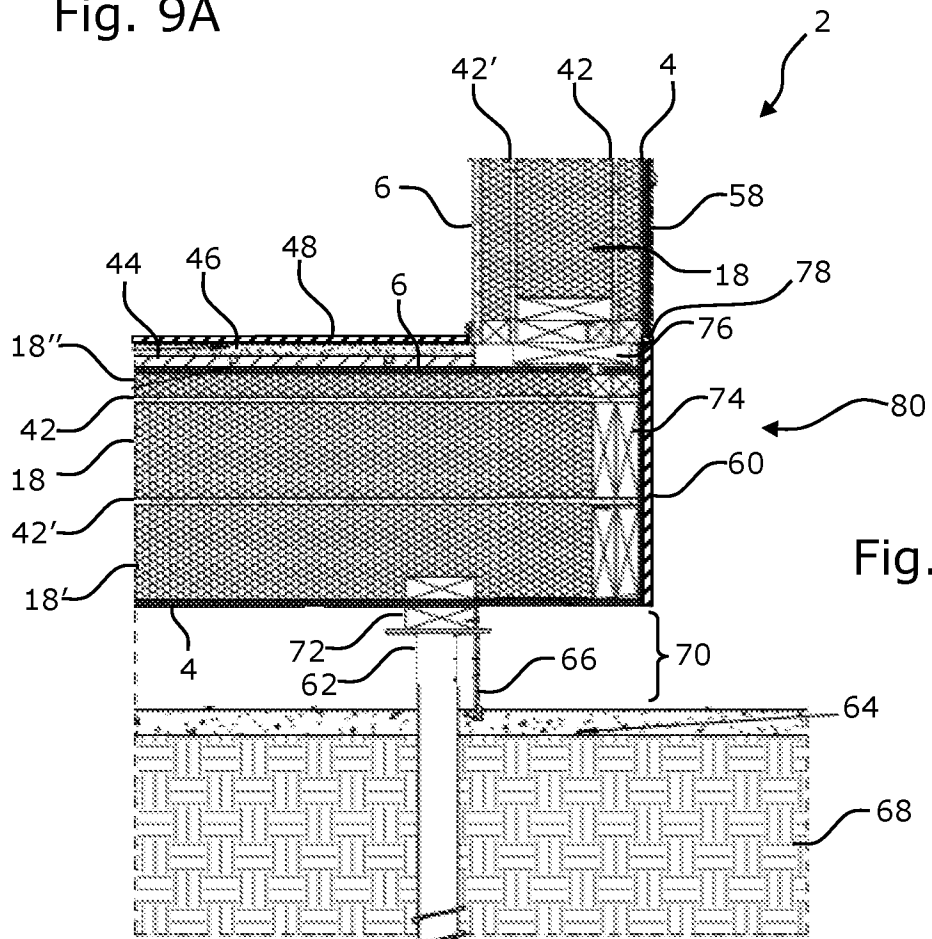
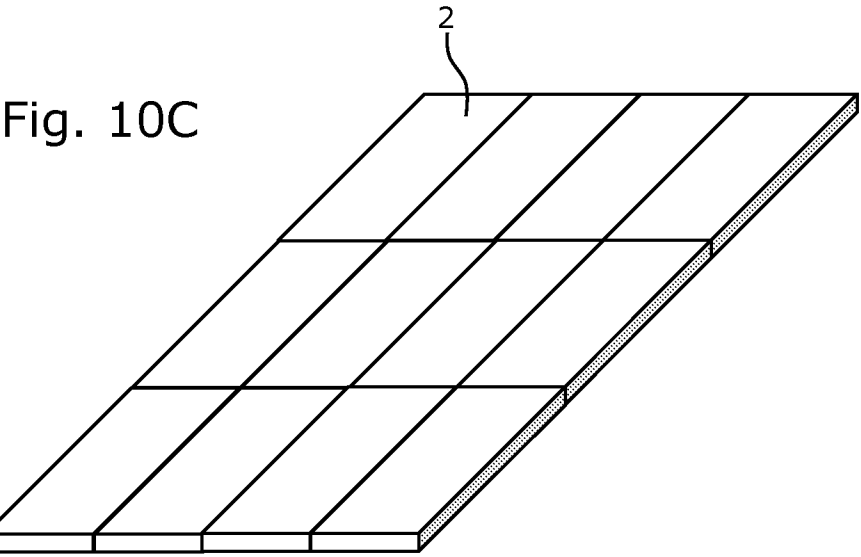
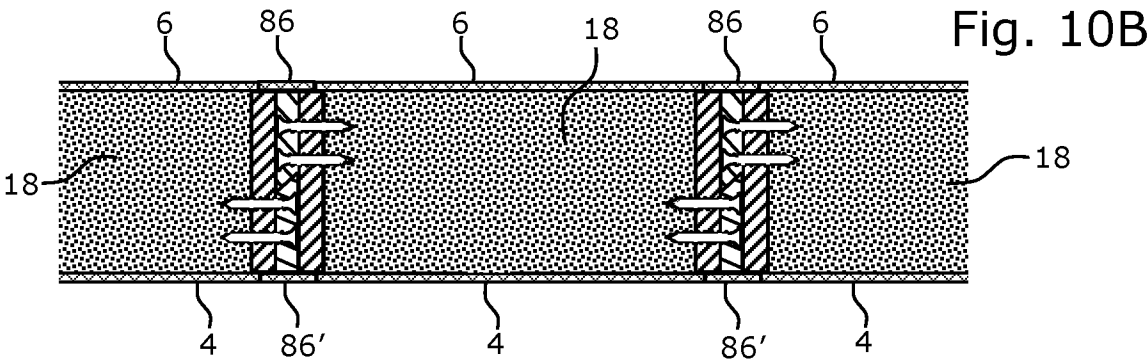
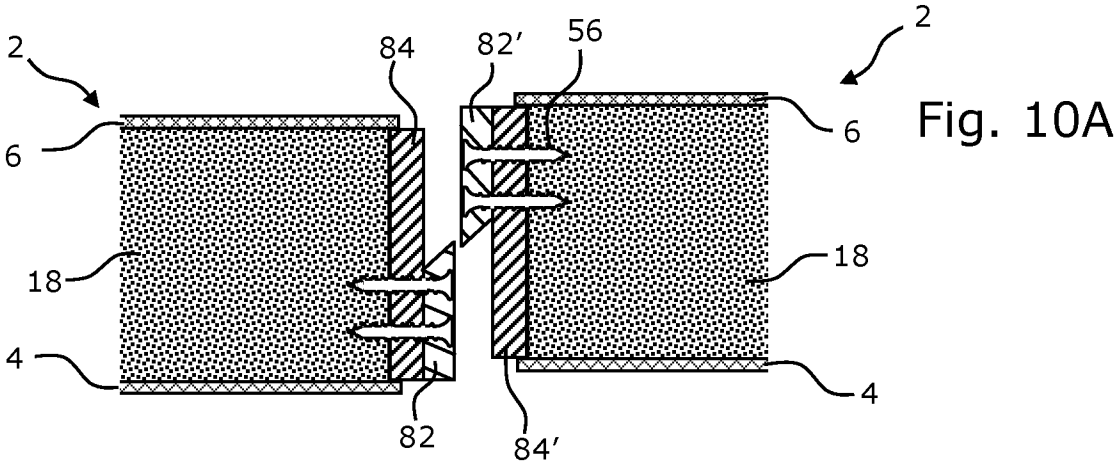


Fig. 9C

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INTERNATIONAL SEARCH REPORT

International application No.

PCT/DK2024/050135

A. CLASSIFICATION OF SUBJECT MATTER <i>E04C 2/296</i> (2006.01)i; <i>E04C 2/36</i> (2006.01)i; <i>E04B 1/80</i> (2006.01)i; <i>E04B 7/22</i> (2006.01); <i>E04C 2/288</i> (2006.01) 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) E04C; E04B; B32B Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched DK, NO, SE, FI: Classes as above Electronic data base consulted during the international search (name of data base and, where practicable, search terms used) EPODOC, FULL TEXT: English		
C. DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	GB 2450994 A (SMEE WILLIAM PATRICK [IE]) 14 January 2009 (2009-01-14) see abstract; page 7, line 19 to page 8, line 14; page 18, lines 9-11; page 18, line 23 to page 19, line 3; claims 1, 4; figures 2-5.	1-14
A	US 2020141118 A1 (KREIZINGER KENNETH R [US]) 07 May 2020 (2020-05-07) see sections [0013], [0184], [0185]; claim 8; figure 10.	1-14
A	WO 2022114959 A1 (HOLLAND COMPOSITES B V [NL]) 02 June 2022 (2022-06-02) see page 4, lines 24-32; page 12, lines 13-20; figures 1-2.	1-14
A	EP 3652388 B1 (AMOVIDO AS [DK]) 25 August 2021 (2021-08-25) see sections [0001], [0052]; figures 1A, 3A, 8A-8F.	1-14
A	EP 2348161 A2 (MJOSUTVIKLING AS [NO]) 27 July 2011 (2011-07-27) see abstract; figures 1-2.	1-14
A	US 2021381237 A1 (LIVINGSTONE PATRICIA MARY [CA]) 09 December 2021 (2021-12-09) see abstract; sections [0065], [0096]; figure 4.	1-14
☐ 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 “D” document cited by the applicant in the international application “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 12 August 2024		Date of mailing of the international search report 15 August 2024
Name and mailing address of the ISA/XN Nordic Patent Institute Helgeshoj Allé 81, 2630 Taastrup Denmark Telephone No. +45 43 50 85 00 Facsimile No. +4543508008		Authorized officer Henrik Mensing Telephone No.

INTERNATIONAL SEARCH REPORT
Information on patent family members

International application No.

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				IE	S20080570	A2	29 October 2008					

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				CA	3120985	A1	03 December 2021					
