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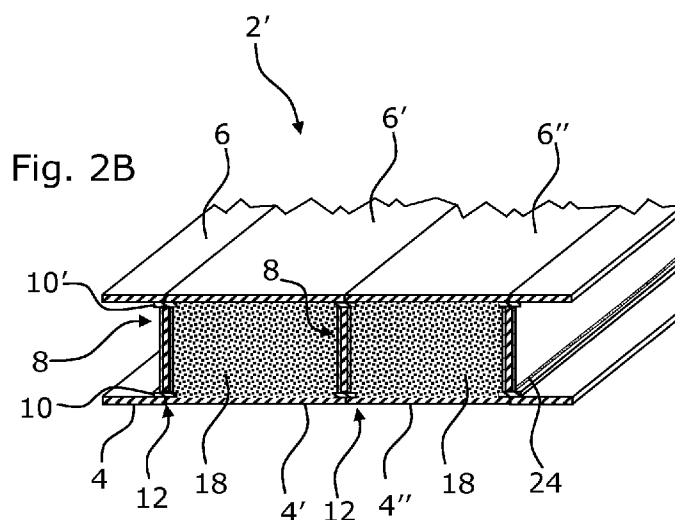
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(54) Title: BUILDING CONSTRUCTION ELEMENT AND METHOD FOR MANUFACTURING A BUILDING CONSTRUCTION ELEMENT



(57) Abstract: A building construction element (2) comprising a sandwich structure. The building construction element (2) comprises: - a plurality of first outer plates (4, 4', 4'') forming a first wall structure (14), wherein the area between adjacent first outer plates (4, 4', 4'') constitutes a joint (12); - a plurality of second outer plates (6, 6', 6'') forming a second wall structure (16), wherein the area between adjacent second outer plates (4, 4', 4'') constitutes a joint (12); - optionally a number of flange members (10, 10') extending along and covering the inside portion of the joints (12) and a plurality of spaced apart intermediate structures (8) where each intermediate structure (8) is a continuous section from a wind turbine blade (20).



## **Building Construction Element and Method for Manufacturing a Building Construction Element**

### **5 Field of invention**

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;
- 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
- 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.

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

### **Prior art**

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).

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. Wood is, however, expensive and it is difficult to determine the exact mechanical properties because they vary largely when comparing different pieces of wood even if the geometry and type of wood is the same.

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It would, however, be an advantage to be able to provide an alternative solution.

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Thus, it is an object of the invention to provide an alternative method and an alternative building construction element which reduces or even eliminates the above-mentioned disadvantages of the prior art.

### **Summary of the invention**

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The object of the present invention can be achieved by a building construction element as defined in claim 1 and by a method as defined in claim 10. Preferred embodiments are defined in the dependent sub-claims, explained in the following description and illustrated in the accompanying drawings.

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The building construction element according to the invention is a building construction element comprising a sandwich structure comprising:

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- one or more first outer plates forming a first wall structure of the building construction element, wherein the area 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 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 extend-

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ing 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.

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

In an embodiment, the construction element is a wall.

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

- In an embodiment, the construction element is a floor element. The building construction element according to the invention is a building construction element comprising a sandwich structure.

The sandwich structure comprises one or more first outer plates forming a first wall structure of the building construction element, wherein the area between adjacent first outer plates constitutes a joint (joints are only present if the first wall structure comprises several first outer plates).

The sandwich structure comprises one or more second outer plates forming a second wall structure of the building construction element, wherein the area between adjacent second outer plates constitutes a joint. Joints are only present if the second wall structure comprises several second outer plates.

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

The sandwich structure comprises a number of flange members extend-

ing along and covering the inside portion of the joints.

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

- 5 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.
- 10 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.
- 15 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
- 20 the building construction element, wherein the area between adjacent second outer plates constitutes a joint.

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

- 25 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.
- 30 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;

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

5 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 a second joint the second wall structure.

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

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

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

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

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

25 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. Hereby, it is possible to approve a fire rated building construction element.

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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.

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

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

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

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

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

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

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

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

25 The method according to the invention is a method for manufacturing a building construction 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 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 constitutes a joint;
- 30 - optionally arranging a number of flange members along the inside portion of the joints and

- 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 a second flange member extending along and covering the inside portion of a second joint the second wall structure or
    - b) 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,
- wherein each intermediate structure is a continuous section from a wind turbine blade.

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;
- 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.

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

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 thickness of the in which the intermediate structures that are used for wall construction are in the range 4-8 mm.

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In an embodiment, the thickness of the intermediate structures that are used for roof and floor separation are larger than 8 mm.

In an embodiment, the method comprising:

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- 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 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.

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

In an embodiment, the flange members comprise concrete.

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

In an embodiment, the flange members comprise plaster.

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

30

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

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 the wall structures between which the intermediate structure extends.

5

In an embodiment, 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;
- 10 - determining the required load bearing capacity of the intermediate structures of the building construction element in order to fulfill one or more predefined requirements related to the load bearing capacity of the building construction element and
- 15 - 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.

20 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.

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

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

In an embodiment, 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.
- 30

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  
5 from a plurality of first outer plates, wherein the area between adjacent first outer plates constitutes a joint.

In an embodiment, the method comprising:

- forming a second wall structure of the building construction element  
10 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.

In an embodiment, the method comprising:

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

In an embodiment, the method comprising:

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

In an embodiment, the method comprising:

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

In an embodiment, the method comprising:

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

In an embodiment, the method comprising:

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

In an embodiment, the method comprising:

- 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:

- 5     - 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
- 10    portion of 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.

In an embodiment, the method comprising:

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

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In an embodiment, 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.

5 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:

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

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

15 In an embodiment, the maximum load-carrying capacity is at least 3000 kg/m<sup>2</sup>.

In an embodiment, the maximum load-carrying capacity is at least 4000 kg/m<sup>2</sup>.

20 In an embodiment, the maximum load-carrying capacity is at least 5000 kg/m<sup>2</sup>.

25 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/m<sup>2</sup>).

30 In an embodiment, the density of the PUR or PIR is in the range 20-80 kg/m<sup>3</sup>.

In an embodiment, the density of the PUR or PIR is in the range 30-70 kg/m<sup>3</sup>.

In an embodiment, the density of the PUR or PIR is in the range 40-60 kg/m<sup>3</sup>.

5 In an embodiment, the density of the PUR or PIR is in the range 45-55 kg/m<sup>3</sup>.

In an embodiment, the method comprising:

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

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

20 In an embodiment, the required load bearing capacity of the intermediate structures of the building construction element in order to fulfill 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.

25 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.

30 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.

5 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.

In an embodiment, the method comprising:

- 10 - 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.

15 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.

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.

In an embodiment, the method comprising:

- 25 - 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.

30 In an embodiment, the method comprising:

- 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.

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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;
- 10 - 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.

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

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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;
- 25 - molding a new element by using the smaller pieces of the building construction element.

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

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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.



In an embodiment, the resin is a polyurethane resin.

It is possible to make the intermediate structures of new PUR and/or PIR. Alternatively, the intermediate structures can be made of PUR and/or PIR comprising fibres (e.g. glass fibres, carbon fibres or aramid fibres). The intermediate structures may be made of PUR and/or PIR comprising recycled PUR and/or PIR material.

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

### **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:

- Fig. 1A shows a perspective view of a building construction element according to the invention;
- 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;
- 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;

- 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;
- 5 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;
- 10 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;
- 15 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;
- 20 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;
- 25 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;
- 30 Fig. 9C shows a cross-sectional view of another building construction element according to the invention
- 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
- 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.

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:

- 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.

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.

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.

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.

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 bricks.

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

10 The sandwich structure comprises:

- 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.

15

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
- 20 - a second flange member 10' extending along and covering 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.

25

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

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'.

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 filled 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.

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.

The low lambda value of PUR (less than 0.028 W/m·K°) 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 cli-

mate change due to the low emission of carbon dioxide.

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  
5 filed with PUR or PIR foam 18.

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  
10 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  
15 made of a material that contains concrete.

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

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

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

In an embodiment, the fire-resistant material 28 is made of a material  
25 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  
30 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.

Fig. 3B illustrates a close-up view of at least a portion of a building construction element 2 according to the invention. The building construction element 2 comprises a second wall structure 16 comprising two adjacent first

outer plates 6, 6' arranged bearing against each other along a joint 12. 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.

5

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.

10

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.

15

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:

20

- 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.

25

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.

30

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.

Fig. 4B illustrates a cross-sectional view of the building construction el-



ement 2 shown in Fig. 4A arranged in a mold 32.

5 The mold 32 comprises a top member 38 extending parallel to a bottom member 38'. The mold 32 comprises two spaced apart end 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.

10 Each of the end press members 36 are connected to a connection member 34 that is attached to an actuator 32. Each 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 structure and the second wall structure of building construction element 2.

15 Fig. 4C illustrates a cross-sectional view of the building construction element 2 arranged in the mold 32 shown in and explained with reference 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.

20 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.

25 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).

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.

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;
- 5    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.

10    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  
15    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.

20    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".  
25

The second step is:  
"Determining the required load bearing capacity of the intermediate structures of the building construction element 2 in order to fulfill pre-  
30    defined requirements"

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"

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.

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 P

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.

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.

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:

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

Where:

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

$E$  is Young's modulus of the column material,

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

$L$  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.

15 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.

20 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 and
- 25 c) several partition plates 42 (only one is indicated) forming a third wall structure of the building construction element 2.

30 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

- 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 reinforcement structures 54 constituting flange members extending along the inside portion of a second wall structure.

- 5      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.
- 10     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  
15     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.  
20     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.

25     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  
30     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'.

- 5 During the production process, the largest components are typically produced first. After shrinkages, the smaller components will typically be produced.

10 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 -<br>535kg/m <sup>3</sup> | B -<br>535kg/m <sup>3</sup> | C -<br>495kg/m <sup>3</sup> |
|---------------------------------|-------------|----------------------|-----------------------------|-----------------------------|-----------------------------|
| 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 <sup>2</sup> ] | 28.0                        | 27.2                        |                             |
| Youngs modulus                  | ISO 1209-2  | [N/mm <sup>2</sup> ] | 625                         | 626                         |                             |
| Tensile strength                | ISO 527-2   | [N/mm <sup>2</sup> ] | 9.5                         |                             |                             |
| Thermal expansion coefficient * | TMA-analyse | [µm/m*K]             | 54                          |                             |                             |
| Tg. **                          | TMA-analyse | [°C]                 | 95                          |                             |                             |

(\*) = as measured between 25°C and 60°C

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

15

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.

20

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 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, 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 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 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 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.

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'.

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.

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       |
| 5  | 4, 4', 4''    | First outer plate                   |
|    | 6, 6', 6''    | Second outer plate                  |
|    | 8             | Section from a wind turbine blade   |
|    | 10, 10'       | Flange -                            |
|    | 12            | Joint                               |
| 10 | 14            | First wall structure                |
|    | 16            | Second wall structure               |
|    | 18, 18', 18'' | Insulation material                 |
|    | 20            | Wind turbine blade                  |
|    | 22            | Wind turbine                        |
| 15 | 24            | Glue                                |
|    | 26, 26'       | Section of a wind turbine blade     |
|    | 28            | Fire-resistant material             |
|    | 30            | Joint cover plate                   |
|    | 32            | Mold                                |
| 20 | 34            | Connection member                   |
|    | 36            | End press member                    |
|    | 38            | Top member                          |
|    | 38'           | Bottom member                       |
|    | 40            | Actuator                            |
| 25 | 42, 42'       | Partition plate (e.g. cement board) |
|    | 44            | Heating portion                     |
|    | 46            | Intermediate portion                |
|    | 48            | Flooring                            |
|    | 50            | Floor portion                       |
| 30 | 52            | Reinforcement member                |
|    | 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 | X                               | Longitudinal axis          |
|    | D <sub>1</sub>                  | Width                      |
|    | D <sub>2</sub>                  | Distance                   |
|    | W <sub>1</sub> , W <sub>2</sub> | Width                      |
|    | H <sub>1</sub> , H <sub>2</sub> | Height                     |
| 20 | F <sub>P</sub>                  | Force                      |
|    | F <sub>E</sub>                  | Force                      |

### Claims

1. Building construction element (2) comprising a sandwich structure comprising:
  - 5       - one or more first outer plates (4, 4', 4'') forming a first wall structure (14) of the building construction element (2), wherein the area between adjacent first outer plates (4, 4', 4'') (if any) constitutes a joint (12);
  - 10       - one or more second outer plates (6, 6', 6'') forming a second wall structure (16) of the building construction element (2, 2', 2''), wherein the area between adjacent second outer plates (4, 4', 4'') (if any) constitutes a joint (12);
  - 15       - optionally a number of flange members (10, 10') or joint cover plates (30) extending along and covering the inside portion of the joints (12) and
  - 20       - a plurality of spaced apart intermediate structures (8) each extending between:
    - a) a first flange member (10) extending along and covering the inside portion of the first wall structure (14) and a second flange member (10') extending along and covering the inside portion of the second wall structure (16) or
    - b) the first wall structure (14) and the second wall structure (16),  
**characterised in** that each intermediate structure (8) is a continuous section from a wind turbine blade (20).
- 25       2. Building construction element (2, 2', 2'') according to claim 1, wherein the first wall structure (14) extends parallel to the second wall structure (16).
- 30       3. Building construction element (2, 2', 2'') according to claim 1 or 2, wherein the flange members (10, 10') are made of a fire-resistant material.
4. Building construction element (2, 2', 2'') according to one of the pre-

ceding claims, wherein the intermediate structure (8) is at least partly covered by a fire-resistant material.

5 5. Building construction element (2, 2', 2'') according to one of the preceding claims, wherein each intermediate structure (8) extends perpendicular to the first wall structure (14) and to the second wall structure (16).

10 6. Building construction element (2, 2', 2'') according to one of the preceding claims, wherein each intermediate structure (8) is glued or mechanically attached to the flange members (10, 10') or wall structures (14, 16) between which the intermediate structure (8) extends.

15 7. Building construction element (2, 2', 2'') according to one of the preceding claims, wherein polyurethane (PUR) foam (18) or polyisocyanurate (PIR) foam (18) is filled into the space between the first wall structure (14) and the second wall structure (16).

20 8. Building construction element (2, 2', 2'') according to one of the preceding claims, wherein the building construction element (2, 2', 2'') is a wall or a horizontal division.

25 9. A building comprising a building construction element (2, 2', 2'') according to one of the preceding claims.

10. Method for manufacturing a building construction element (2, 2', 2''), the method comprising:

- 30
- forming a first wall structure (14) of the building construction element (2) from one or more (e.g. a plurality of) first outer plates (4, 4', 4''), wherein the area between adjacent first outer plates (4, 4', 4'') (if any) constitutes a joint (12);
  - forming a second wall structure (16) of the building construction element (2) from one or more (e.g. a plurality of) second outer

- plates (6, 6', 6''), wherein the area between adjacent second outer plates (6, 6', 6'') (if any) constitutes a joint (12);
- optionally arranging a number of flange members (10, 10') along the inside portion of the joints (12) and
  - 5     - arranging a plurality of spaced apart intermediate structures (8) to extend between:
    - a) 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 the inside portion of a second joint (12) the second wall structure (16),
    - 10     - filling polyurethane (PUR) foam or polyisocyanurate (PIR) foam into the space between the first wall structure (14) and the second wall structure (16) or
    - b) the first wall structure (14) and the second wall structure (16),
  - 15     **characterised in** that each intermediate structure (8) is a continuous section from a wind turbine blade (20).

11. Method according to claim 10 comprising:
- prior to construction of the building construction element (2, 2', 2'')
  - 20     defining a plurality of different types of construction elements (2, 2', 2'') having different predefined minimum required load capacity;
  - 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
  - 25     single type having a load capacity above its predefined minimum required load capacity when the suitable intermediate structures (8) are used in the building construction element (2, 2', 2'').

12. Method according to claim 11 comprising:
- 30     - 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'').



13. Method according to one of the preceding claims 10-12, wherein the first wall structure (14) extends parallel to the second wall structure (16).
- 5
14. Method according to one of the preceding claims 10-13, wherein the flange members (10, 10') are made of a fire-resistant material.
- 15
15. Method according to one of the preceding claims 10-14, wherein the intermediate structure (8) is at least partly covered by a fire-resistant material.
- 10
16. Method according to one of the preceding claims 10-15, wherein the method comprising:
- 15
- gluing or mechanically attaching each intermediate structure (8) to the flange members (10, 10') or the wall structures between which the intermediate structure (8) extends.
- 20
17. 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.

Fig. 1A

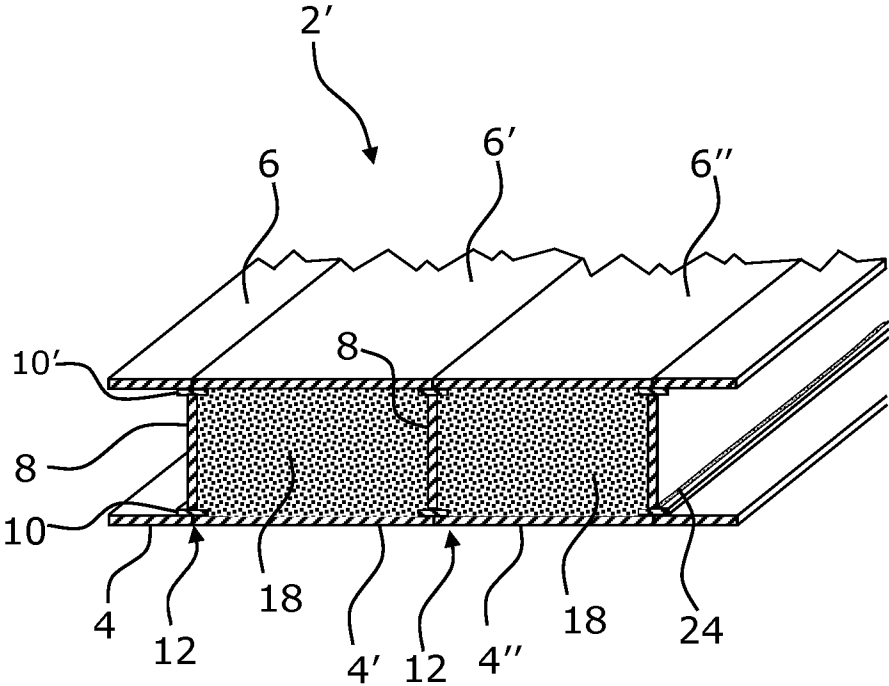
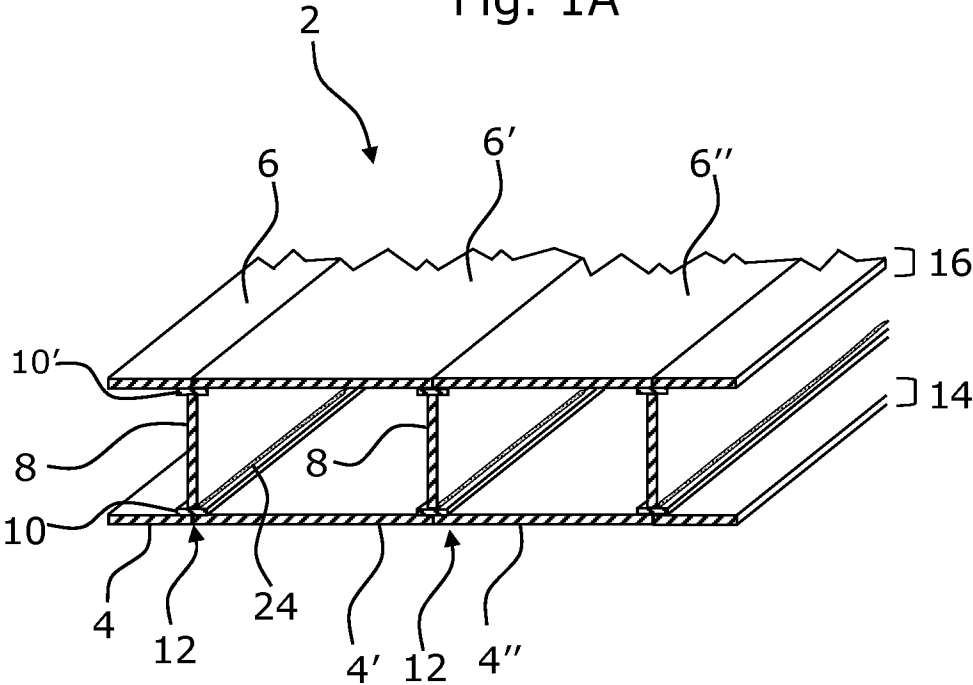


Fig. 1B



Fig. 3A

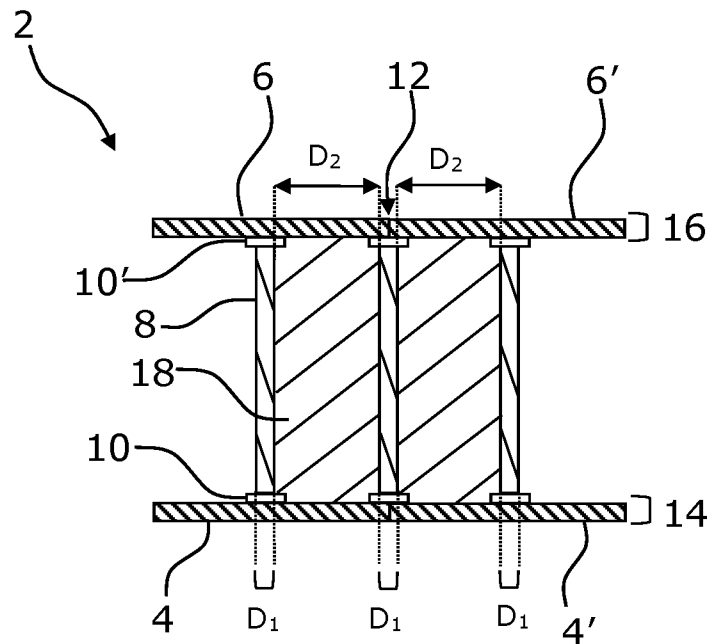
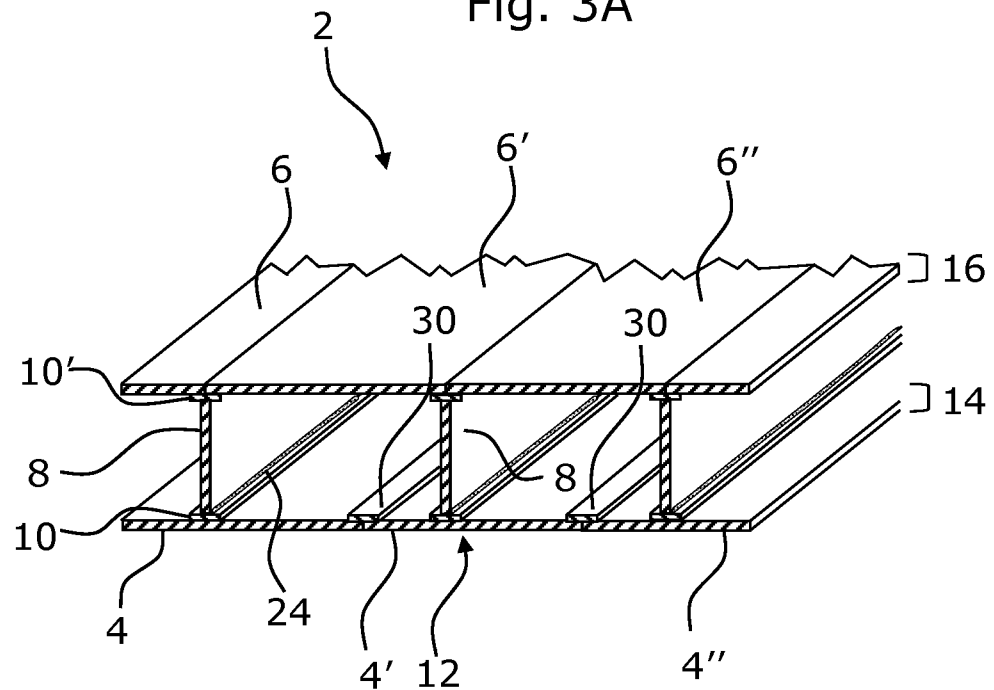


Fig. 3B

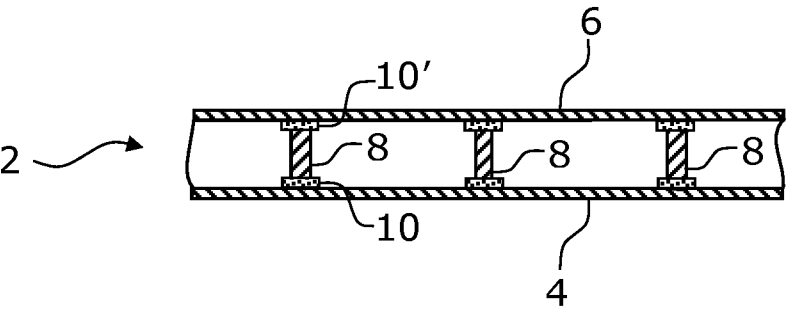


Fig. 4A

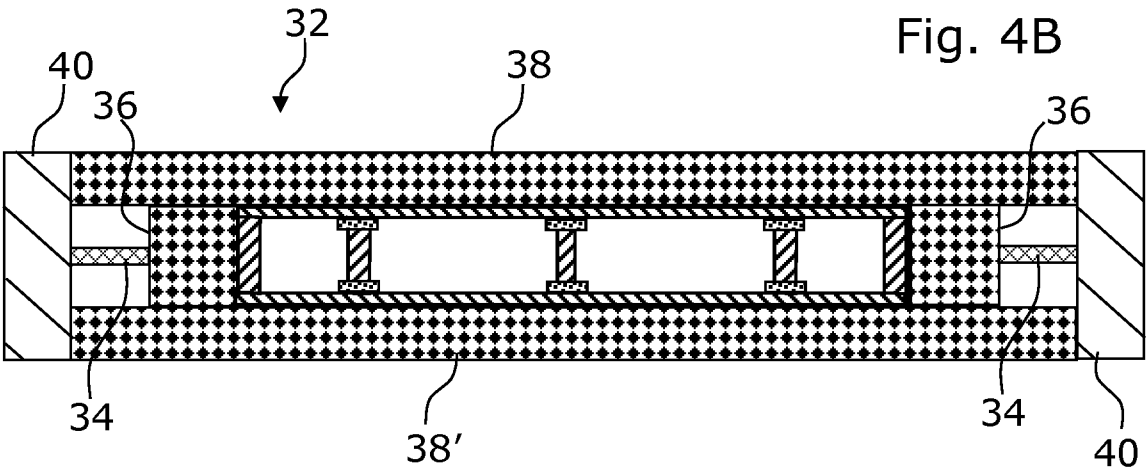


Fig. 4B

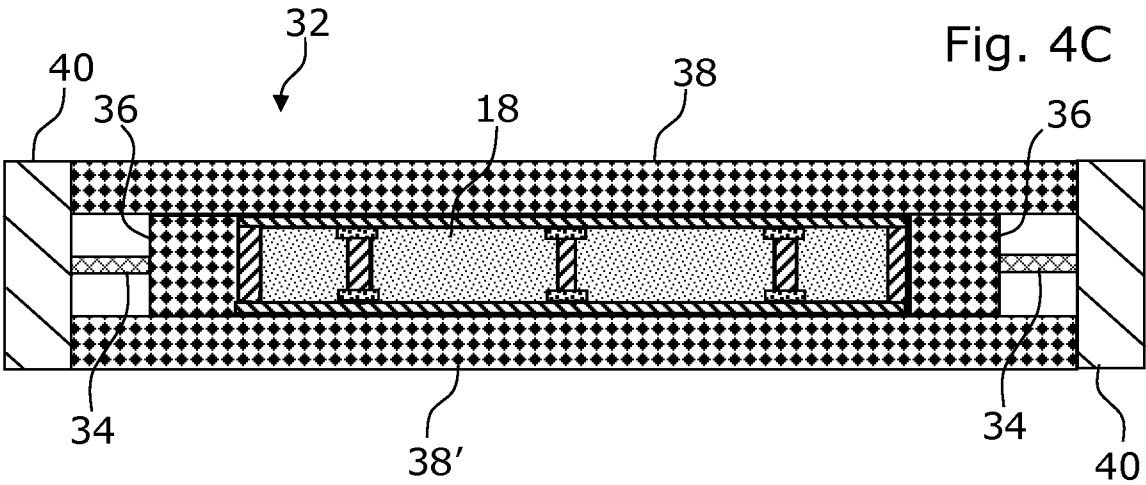


Fig. 4C

5/10

Fig. 5A

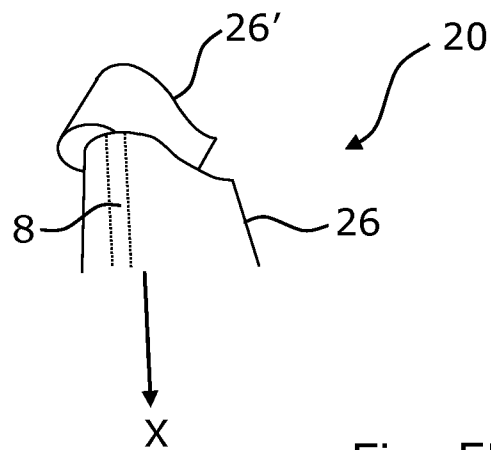
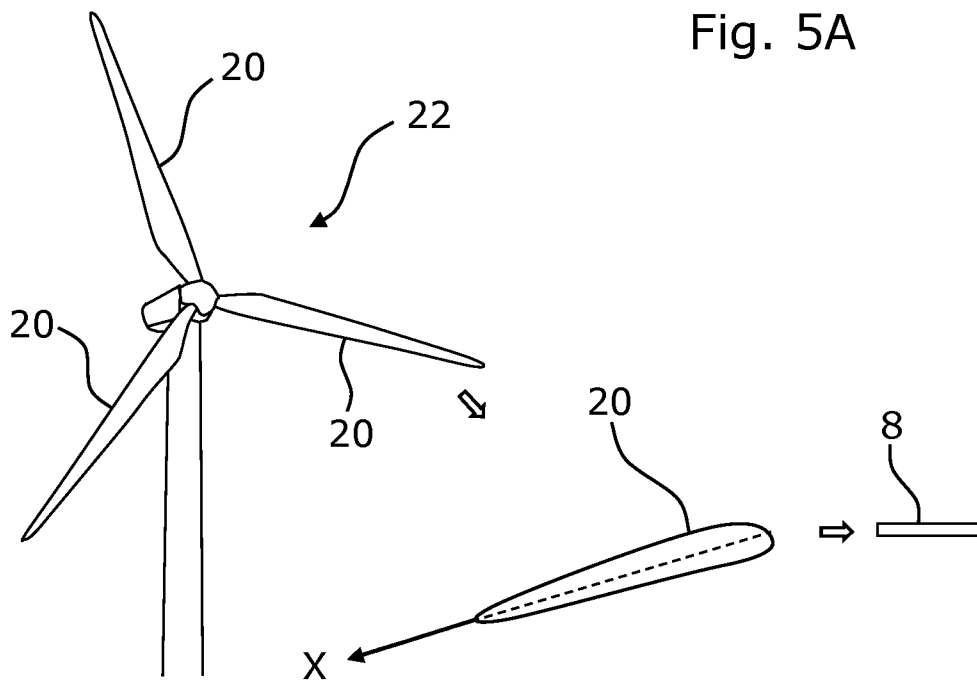


Fig. 5B

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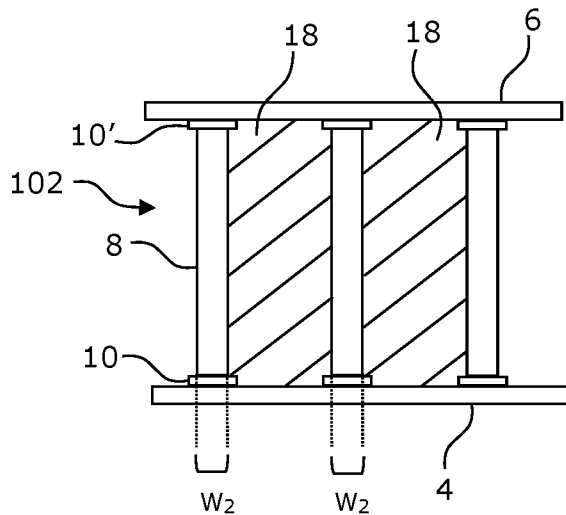


Fig. 6A

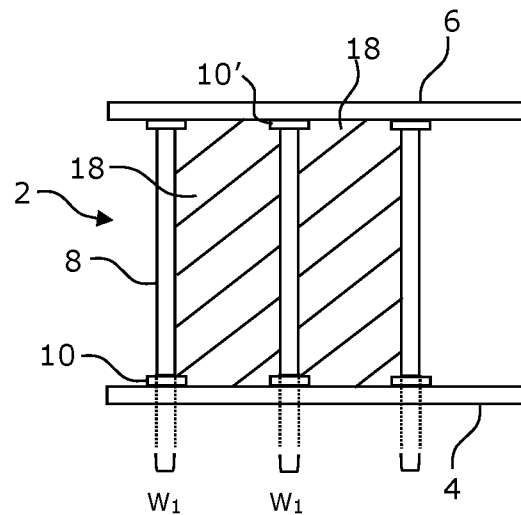


Fig. 6B

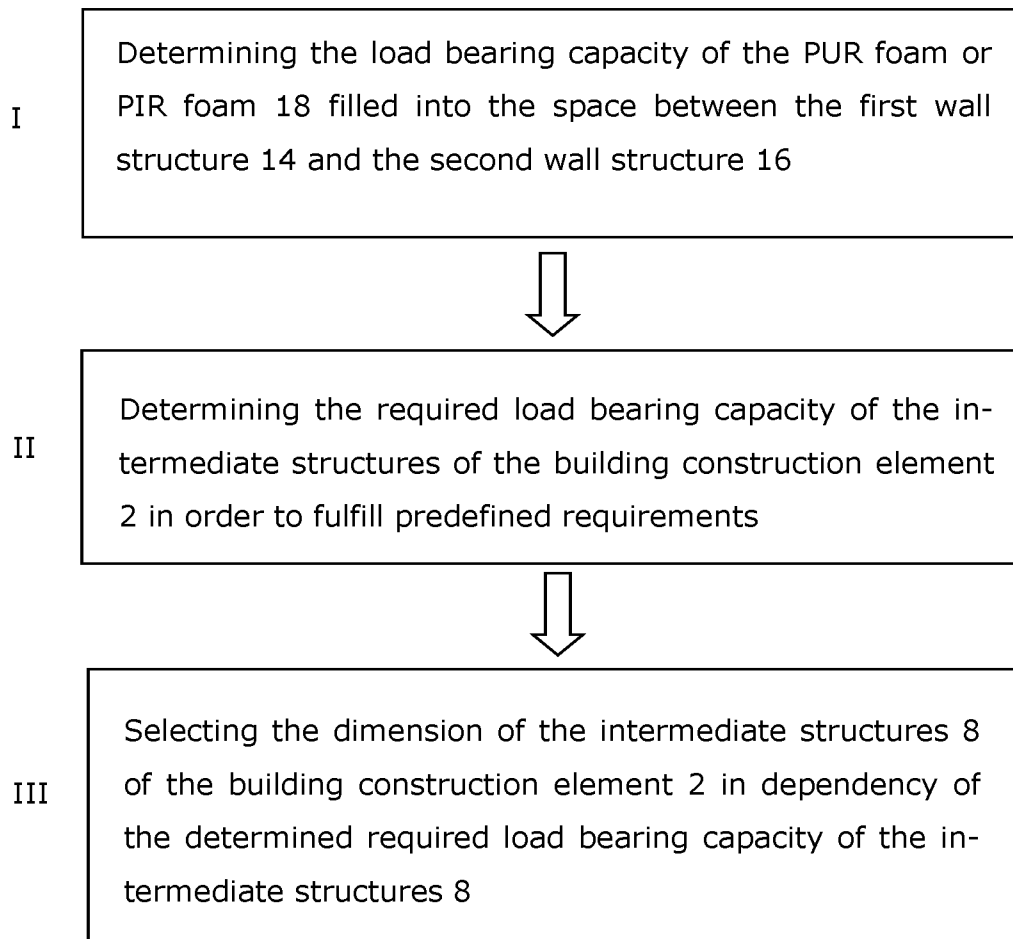


Fig. 6C

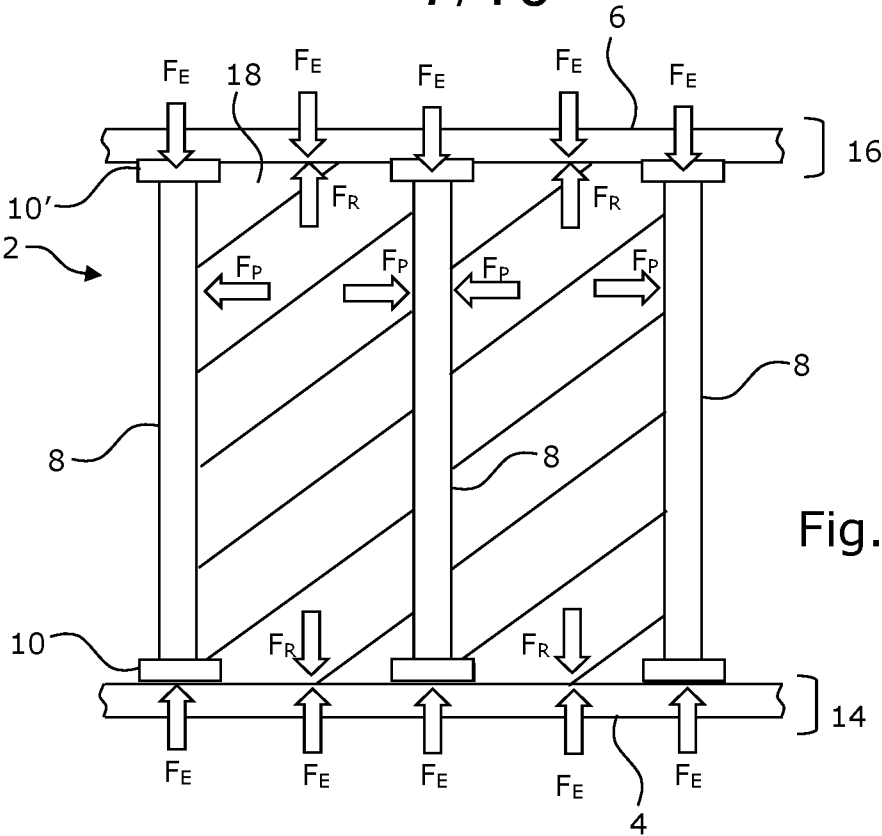


Fig. 7A

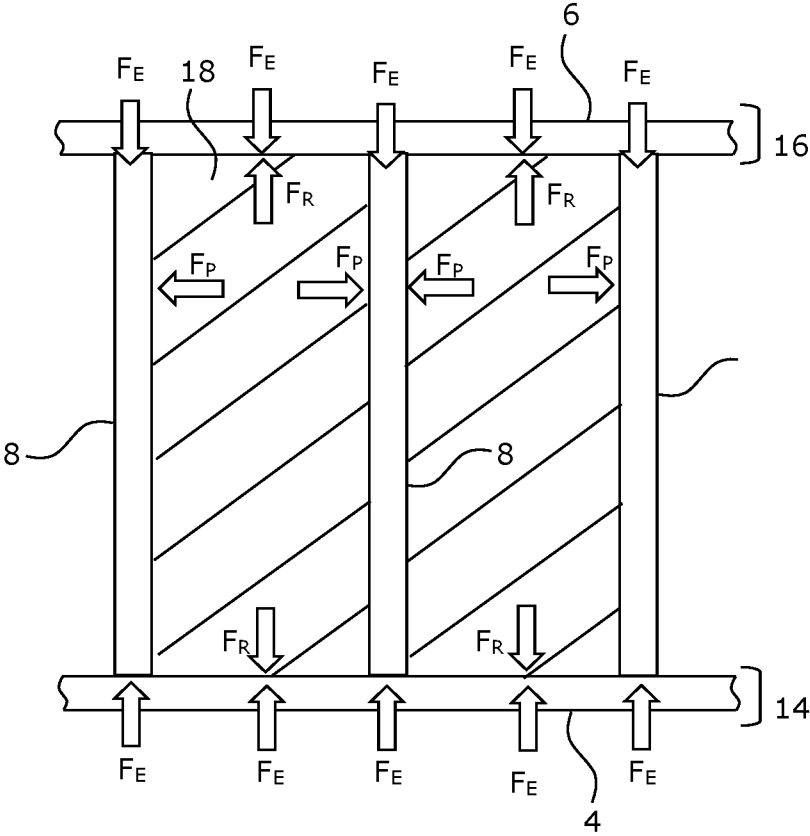


Fig. 7B



Fig. 8A

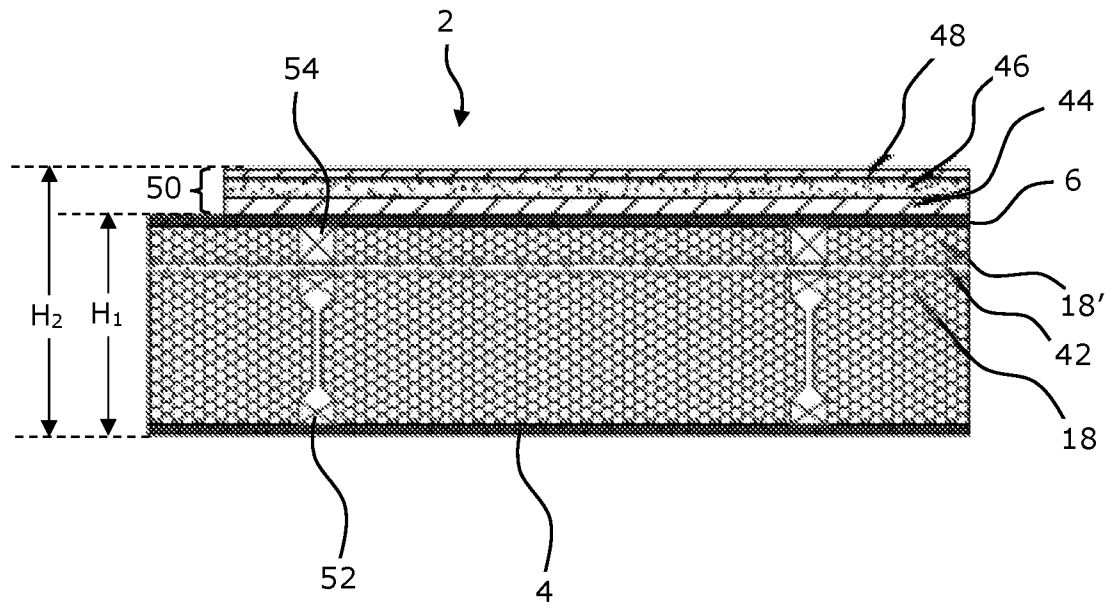


Fig. 8B

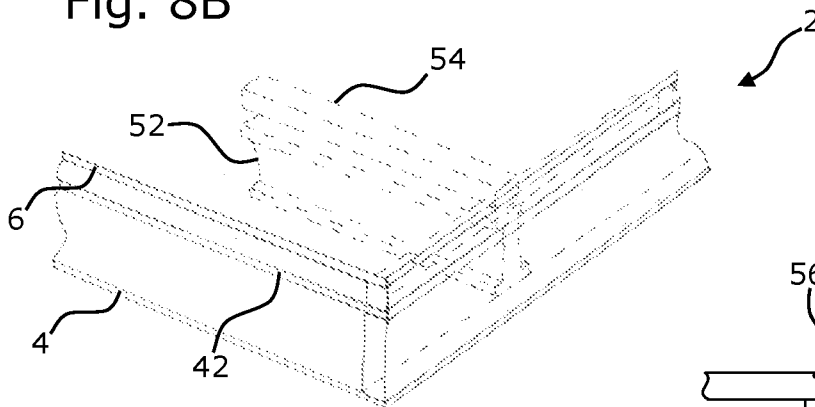
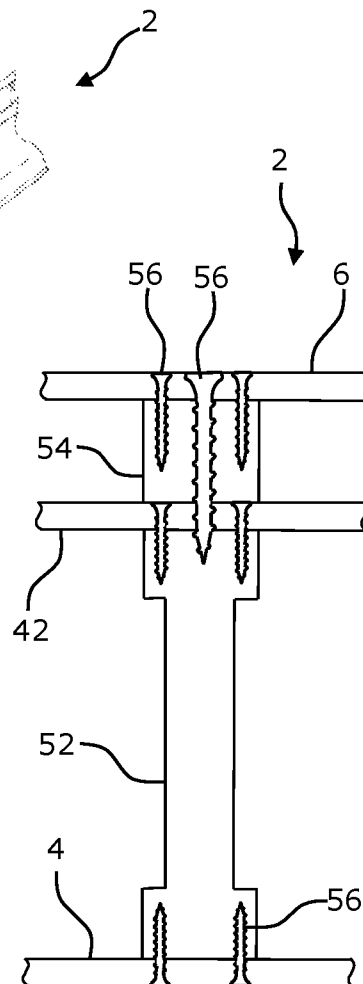


Fig. 8C



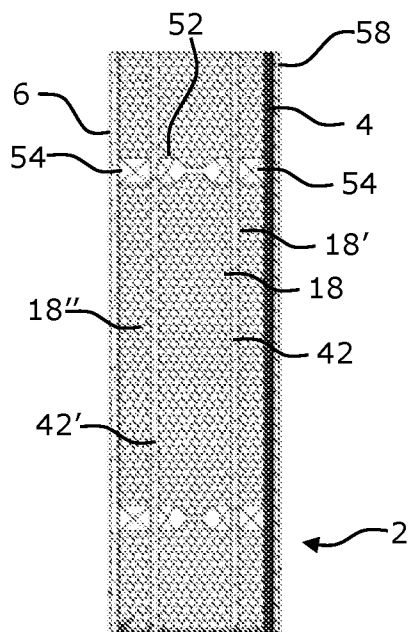


Fig. 9A

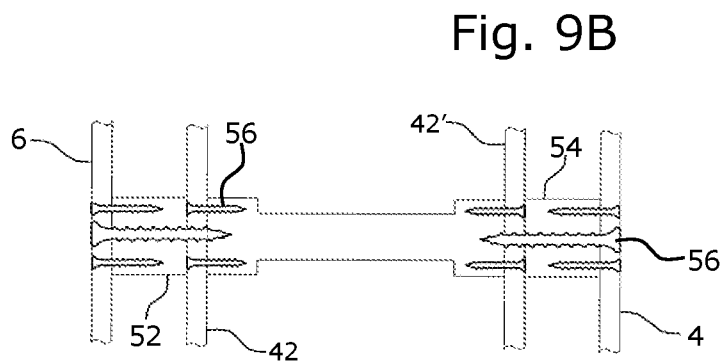


Fig. 9B

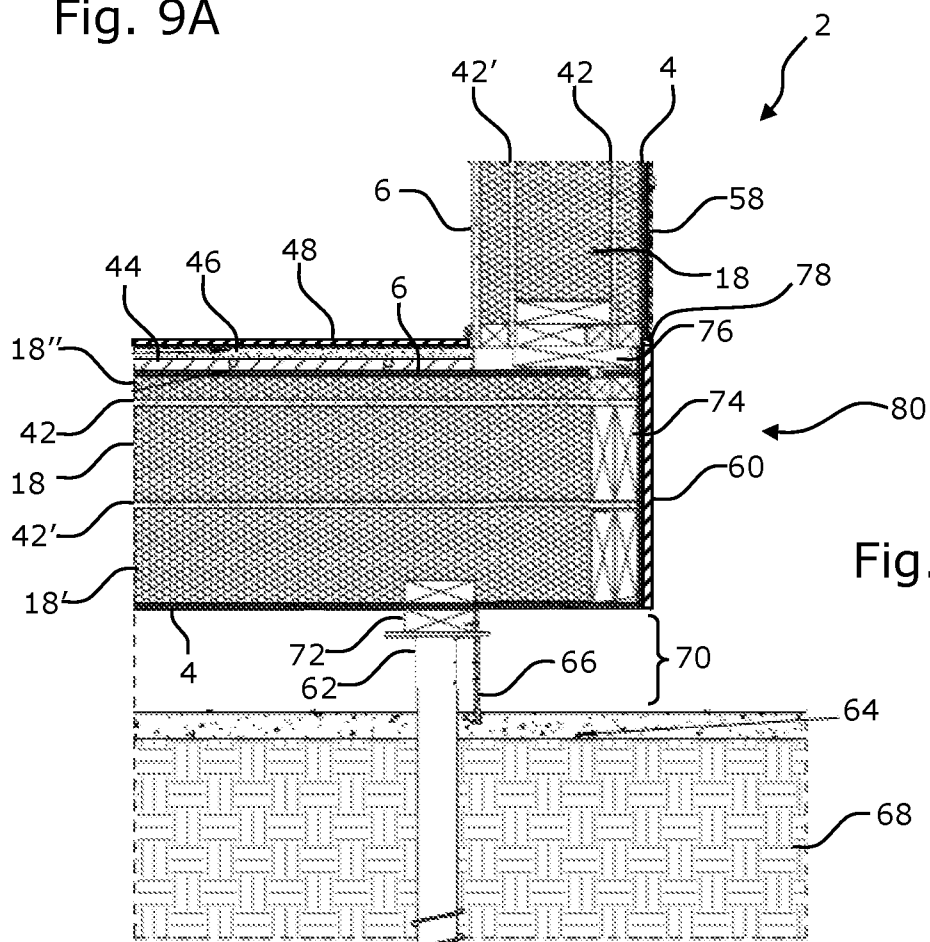
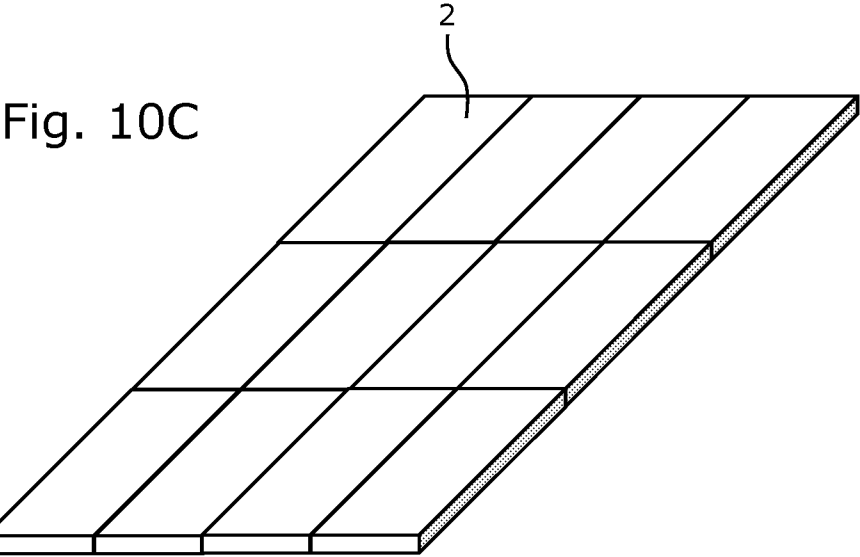
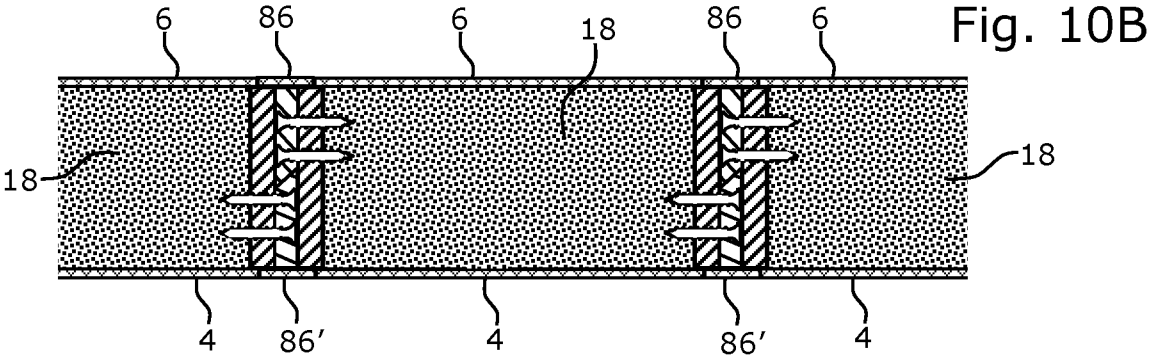
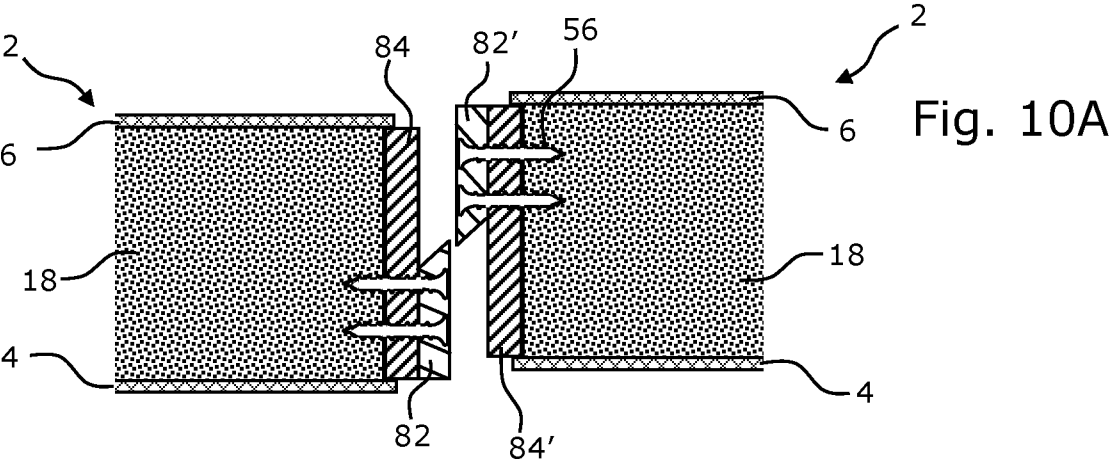


Fig. 9C



## INTERNATIONAL SEARCH REPORT

International application No.

PCT/DK2024/050134

**A. CLASSIFICATION OF SUBJECT MATTER****E04B 1/02**(2006.01)i; **E04B 1/61**(2006.01)i; **E04C 2/284**(2006.01)i; E04B 1/94(2006.01); *F03D 1/06*(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)

E04B; E04C; F03D

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, ENGLISH FULL-TEXT

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

| Category* | Citation of document, with indication, where appropriate, of the relevant passages                                                                                                    | Relevant to claim No. |
|-----------|---------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|-----------------------|
| A         | DK 202201089 A1 (SMARTPANELS APS [DK]) 17 July 2024 (2024-07-17)<br>See page 5 lines 6-8, page 6 lines 9-10 , claim 1 and figures 1A and 4A. (public available 31/05/2024).           | 1-17                  |
| A         | WO 2023088951 A1 (WINGBEAM AS [NO]) 25 May 2023 (2023-05-25)<br>See claims and figures.                                                                                               | 1-17                  |
| A         | SE 2200045 A1 (HIFORM AS [NO]) 12 May 2023 (2023-05-12)<br>See abstract, claims and figures .                                                                                         | 1-17                  |
| A         | WO 2023111367 A1 (TECNORENOVA RECICLAJE S L [ES]) 22 June 2023 (2023-06-22)<br>See paragraph [0010], claim 1 and figures.                                                             | 1-17                  |
| A         | CN 220483886 U (GUONENG UNITED POWER TECH BAODING CO LTD) 13 February 2024 (2024-02-13)<br>See Espacenet machine translation paragraph [0028], claims especially claim 8 and figures. | 1-17                  |



Further documents are listed in the continuation of Box C.



See patent family annex.

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“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

**13 August 2024**

Date of mailing of the international search report

**16 August 2024**

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**INTERNATIONAL SEARCH REPORT**  
**Information on patent family members**

International application No.  
**PCT/DK2024/050134**

| Patent document<br>cited in search report |            |    | Publication date<br>(day/month/year) | Patent family member(s) |            |    | Publication date<br>(day/month/year) |
|-------------------------------------------|------------|----|--------------------------------------|-------------------------|------------|----|--------------------------------------|
| DK                                        | 202201089  | A1 | 17 July 2024                         | WO                      | 2024114873 | A1 | 06 June 2024                         |
| WO                                        | 2023088951 | A1 | 25 May 2023                          | NONE                    |            |    |                                      |
| SE                                        | 2200045    | A1 | 12 May 2023                          | NONE                    |            |    |                                      |
| WO                                        | 2023111367 | A1 | 22 June 2023                         | ES                      | 1285027    | U  | 18 January 2022                      |
|                                           |            |    |                                      | ES                      | 1285027    | Y  | 08 April 2022                        |
|                                           |            |    |                                      | ES                      | 2944233    | A1 | 19 June 2023                         |
| CN                                        | 220483886  | U  | 13 February 2024                     | NONE                    |            |    |                                      |