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(54) CONSTRUCTION ELEMENT

(57) A construction element (1) comprises a first layer of plate shaped insulating material (3) and a second layer of plate shaped insulating material (5). The first layer of plate shaped insulating material comprises or consists of a board made of expanded polystyrene (EPS). The second layer of plate shaped insulating material comprises or consists of a board made of ligno-

cellulose fibers or cellulose fibers. The second layer of plate shaped insulating material (5) has a density of less than 70 kg/m³. The ratio of the thickness (D1) of the first layer of plate shaped insulating material to the thickness (D2) of the second layer of plate shaped insulating material is preferably between 2 and 0.5

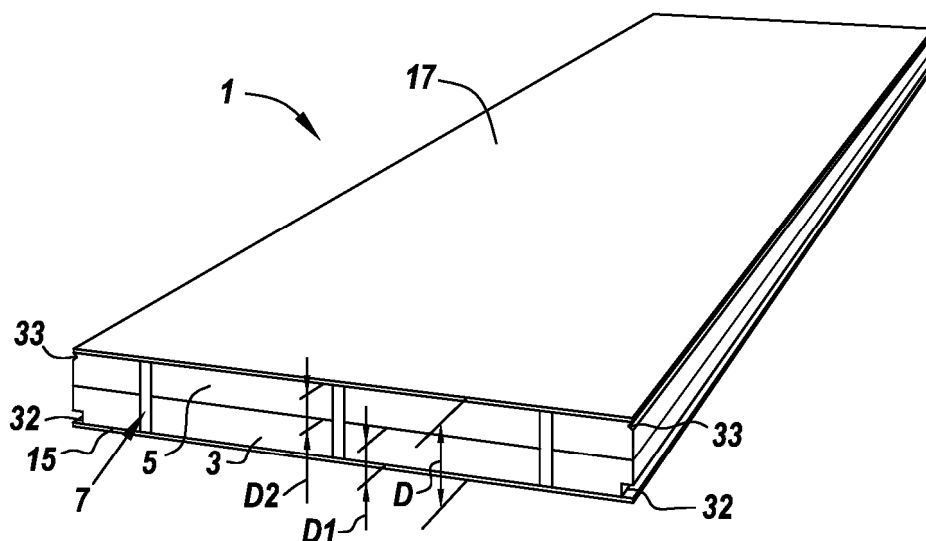


Fig. 1

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Description

[0001] The present invention relates to a thermally insulating construction element.

[0002] The construction element according to the invention comprises at least one core of insulating material. This type of construction element is known in the current prior art, for example from EP0775787, where the four edges of the construction element are reinforced by a support beam at each edge so that the construction element is self-supporting, wherein the support beams have the same height as the core of insulating material.

[0003] EP2141299 describes a construction element having at least one core of insulating material, a first support beam, and board material on both sides of the core of insulating material. Thermal bridging is prevented by the support beams in the core of insulating material not being as high as the thickness of the core of insulating material next to the support beam(s).

[0004] EP2273024 describes a construction element having at least one core of insulating material, a first support beam, an upper board, and a lower board, wherein the upper board and the lower board are acoustically decoupled from one another, in other words wherein the upper board and lower board are connected to one another via the core of insulating material and not via the first support beam. To achieve this acoustic decoupling, an air chamber is provided between the upper board and the lower board at the location of the support beam, wherein the air chamber extends over the entire length of the support beam.

[0005] NL 2022483 describes a construction element, in particular a roof element, having at least one upper board and a lower board having a core of insulating material therebetween, at least two inner support beams and at least two outer support beams, wherein the core of insulating material is provided with at least one oblong chamber that extends and, at at least one end thereof, opens into a longitudinal plane or a transverse plane for accommodating an additional support beam within the oblong chamber.

[0006] It is an object of the invention to provide a thermally insulating construction element that is ideally suited for thermal insulation and is largely bio-based.

[0007] The first aspect of the invention relates to a construction element. The construction element comprises a first layer of plate shaped insulating material and a second layer of plate shaped insulating material. The second layer of plate shaped insulating material is located above the first layer of plate shaped insulating material. The first layer of plate shaped insulating material comprises or consists of a board made of polymer foam. The second layer of plate shaped insulating material is a board comprising or consisting of lignocellulose fibers or cellulose fibers.

[0008] The construction element according to the invention has the advantage that it is produced to a large

extent from bio-based material and at the same time has a very good thermal insulation value in a thickness that is as compact as possible.

[0009] Placing the second layer of plate shaped insulating material over the first layer of plate shaped insulating material, rather than vice versa, has the advantage that less water vapor is absorbed in the construction element because the first layer of plate shaped insulating material is much more vapor impermeable than the second layer of plate shaped insulating material due to its polymer foam composition. It is desirable that such construction elements are highly vapor impermeable, so that little or no water vapor from inside the building diffuses into or through the construction element.

[0010] Since the construction element comprises the second layer of plate shaped insulating material above the first layer of plate shaped insulating material, the construction element has yet another advantage in terms of its thermal insulation properties. The lignocellulose fibers or cellulose fibers of the second layer of plate shaped insulating material provide a higher thermal resistance for the construction element due to their high specific heat capacity compared to that of the polymer foam of the first layer of plate shaped insulating material. This means, for example, that when the construction element is used as a roof element, on hot days it takes hours longer for the attic under the roof element to heat up significantly. This means that the construction element according to the invention performs better as a thermally insulating roof element. This advantage is more pronounced when a wood fiberboard is used as the second layer of plate shaped insulating material.

[0011] The second layer of plate shaped insulating material preferably comprises at least 85 percent by weight of lignocellulose fibers and/or cellulose fibers.

[0012] The construction element according to the invention preferably consists of at least 85 percent by weight and more preferably of at least 90 percent by weight of bio-based material.

[0013] The ratio of the thickness of the first layer of plate shaped insulating material to the thickness of the second layer of plate shaped insulating material is preferably between 2 and 0.5, more preferably between 0.3 and 0.7, and more preferably between 0.4 and 0.6.

[0014] Such embodiments provide a construction element that largely consists of bio-based material and has good thermal insulation performance for its thickness. The specific thermal insulation values of the second layer of plate shaped insulating material are not as good as the specific thermal insulation values of the first layer of plate shaped insulating material.

[0015] The second layer of plate shaped insulating material is preferably in contact with the first layer of plate shaped insulating material. This ensures a simple design of the construction element and easy production.

[0016] The second layer of plate shaped insulating material is preferably bonded to the first layer of plate shaped insulating material. This ensures that the construction element is easier to produce. It is then, for example, easier to mill grooves into this assembly after the second layer of plate shaped insulating material is bonded to the first layer of plate shaped insulating material in order to insert ribs that can provide the self-supporting character of the construction element.

[0017] The second layer of plate shaped insulating material can be bonded to the first layer of plate shaped insulating material using wood glue, using one-component polyurethane adhesive, using polyolefin hot melt adhesive, using polyurethane hot melt adhesive, or using pressure sensitive adhesive (PSA) hot melt adhesive.

[0018] The second layer of plate shaped insulating material is preferably at least 50 mm thick, more preferably at least 75 mm thick. This allows good ecological values to be achieved, as the construction element largely consists of bio-based material.

[0019] In the preferred construction element, the polymer foam is selected from polyisocyanurate foam, polyurethane foam, phenolic foam, expanded polystyrene (EPS) or extruded polystyrene foam (XPS). These embodiments provide good thermal insulation values for the construction element.

[0020] The use of polyisocyanurate foam in the first layer of plate shaped insulating material is in particularly desirable because polyisocyanurate has the best thermal insulation values in the thinnest thicknesses. Because the thickness of the construction element must be limited and the construction element comprises a second layer of plate shaped insulating material in addition to the first layer of plate shaped insulating material, it is desirable for the first layer of plate shaped insulating material to be thin but still have good thermal properties.

[0021] The use of polyisocyanurate or the use of polyurethane as the material of or in the first layer of plate shaped insulating material also allows the construction element to comprise larger amounts of bio-based material because polyisocyanurate and polyurethane can be produced partially or completely using bio-based polyols.

[0022] The second layer of plate shaped insulating material preferably has a density of less than 70 kg/m³, more preferably of less than 60 kg/m³, and even more preferably of less than 55 kg/m³. These embodiments provide good thermal insulation values for the construction element.

[0023] The second layer of plate shaped insulating material can be or comprise a wood fiberboard, a flax fiberboard, or a hemp fiberboard. These are bio-based materials that have good thermal insulation values. The use of a wood fiberboard has the advantage that waste wood can be used in the production of the wood fiberboard, as a result of which the ecological score of the

construction element is even better.

[0024] A preferred embodiment is characterized in that the lignocellulose fibers or the cellulose fibers are bound by a binding agent, for example by a resin or by a textile binding fiber. Examples of textile binding fibers that can be used are bicomponent fibers, for example bicomponent polyester fibers.

[0025] These embodiments have the advantage that by using the binding agent, the second layer of plate shaped insulating material has sufficient stiffness and integrity for use in the construction element.

[0026] The second layer of plate shaped insulating material can comprise a flame-resistant additive, for example an ammonium salt. It is an advantage that the construction element thus has improved flame-retardant properties. Due to its composition, the first layer of plate shaped insulating material has good to very good flame-retardant properties. This is intrinsically not the case for lignocellulose or cellulose-based products, such as the second layer of plate shaped insulating material. The addition of, for example, at least 5 percent by weight (and preferably less than 15 percent by weight) of a flame-resistant additive, for example an ammonium salt, ensures good flame-retardant properties of the second layer of plate shaped insulating material.

[0027] The construction element preferably comprises one or more ribs. These ribs ensure the stiffness of the construction element and the self-supporting character thereof, for example for use as a self-supporting roof element.

[0028] The ribs are preferably integrated into the first layer of plate shaped insulating material and the second layer of plate shaped insulating material.

[0029] The rib or ribs preferably do not protrude above the top surface of the second layer of plate shaped insulating material.

[0030] The rib or ribs preferably do not protrude above the bottom surface of the first layer of plate shaped insulating material.

[0031] A preferred construction element is characterized in that the one or more ribs pass through the first layer of plate shaped insulating material and through the second layer of plate shaped insulating material.

[0032] A preferred construction element is characterized in that at least one of the one or more ribs is in contact with the first layer of plate shaped insulating material and with the second layer of plate shaped insulating material on one side, preferably on both sides.

[0033] This contact is preferably a contact with a seal, for example, by means of a foaming sealant. This increases the thermal insulation capacities of the construction element.

[0034] It is possible, for example, to provide polyurethane foam material in the vertical separation between the first layer of plate shaped insulating material and the second layer of plate shaped insulating material on the one hand and the rib on the other hand. This poly-

urethane can be applied as a liquid, after which it foams and provides the insulating seal between the first layer of plate shaped insulating material and the second layer of plate shaped insulating material on the one hand and the rib on the other hand.

[0035] The ribs are preferably wood-based or comprise wood-based material. The ribs can be, for example, wooden beams or CLT (construction laminated timber).

[0036] The rib(s) can preferably comprise an uppermost beam and a lowermost beam, wherein the uppermost beam is located above the lowermost beam in the direction perpendicular to the construction element, wherein the uppermost beam is connected to the lowermost beam by means of one or more stiffening plates or stiffening ribs so that the rib forms a reinforcement rib in the construction element.

[0037] Such embodiments have the advantage that less thermal bridging occurs through the construction element due to the presence of the ribs. This means that the thermal insulation performance of such construction elements is better.

[0038] Preferably, there is thermally insulating material between the uppermost beam and the lowermost beam. Said thermally insulating material can be, for example, polyisocyanurate, polyurethane, polystyrene, such as expanded polystyrene or extruded polystyrene, phenolic foam, perlite, vermiculite, foam glass, glass wool, rock wool, wood wool, flax wool, sheep's wool, down feathers, wood fiber, flax fiber, or flake foam.

[0039] These embodiments have the advantage that the thermal insulation value of the construction element is even better.

[0040] Preferably, the entire space between the uppermost beam and the lowermost beam is filled with thermally insulating material.

[0041] These embodiments have the advantage that the thermal insulation value of the construction element is even better.

[0042] The thermally insulating material located between the uppermost beam and the lowermost beam is preferably bio-based. As a result, the mass percentage of bio-based material in the construction element is even higher.

[0043] The uppermost beam and the lowermost beam are preferably wood-based or comprise wood-based material. The uppermost beam and the lowermost beam can be, for example, wooden beams or CLT (construction laminated timber).

[0044] The one or more stiffening plates are preferably at least partially made of CPL (continuous pressed laminate) or HPL (high-pressure laminate) or particle board or wood fiberboard or gypsum board or plastics material sheet or plywood or LVL (laminated veneer lumber) or OSB (oriented strand board) or gypsum fiberboard. CPL is relatively stiff and is available in rolls, allowing it to be used without joints for the manufacture of stiffening plates. Other roll materials with similar me-

chanical properties that can be used for the stiffening plates are, for example, steel or aluminum, but these materials are thermally conductive.

[0045] The construction element according to the invention preferably comprises a lower board. More preferably, this is a lower board made of wood-based material, for example of particle board, of wood fiberboard, for example HDF (high density fiberboard) or MDF (medium density fiberboard), of OSB (oriented strand board), of CLT (construction laminated timber), or of multiplex board.

[0046] The use of a lower board contributes to the self-supporting character of the construction element.

[0047] The use of a lower board made of wood-based material ensures that the mass percentage of bio-based material in the construction element is even higher.

[0048] The first layer of plate shaped insulating material is preferably in contact with the lower board.

[0049] More preferably, the first layer of plate shaped insulating material is bonded to the lower board.

[0050] These embodiments simplify the method for producing the construction element. The first layer of plate shaped insulating material can be bonded to the lower board, after which the second layer of plate shaped insulating material can be attached, for example by bonding to the first layer of plate shaped insulating material. If ribs are attached, then grooves can be milled through the second layer of insulating material and the first layer of insulating material, and the ribs can be attached. These ribs can be bonded to the lower board or attached to the lower board in another way.

[0051] The construction element according to the invention preferably comprises an upper board. More preferably, this is an upper board made of wood-based material, for example of particle board, of wood fiberboard, for example HDF (high density fiberboard) or MDF (medium density fiberboard), of OSB (oriented strand board), of CLT (construction laminated timber), or of multiplex board.

[0052] The use of an upper board contributes to the self-supporting character of the construction element.

[0053] The use of an upper board made of wood-based material ensures that the mass percentage of bio-based material in the construction element is even higher.

[0054] The second layer of plate shaped insulating material is preferably in contact with the upper board. More preferably, this is a contact without bonding between the upper board and the second layer of plate shaped insulating material.

[0055] However, the upper board can be bonded to the second layer of plate shaped insulating material.

[0056] Preferably, battens are attached to the upper board.

[0057] A preferred construction element is characterized in that the first layer of plate shaped insulating material comprises a facer on the upper side and on

the underside.

[0058] The facer preferably comprises or consists of a sheet of aluminum. More preferably, the sheet of aluminum has a thickness of more than 40 micrometers, and more preferably of less than 75 micrometers, more preferably of less than 60 micrometers.

[0059] The facer can be a laminate. The laminate can preferably comprise:

- a plastics material film (that can be coated), preferably on the outside of the laminate and preferably before the outer surface of the first layer of plate shaped insulating material is formed,
- one or more aluminum sheets, wherein each aluminum sheet is at least 5 micrometers thick, and preferably less than 20 micrometers thick; and
- one or more layers of paper, preferably one or more layers of kraft paper.

[0060] Examples of first layers of insulating material that comprise a facer on the underside and on the upper side are polyisocyanurate boards and polyurethane boards.

[0061] The construction element according to the invention can comprise one or more ribs and a lower board, wherein the one or more ribs are attached to the lower board, preferably by means of an adhesive bond and/or by means of staples, nails or screws.

[0062] Such embodiments ensure good self-supporting character and good stiffness of the construction element.

[0063] The construction element according to the invention can comprise one or more ribs and an upper board, wherein the upper board is attached to the one or more ribs, preferably by means of an adhesive bond and/or by means of staples, nails or screws.

[0064] Such embodiments ensure good self-supporting character and good stiffness of the construction element.

[0065] Preferably, the thickness D of the construction element is less than 250 mm.

[0066] The construction element according to the invention can be a roof element, more preferably a pitched roof element.

[0067] The construction element can comprise one or more cutouts. More preferably, the cutouts run over the full thickness of the first layer of plate shaped insulating material and over the full thickness of the second layer of plate shaped insulating material.

[0068] The cutouts are preferably made of wood-based material. This increases the mass percentage of bio-based material in the construction element.

[0069] The construction element preferably comprises a lower board and an upper board and the cutouts are placed between the lower board and the upper board.

[0070] A preferred construction element is characterized in that at least one edge, and preferably both

edges, of the second layer of plate shaped insulating material comprises a longitudinal groove in the second layer of plate shaped insulating material.

[0071] In case of lateral contact of two such construction elements in a building structure, the longitudinal grooves in the second layer of plate shaped insulating material of the contacting construction elements can be in contact. A sealant, for example applied in a liquid state, for example liquid-applied polyurethane, can be applied to the longitudinal grooves before the building structure is sealed.

[0072] The longitudinal groove in the second layer of plate shaped insulating material preferably has a triangular cross section.

[0073] More preferably, the construction element comprises an upper board, wherein the upper board at the edge of the construction element comprising the longitudinal groove does not extend to the edge of the second layer of plate shaped insulating material parallel to the edge of the construction element comprising the longitudinal groove, so that when the construction element at the edge comprising the longitudinal groove is in contact with a second such construction element at its edge comprising the longitudinal groove, the longitudinal grooves of both construction elements are in contact. The upper board of the construction element is not in contact with the upper board of the second such insulating material at the corresponding edge, so that liquid sealant can be applied from above into both contacting longitudinal grooves.

[0074] Such embodiments have the advantage that a better performing thermally insulating construction element is obtained.

[0075] A preferred construction element is characterized in that at least one edge of the first layer of plate shaped insulating material comprises a longitudinal recess in the first layer of plate shaped insulating material, wherein the longitudinal recess is provided for connection in a building structure of two such construction elements at their edges comprising the longitudinal recesses by means of a tongue, preferably an airtight tongue.

[0076] Because the first layer of plate shaped insulating material usually has a higher stiffness than the second layer of plate shaped insulating material due to its composition, it is advantageous to provide the longitudinal recess before a tongue is placed in the first layer of plate shaped insulating material, and preferably no recess before a tongue is provided in the second layer of plate shaped insulating material.

[0077] The longitudinal recess preferably has a rectangular cross section, more preferably with a greater width than height.

[0078] The longitudinal recess is preferably open on the underside of the first layer of plate shaped insulating material.

[0079] In a construction element according to the invention comprising a lower board, the longitudinal re-

cess is preferably delimited at the bottom by the lower board.

[0080] The construction element at both edges of the first layer of plate shaped insulating material preferably comprises a longitudinal recess in the first layer of plate shaped insulating material.

[0081] A preferred construction element comprising a longitudinal groove in the second layer of plate shaped insulating material and a longitudinal recess in the first layer of plate shaped insulating material is characterized in that the cross section of the longitudinal recess is greater than the cross section of the longitudinal groove.

[0082] The second aspect of the invention relates to a building structure. The building structure comprises a first construction element according to the invention and a second construction element according to the invention. Both the first construction element and the second construction element are characterized in that at least one edge of the first layer of plate shaped insulating material comprises a longitudinal recess. In the first construction element, the edge comprising the longitudinal recess is in contact with the edge comprising the longitudinal recess of the second construction element. A tongue, preferably an airtight tongue, is attached in the two longitudinal recesses to connect the first construction element and the second construction element, preferably in an airtight manner.

[0083] Preferably, both the first contain and the second construction element comprise a longitudinal groove in their second layer of plate shaped insulating material. The longitudinal groove of the first construction element is in contact with the longitudinal groove of the second construction element, wherein these two contacting longitudinal grooves comprise a sealant, preferably polyurethane, that can be applied in a liquid state.

[0084] A preferred building structure is characterized in that both the first construction element and the second construction element have a rectangular shape with a longitudinal orientation. The first construction element is in contact along its longitudinal direction with the longitudinal direction of the second construction element.

[0085] The longitudinal direction of the first construction element and the second construction element can be oriented vertically inclined in the building structure.

[0086] Alternatively, the longitudinal direction of the first construction element and the second construction element can be horizontally oriented in the building structure.

[0087] The third aspect of the invention relates to a roof structure comprising a construction element according to any of the preceding embodiments of the first aspect of the invention, or comprising a building structure according to any of the preceding embodiments of the second aspect of the invention. The roof structure is preferably a pitched roof structure.

[0088] One aspect of the invention further relates to a construction element according to any of the preceding embodiments of the first aspect of the invention, wherein the first layer of plate shaped insulating material is located on top of the second layer of plate shaped insulating material and is preferably in contact therewith, more preferably in bonded contact.

[0089] With a view to better demonstrating the characteristics of the invention, the following, as an example without any restrictive character, describes some preferred embodiments, with reference to the accompanying drawings, wherein:

Fig. 1 shows a construction element according to the invention;

Fig. 2 shows a rib that can be used in construction elements according to the invention;

Fig. 3 shows a building structure according to the invention;

Fig. 4 shows a roof structure according to the invention; and

Fig. 5 shows a detail of the roof structure of Fig. 4.

[0090] Fig. 1 shows an example of a construction element 1 according to the invention. The construction element 1 comprises a first layer of plate shaped insulating material 3 and a second layer of plate shaped insulating material 5. The second layer of plate shaped insulating material 5 is in contact with and bonded to the first layer of plate shaped insulating material 3.

[0091] The first layer of plate shaped insulating material 5 is a board made of polymer foam. An example of such a first layer of plate shaped insulating material is a polyisocyanurate insulating board comprising facers on the upper side and on the underside of the board. Said polyisocyanurate insulating board has a density of 35 kg/m³.

[0092] The second layer of plate shaped insulating material is a board comprising or consisting of lignocellulose fibers or cellulose fibers. An example of a second layer of plate shaped insulating material that can be used in construction elements according to the invention is a wood fiberboard, for example having a density of 50 kg/m³. Said wood fiberboard comprises 6 percent by weight of ammonium salt as a flame retardant and 5 percent by weight of textile binding fibers (in this case bicomponent polyester fibers) that provide the stiffness of this second layer of plate shaped insulating material.

[0093] In the example of Fig. 1, the thickness D1 of the first layer of plate shaped insulating material is 96 mm and the thickness D2 of the second layer of plate shaped insulating material is 100 mm.

[0094] The construction element 1 of the example of

Fig. 1 comprises a lower board 15 made of particle board having a density of 630 kg/m^3 . In the example, the lower board 15 is 12 mm thick. In the example, the first layer of plate shaped insulating material 3 is bonded to the lower board 15.

[0095] The construction element 1 of the example of Fig. 1 comprises an upper board 17 made of particle board having a density of 630 kg/m^3 . In the example, the upper board 17 is 12 mm thick. The upper board 17 is in contact with the second layer of plate shaped insulating material 5 but is not bonded thereto.

[0096] The total thickness D of the construction element of Fig. 1 is therefore 220 mm.

[0097] The construction element 1 comprises a number of ribs 7. In the example, the ribs 7 are wooden beams having a height of 196 mm and a width of 28 mm.

[0098] The ribs 7 are attached to the lower board 17 by means of an adhesive bond. Alternatively or additionally, the ribs 7 can be attached to the lower board by means of nails, staples or screws.

[0099] The ribs 7 pass through the first layer of plate shaped insulating material 3 and through the second layer of plate shaped insulating material 5. Polyurethane foam material (not indicated in the figure) can be provided in the vertical separation between the first layer of plate shaped insulating material and the second layer of plate shaped insulating material on the one hand and the rib on the other hand. This polyurethane is applied as a liquid, after which it foams and provides the insulating seal between the first layer of plate shaped insulating material and the second layer of plate shaped insulating material on the one hand and the rib on the other hand.

[0100] The upper board 17 is attached to the ribs 7 by means of an adhesive bond. Alternatively or additionally, the upper board 17 can be attached to the ribs 7 by means of staples, nails or screws.

[0101] At both edges, the first layer of plate shaped insulating material 3 comprises a longitudinal recess 32. In the example, the longitudinal recesses 32 have a rectangular cross section with a greater width than height.

[0102] The longitudinal recesses 32 are open on the underside of the first layer of plate shaped insulating material 3. The longitudinal recesses 32 are delimited at the bottom by the lower board.

[0103] The longitudinal recesses 32 are provided for connection in a building structure of two such construction elements at their edges comprising the longitudinal recess by means of a tongue, preferably an airtight tongue.

[0104] At both edges of the second layer of plate shaped insulating material 5, the construction element 1 comprises a longitudinal groove 33 having a triangular cross section. The longitudinal groove 33 is provided on the upper side of the second layer of plate shaped insulating material 5. As is evident in Fig. 1,

the upper board 17 at the edge of the construction element comprising the longitudinal groove 33 does not extend to the edge of the second layer of plate shaped insulating material 5 parallel to the edge of the construction element comprising the longitudinal groove. In a building structure where two such construction elements are in contact at their edges, this allows liquid sealant to be applied from above between the upper boards into the contacting longitudinal grooves of the contacting construction elements.

[0105] Fig. 2 shows an example of a rib 7 that can be used in construction elements according to the invention. The rib 7 comprises an uppermost beam 8 and a lowermost beam 9. The uppermost beam 8 is located above the lowermost beam 9 in the direction perpendicular to the construction element. The uppermost beam 8 is connected to the lowermost beam 9 by means of stiffening plates 10 or stiffening ribs. As a result, the rib forms a reinforcement rib for the construction element. The uppermost beam 8 and the lowermost beam 9 are, for example, wooden beams.

[0106] Thermally insulating material 11 is placed between the uppermost beam 8 and the lowermost beam 9. This can be, for example, polyisocyanurate, polyurethane, polystyrene, such as expanded polystyrene or extruded polystyrene, phenolic foam, perlite, vermiculite, foam glass, glass wool, rock wool, wood wool, flax wool, sheep's wool, down feathers, wood fiber, flax fiber, or flake foam.

[0107] The ribs of Fig. 2 can be used to replace the "full" ribs of the construction element of Fig. 1.

[0108] Fig. 3 is an expanded view of an example of a building structure according to the invention. The building structure is a pitched roof structure. The building structure comprises two construction elements 1 according to the invention. The reference signs have the same meaning as in Fig. 1. The construction elements comprise cutouts 30, in the example over the full thickness of the first layer of plate shaped insulating material 3 and over the full thickness of the second layer of plate shaped insulating material 5.

[0109] The two construction elements 1 comprise recesses 32 on their sides in the first layer of plate shaped insulating material 3. An airtight tongue 45 is attached in these recesses 32 for the airtight connection of the two construction elements 1.

[0110] Fig. 4 shows a roof structure 40 according to the invention under construction. The roof structure comprises a limited number of purlins 24. Construction elements 1 according to the invention are attached to the purlins 24. Battens 20 can be attached to the construction elements 1 in advance. Next, tile battens 22 can be attached, followed by a roof covering, for example roof tiles 21.

[0111] As shown more clearly in detailed Fig. 5, the construction elements 1 comprise recesses 32 on their sides in the first layer of plate shaped insulating material 3. An airtight tongue 45 is attached in these recesses

32 for the airtight connection of the construction elements 1. Fig. 5 shows that the construction elements 1 comprise ribs as illustrated in Fig. 2.

[0112] At the edge of the second layer of plate shaped insulating material 5, the construction elements 1 also comprise a longitudinal groove 33 having a triangular cross section. The longitudinal groove 33 is provided on the upper side of the second layer of plate shaped insulating material 5. The upper board 17 at the edge of the construction element comprising the longitudinal groove 33 does not extend to the edge of the second layer of plate shaped insulating material 5 parallel to the edge of the construction element. Sealant 34 is applied from above, between the upper boards 17, in the contacting longitudinal grooves 33. This allows the building structure to be well sealed. The sealant 34 can be applied as a liquid polyurethane that subsequently hardens.

[0113] In the roof structure of Fig. 4, the construction elements are in contact with one another in the longitudinal direction. The longitudinal direction of said construction elements is oriented vertically inclined in the roof structure.

[0114] However, it is also possible that, in a roof identical to the one shown in Fig. 4, the longitudinal direction of the roof elements is horizontally oriented instead of inclined.

[0115] The invention further relates to the following list of numbered paragraphs:

1.- A construction element, wherein the construction element (1) comprises a first layer of plate shaped insulating material (3) and a second layer of plate shaped insulating material (5), wherein the second layer of plate shaped insulating material is located above the first layer of plate shaped insulating material;

wherein the first layer of plate shaped insulating material comprises or consists of a board made of polymer foam;

wherein the second layer of plate shaped insulating material comprises or consists of a board made of lignocellulose fibers or cellulose fibers;

wherein the ratio of the thickness (D1) of the first layer of plate shaped insulating material to the thickness (D2) of the second layer of plate shaped insulating material is preferably between 2 and 0.5, and more preferably between 0.3 and 0.7.

2.- The construction element according to paragraph 1, characterized in that the second layer of plate shaped insulating material (5) is in contact with the first layer of plate shaped insulating material (3).

3.- The construction element according to any of the preceding paragraphs, characterized in that the second layer of plate shaped insulating material (5) is bonded to the first layer of plate shaped insulating material (3).

4.- The construction element according to any of the preceding paragraphs, characterized in that the second layer of plate shaped insulating material is at least 50 mm thick, and preferably at least 75 mm thick.

5.- The construction element according to any of the preceding paragraphs, characterized in that the polymer foam is selected from polyisocyanurate foam, polyurethane foam, phenolic foam, expanded polystyrene (EPS) or extruded polystyrene foam (XPS).

6.- The construction element according to any of the preceding paragraphs, characterized in that the second layer of plate shaped insulating material (5) has a density of less than 70 kg/m³, and preferably less than 60 kg/m³, and more preferably less than 55 kg/m³.

7.- The construction element according to any of the preceding paragraphs, characterized in that the second layer of plate shaped insulating material (5) is or comprises a wood fiberboard, a flax fiberboard or a hemp fiberboard.

8.- The construction element according to any of the preceding paragraphs, characterized in that the lignocellulose fibers or the cellulose fibers are bound by a binding agent, for example by a resin or by a textile binding fiber, for example by a bicomponent fiber, for example a bicomponent polyester fiber.

9.- The construction element according to any of the preceding paragraphs, characterized in that the second layer of plate shaped insulating material (5) comprises a flame-resistant additive, for example an ammonium salt.

10.- The construction element according to any of the preceding paragraphs, characterized in that the construction element comprises one or more ribs (7).

11.- The construction element according to paragraph 10, characterized in that the one or more ribs (7) pass through the first layer of plate shaped insulating material (3) and through the second layer of plate shaped insulating material (5).

12.- The construction element according to para-

graph 10 or 11, characterized in that at least one of the one or more ribs (7) is in contact with the first layer of plate shaped insulating material (3) and with the second layer of plate shaped insulating material (5) on one side, preferably on both sides, wherein said contact is preferably a contact with a seal, preferably by means of a foaming sealant.

13.- The construction element according to any of the preceding paragraphs, characterized in that the rib(s) comprise(s) an uppermost beam (8) and a lowermost beam (9), wherein the uppermost beam is located above the lowermost beam in the direction perpendicular to the construction element, wherein the uppermost beam is connected to the lowermost beam by means of one or more stiffening plates (10) or stiffening ribs so that the rib forms a reinforcement rib in the construction element.

14.- The construction element according to paragraph 13, characterized in that thermally insulating material (11), for example polyisocyanurate, polyurethane, polystyrene, such as expanded polystyrene or extruded polystyrene, phenolic foam, perlite, vermiculite, foam glass, glass wool, rock wool, wood wool, flax wool, sheep's wool, down feathers, wood fiber, flax fiber, or flake foam, is located between the uppermost beam (8) and the lowermost beam (9).

15.- The construction element according to any of the preceding paragraphs, characterized in that the construction element comprises a lower board (15), preferably made of wood-based material, for example of particle board, of wood fiberboard, for example HDF (high density fiberboard) or MDF (medium density fiberboard), of OSB (oriented strand board), of CLT (construction laminated timber), or of multiplex board.

16.- The construction element according to paragraph 15, characterized in that the first layer of plate shaped insulating material (3) is in contact with the lower board (15), wherein the first layer of plate shaped insulating material is preferably bonded to the lower board.

17.- The construction element according to any of the preceding paragraphs, characterized in that the construction element comprises an upper board (17), preferably made of wood-based material, for example of particle board, of wood fiberboard, for example HDF (high density fiberboard) or MDF (medium density fiberboard), of OSB (oriented strand board), of CLT (construction laminated timber), or of multiplex board.

18.- The construction element according to para-

graph 17, characterized in that the upper board (17) is in contact with the second layer of plate shaped insulating material (5).

19.- The construction element according to paragraph 18, characterized in that said contact of the upper board (17) with the second layer of plate shaped insulating material (5) is a contact without bonding between the upper board (17) and the second layer of plate shaped insulating material (5).

20.- The construction element according to paragraph 18, characterized in that the upper board (17) is bonded to the second layer of plate shaped insulating material (5).

21.- The construction element according to any of the preceding paragraphs 17-20, characterized in that battens (20) are attached to the upper board.

22.- The construction element according to any of the preceding paragraphs, characterized in that the first layer of plate shaped insulating material comprises a facer on the upper side and on the underside, wherein the facer preferably comprises a sheet of aluminum.

23.- The construction element according to any of the preceding paragraphs, characterized in that the construction element comprises one or more ribs (7), and in that the construction element comprises a lower board (15), wherein the one or more ribs are attached to the lower board, preferably by means of an adhesive bond and/or by means of staples, nails or screws.

24.- The construction element according to any of the preceding paragraphs, characterized in that the construction element comprises one or more ribs, and in that the construction element comprises an upper board (17), wherein the upper board is attached to the one or more ribs (7), preferably by means of an adhesive bond and/or by means of staples, nails or screws.

25.- The construction element according to any of the preceding paragraphs, characterized in that the thickness D of the construction element is less than 250 mm.

26.- The construction element according to any of the preceding paragraphs, characterized in that the construction element is a roof element, preferably a pitched roof element.

27.- The construction element according to any of the preceding paragraphs, characterized in that the

construction element comprises one or more cut-outs (30), preferably cutouts extending through the full thickness of the first layer of plate shaped insulating material and through the full thickness of the second layer of plate shaped insulating material.

28.- The construction element according to any of the preceding paragraphs, characterized in that at least one edge, and preferably both edges, of the second layer of plate shaped insulating material (5) comprises a longitudinal groove (33) in the second layer of plate shaped insulating material, wherein the longitudinal groove (33) preferably has a triangular cross section.

29.- The construction element according to paragraph 28, characterized in that the construction element comprises an upper board (17), wherein the upper board at the edge of the construction element comprising the longitudinal groove (33) does not extend to the edge of the second layer of plate shaped insulating material (5) parallel to the edge of the construction element comprising the longitudinal groove,

so that when the construction element at the edge comprising the longitudinal groove is in contact with a second such construction element at its edge comprising the longitudinal groove, the longitudinal grooves of both construction elements are in contact, wherein the upper board of the construction element at the relevant edge is not in contact with the upper board of the second such insulating material so that liquid sealant can be applied from above to both contacting longitudinal grooves.

30.- The construction element according to any of the preceding paragraphs, characterized in that at least one edge of the first layer of plate shaped insulating material (3) comprises a longitudinal recess (32) in the first layer of plate shaped insulating material, wherein the longitudinal recess is provided for connection in a building structure by means of a tongue, preferably an airtight tongue, of two such construction elements at their edges comprising the longitudinal recess.

31.- The construction element according to paragraph 30, characterized in that the longitudinal recess (32) is open on the underside of the first layer of plate shaped insulating material (3).

32.- The construction element according to any of the preceding paragraphs 30-31, characterized in that the construction element comprises a lower board (15), and in that the longitudinal recess (32) is delimited at the bottom by the lower board.

33.- The construction element according to para-

graph 28 or 29 and according to any of the preceding paragraphs 30-32, characterized in that the cross section of the longitudinal recess (32) is greater than the cross section of the longitudinal groove (33).

34.- A building structure, characterized in that the building structure (40) comprises a first construction element (1) according to any of the preceding paragraphs 30-33 and a second construction element according to any of the preceding paragraphs 30-33, wherein, in the first construction element, the edge comprising the longitudinal recess is in contact with the edge comprising the longitudinal recess of the second construction element, wherein a tongue (45), preferably an airtight tongue, is attached in these two longitudinal recesses to connect the first construction element and the second construction element, preferably in an airtight manner.

35.- The building structure according to paragraph 34, characterized in that the first construction element (1) is a construction element according to paragraph 28 or 29, and in that the second construction element (1) is a construction element according to paragraph 28 or 29, wherein the longitudinal groove (33) of the first construction element is in contact with the longitudinal groove (33) of the second construction element, wherein these two contacting longitudinal grooves (33) comprise a sealant, preferably polyurethane.

36.- The building structure according to any of the preceding paragraphs 34-35, characterized in that the first construction element and the second construction element have a rectangular shape with a longitudinal orientation, wherein the first construction element in the longitudinal direction is in contact with the longitudinal direction of the second construction element, wherein the longitudinal direction of the first construction element and the second construction element is preferably oriented vertically inclined or horizontally oriented.

37.- A roof structure, characterized in that the roof structure comprises a construction element according to any of the preceding paragraphs 1-33, or in that the roof structure comprises a building structure according to any of the preceding paragraphs 34-36, wherein the roof structure is preferably a pitched roof structure.

[0116] The present invention is by no means limited to the embodiments described above, but different variants may be realized without exceeding the scope of the invention.

Claims

1. A construction element, wherein the construction element (1) comprises a first layer of plate shaped insulating material (3) and a second layer of plate shaped insulating material (5);

wherein the first layer of plate shaped insulating material comprises or consists of a board made of polymer foam; wherein the polymer foam is expanded polystyrene (EPS); wherein the second layer of plate shaped insulating material comprises or consists of a board made of lignocellulose fibers or cellulose fibers; wherein the second layer of plate shaped insulating material (5) has a density of less than 70 kg/m³, and preferably less than 60 kg/m³, and more preferably less than 55 kg/m³; wherein the ratio of the thickness (D1) of the first layer of plate shaped insulating material to the thickness (D2) of the second layer of plate shaped insulating material is preferably between 2 and 0.5, and more preferably between 0.3 and 0.7.

2. The construction element of claim 1, **characterized in that** the second layer of plate shaped insulating material is located above the first layer of plate shaped insulating material
3. The construction element according to any of the preceding claims, **characterized in that** the second layer of plate shaped insulating material (5) is in contact with the first layer of plate shaped insulating material (3).
4. The construction element according to any of the preceding claims, **characterized in that** the second layer of plate shaped insulating material (5) is bonded to the first layer of plate shaped insulating material (3).
5. The construction element according to any of the preceding claims, **characterized in that** the second layer of plate shaped insulating material is at least 50 mm thick, and preferably at least 75 mm thick.
6. The construction element according to any of the preceding claims, **characterized in that** the second layer of plate shaped insulating material (5) is or comprises a wood fiberboard, a flax fiberboard or a hemp fiberboard.
7. The construction element according to any of the preceding claims, **characterized in that** the lignocellulose fibers or the cellulose fibers are bound by

a binding agent, for example by a resin or by a textile binding fiber, for example by a bicomponent fiber, for example a bicomponent polyester fiber.

8. The construction element according to any of the preceding claims, **characterized in that** the second layer of plate shaped insulating material (5) comprises a flame-resistant additive, for example an ammonium salt.
9. The construction element according to any of the preceding claims, **characterized in that** the construction element comprises one or more ribs (7); preferably wherein the one or more ribs are wood-based ribs.
10. The construction element according to any of the preceding claims, **characterized in that** the thickness D of the construction element is less than 250 mm.
11. The construction element according to any of the preceding claims, **characterized in that** the construction element is a roof element, preferably a pitched roof element.
12. The construction element according to any of the preceding claims, **characterized in that** the construction element comprises one or more cutouts (30), preferably cutouts extending through the full thickness of the first layer of plate shaped insulating material and through the full thickness of the second layer of plate shaped insulating material.
13. A roof structure, **characterized in that** the roof structure comprises a construction element according to any of the preceding claims, wherein the roof structure is preferably a pitched roof structure.

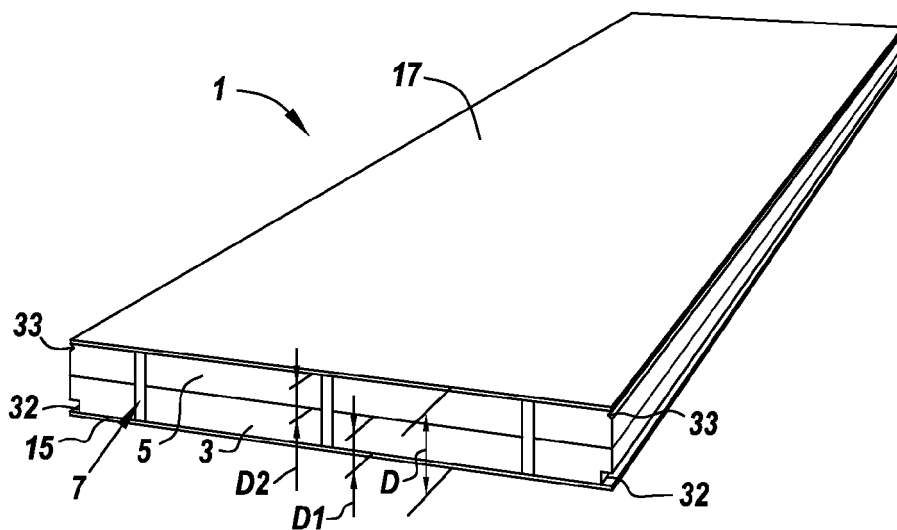


Fig. 1

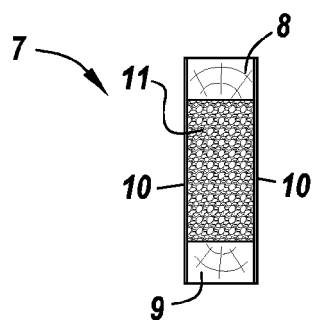


Fig. 2

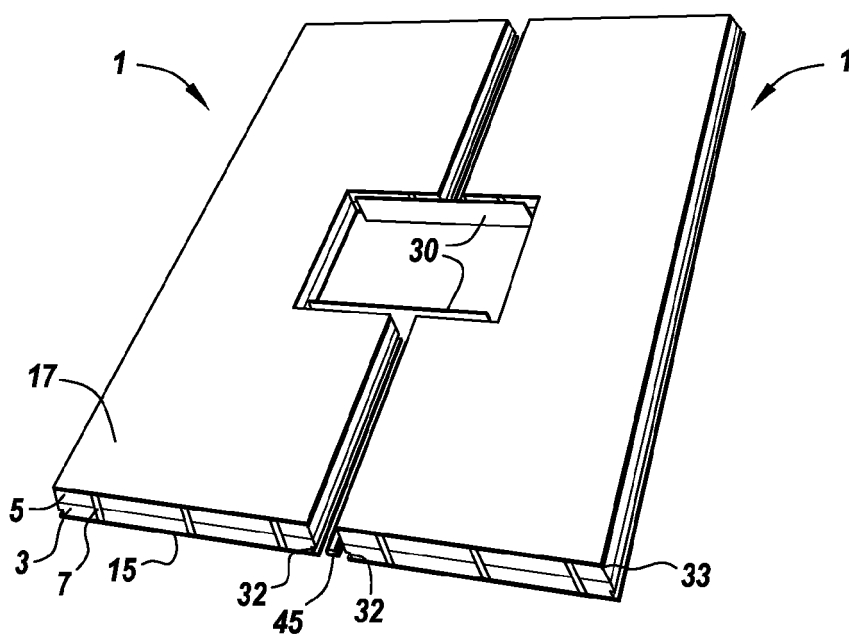


Fig. 3

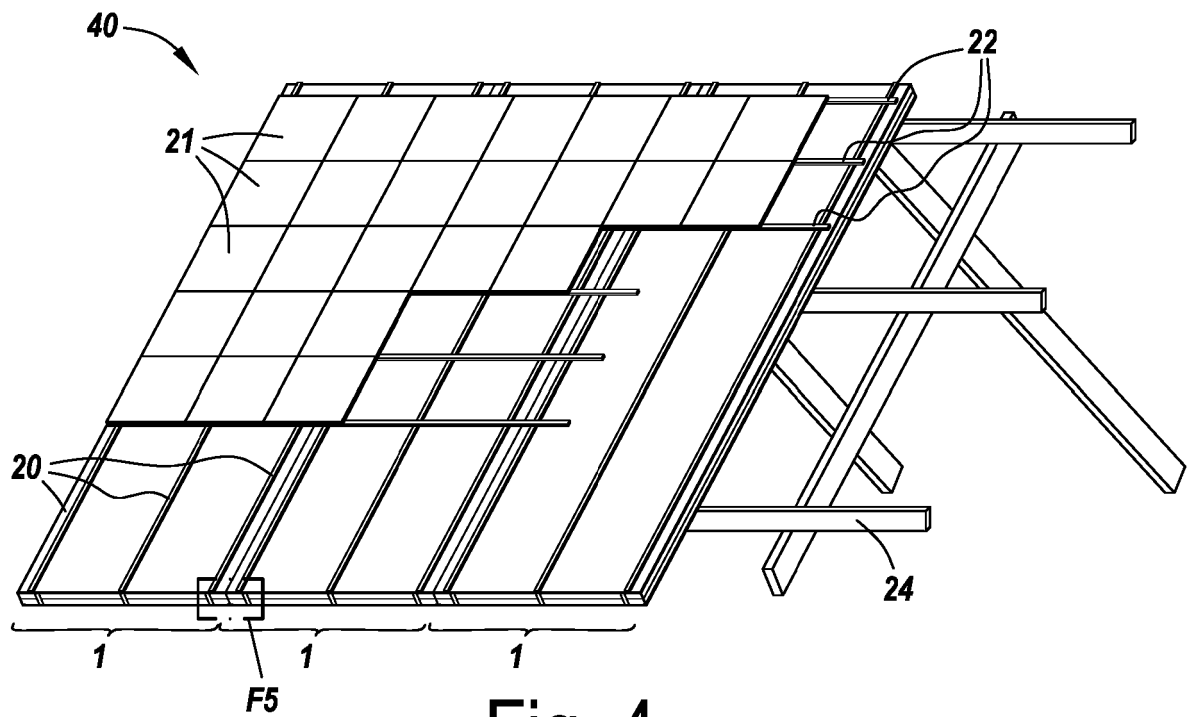


Fig. 4

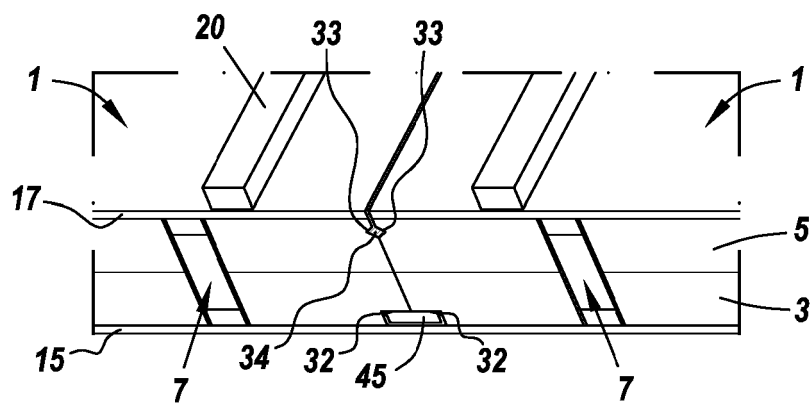


Fig. 5

REFERENCES CITED IN THE DESCRIPTION

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