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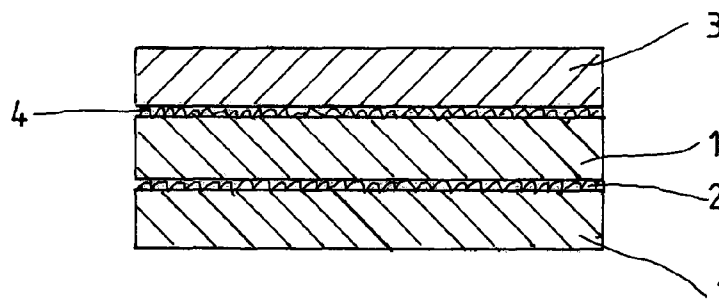
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(54) Title: INSULATING CONSTRUCTION ELEMENT, USE OF AN INSULATING CONSTRUCTION ELEMENT AND METHOD FOR MANUFACTURING AN INSULATING CONSTRUCTION ELEMENT

Fig. 1



(57) Abstract: The invention relates to an insulating construction element made of at least one board comprising fibres, aerogel particles and at least one binder. To achieve an insulating construction element which is especially easy to handle, easy to produce and which has high insulation properties the board comprises 20 to 40 per cent by weight mineral wool fibres, 45 to 70 per cent by weight aerogel particles and 8 to 12 per cent by weight binder which components are pressed and cured to the board having a density of 130 kg/m³ to 200 kg/m³.

Insulating construction element, use of an insulating construction element and method for manufacturing an insulating construction element

The invention relates to an insulating construction element made of at least one board comprising fibres, aerogel particles and at least one binder. The invention relates further to the use of an insulating construction element made of at least one board comprising components fibres, aerogel particles and at least one binder. Finally the invention relates to a method for manufacturing an insulating construction element.

Insulating construction elements made of at least one board consisting of fibres, aerogel particles and at least one binder are for example known from US 2003/0077438 A1 which describes a composite material that contains 5 to 97%-vol aerogel particles, at least one binder and at least one fibre material, the diameter of the aerogel particles being ≥ 0.5 mm. Furthermore this prior art discloses a process for manufacturing such a composite material and the use of such a composite material.

According to the prior art a composite material is manufactured in that the aerogel particles and the fibre materials are mixed with a binder, and the mixture is subjected to shaping and hardening. The fibre material may contain glass fibres as the principle component. Nevertheless, this pre-known composite material has densities of above 250 kg/m³ and is therefore not useful for a lot of applications in the building industries because of its weight. The handling of boards being made of such a composite material has the disadvantage that handling such a board by one person means that the board has to be small in size and therefore a lot of boards are needed for example to built-up a layer of insulating material. Such layers of insulating material are often used in the area of façades of buildings or in the inner parts of buildings. Nevertheless using such boards being small

in its size means that a lot of fixing material has to be used and that a lot of joints will exist which are at least thermal bridges which have to be avoided.

It is one object of the invention to provide an insulating construction element which avoids the before mentioned drawbacks of the prior art and which is especially easy to handle, easy to produce and which has high insulation properties.

According to the invention this object is achieved with an insulating construction element made of at least one board comprising fibres, aerogel particles and at least one binder, whereby 20 to 40 per cent by weight mineral wool fibres, 45 to 70 per cent by weight aerogel particles and 8 to 12 per cent by weight binder are pressed and cured to the board having a density of 130 kg/m³ to 200 kg/m³.

Such an insulation construction element can be used in a beneficial way as an insulating element for internal insulation of window and door openings, in areas behind radiators, as insulation under floors and/or for external insulation of building façades. Such an insulating construction element can be manufactured according to the invention in that a mixture of 20 to 40 per cent by weight fibres, especially mineral wool fibres, 45 to 70 per cent by weight aerogel particles and 8 to 12 per cent by weight of at least one binder is provided, the mixture is pressed into the shape of a board having a density of 130 kg/m³ to 200 kg/m³ and the board is finally cured.

A board according to the invention has a beneficial vapor permeability which makes the board suitable for internal insulation purposes. Furthermore such boards can be easily and advantageously be used for insulation purposes from inside for example for refurbishment of buildings. The high insulation value which can be achieved with such a board has the advantage that boards with small thickness can be produced having beneficial insulation properties. Such boards can therefore be used for purposes for which already well-known boards are not applicable. The net interior space will not be reduced much by using such insulation boards. Especially applications for internal insulation including window and door openings, the space behind radiators and other applications, where the room for insulation is very much limited can be insulated with high efficiency by using the insulating construction element according to the invention. Of course the insulating construction element according to the invention can also be used in the area of external insulation and as insulation under floors without drawbacks.

According to a further feature of the invention the board has a thermal conductivity λ of less than 0.022 W/(mK). To achieve an element according to the invention wherein the board has a density of 180 kg/m³ and a thermal conductivity λ of 0.019 W/(mK) or less and wherein the board comprises up to 30 per cent by weight fibres, especially mineral wool fibres, 50 to 70 per cent by weight aerogel particles, especially hydrophobic aerogel particles and up to 10 per cent by weight binder are mixed and are shaped to a board which is finally cured.

At least a part of the fibres can be other than mineral wool fibres.

A further feature of the insulating construction element according to the invention is that the binders are dry binders, especially a polar binder. The aerogel particles are hydrophobic, which ensures that the binder does not smear onto the surface of the aerogel particles, which would have a detrimental fact on the thermal conductivity. Polar binders, such as Novolac ® dry binders do not participate in binding the small-sized aerogel particles, which are highly non-polar. This has the effect that less binders are used for the provision of composites of adequate strength than is expected. Furthermore the aerogel particles are kept entrapped in a fibre "cage", where the fibres are connected by binder at crossings between fibres. Thereby the aerogel particles are kept inside the board.

Curing insulating construction elements in the shape of boards is time consuming because of the very low thermal conductivity meaning that it is difficult to transfer heat into the centre of the boards for curing of the binder in a heat press. Therefore according to a further feature of the invention the board has a thickness of less than 30 mm, especially of 20 mm or of 10 mm. Such boards can be easily cured in a short time. Having a low thermal conductivity of λ 0.019 W/(mK) such boards can be used in the before mentioned areas of limited space. Furthermore such boards with small thickness can be easily fixed to each other, especially by gluing to achieve insulating construction elements having a higher thickness of for example 40 mm to 200 mm. Such a production of insulating construction elements with higher thicknesses is more efficient and it has to be taken into account that the curing time of insulating construction elements made of the before mentioned components increases steeply with the thickness of the board to be manufactured.

The board may be provided with at least one covering layer being connected to at least one main surface of the board. As a covering layer a web, especially a thin woven or non-woven web made of glass fibres is of advantage. Such a covering layer will provide extra strength to the board and further facilitate subsequent gluing of two boards together or to a further construction element, such as a wall, for example made of plaster boards and/or usually used bricks and/or concrete. The covering layer has further the advantage that any potential dust released from the board may be reduced by such a covering layer, limiting any potential annoyance to the person handling or installing the board. Moreover the board may have an appearance of increased quality to the customer.

According to the invention such a covering layer may also function as a carrier web during production of the boards reducing the risk of damage to the boards during manufacturing them, especially prior to pressing and curing of the mixture into boards. A board according to the invention connected to a gypsum board forms a sandwich element which can be installed very quickly and with a minimum of subsequent finishing e. g. covering the system with a coating made of wallpaper and/or a paint. It is of particular interest for energy refurbishment of existing buildings that the installation of the insulation will provide at least possible disturbances, both with regard to time consumption and noise, dust release etc. during installation to the people living or working in the building. Because of the low density of the insulating construction element according to the invention together with the good thermal insulation properties which have the effect that the insulating construction element can be produced with a small thickness such boards can be used with gypsum boards of normal thickness without increasing the weight of such thermal insulation composite systems in a way that it can be easily handled by only one person.

On the other hand the insulating construction elements according to the invention can be easily installed to inner walls, for example by gluing, and subsequently provided with a finishing layer, such as a render. An insulating construction element according to the invention has a surface which is appropriate for the application of render to the boards.

Finally an insulating construction element according to the invention with the specification of the following table is of advantage:

Parameter	Value	Tolerance
Density	180 kg/m ³	± 10%
Lambda	19 m W/mK	CEN
Compression strength	≥ 5 kPa	
Delaminating strength	≥ 1 kPa	
Thickness	10 mm, 20 mm	± 1.0 mm
Length	1200 mm	± 2.0 mm
Width	600 mm	± 2.0 mm
Covering web	One/both sides	

The aerogel particulate material can be any type of aerogel. In particular, the aerogel can be organic or inorganic. In view of their fire-resistant properties, inorganic aerogels are often preferred. Organic aerogels include carbon aerogels and polymeric aerogels, which generally are cheaper than inorganic aerogels, and further generally have better insulation properties.

Prototypes were made using Cabot nanogel™ fine particle aerogel with favourable results.

The invention will be described in the following by way of example and with reference to the drawing in which

Fig. 1 is a schematic drawing of a first embodiment of an insulating construction element.

Fig. 2 is a schematic drawing of a second embodiment of an insulating construction element.

Fig. 3 is a schematic drawing of a third embodiment of an insulating construction element in connection with an inner wall of a building.

Fig. 4 is a photo of a board according to the invention.

Fig. 1 shows an insulating construction element made of two boards 1 each consisting of 30 per cent by weight mineral wool fibres, 60 per cent by weight hydrophobic aerogel particles and 10 per cent by weight polar binder. Each board 1 has a density of 135 kg/m^3 and a thermal conductivity λ of 0.019 W/(mK) . Furthermore each board 1 has a thickness of 20 mm. The boards 1 are fixed to each other by a layer 2 of an adhesive which can be a hot melt adhesive in form of a thermal plastics applied in molten form which solidifies on cooling to form strong bonds between the boards 1. The layer 2 can cover the big surface of the boards 1 in total or partly.

The insulating construction element according to figure 1 furthermore consists of a layer of a gypsum board 3 which is fixed to the big surface of one of the boards 1 by a further adhesive 4 which covers the big surface of the board 1 in total or partly.

The layer 2 between the boards 1 and the layer of adhesive 4 between the board 1 and the gypsum board 3 can be arranged on the big surfaces of the board 1 and/or the gypsum board 3 in the form of spots and/or stripes.

Figure 2 shows a further embodiment of the insulating construction element made of one board 1 having a big surface 5 on which stripes of an adhesive are arranged and on which stripes 6 a covering layer in form of a web 7 made of glass fibres is fixed.

The board 1 has the components according to the boards 1 used in the embodiment according to figure 1. The insulating construction element according to figure 2 can also have a second web 7, e.g. thin woven or non-woven glass fibre web, on the big surface 8 or on one of the lateral surfaces 9 of the board 1.

Figure 3 shows the use of a third embodiment of an insulating construction element according to the invention on an inner wall 10 of a building. The insulating construction element according to figure 3 consists of two boards 1 being arranged offset providing a shoulder 11 communicating with a shoulder 11 of a neighboring insulating construction element. Figure 3 shows two boards 1 being arranged offset to each other in the longitudinal direction of the boards 1. Nevertheless, the boards 1 being glued together can be arranged offset in two directions being arranged perpendicular to each other. The

advantage of such an insulating construction element is that thermo bridges between neighboring insulating construction elements are avoided.

Each board 1 according to the embodiment of figure 3 consists of the components according to the embodiments of figure 1 or 2. The boards 1 are fixed together by a layer 2 of an adhesive according to the description before.

After fixing the insulating construction elements to the inner wall 10, for example by gluing the boards 1 onto the inner wall so the outer side of the boards 1 are covered by a render 12. The boards 1 have a thickness of 20 mm whereas the render 12 has a thickness of 2 up to 3 mm. Finally at least the board 1 being covered by the render 12 has a delaminating strength of 1 kPa.

In Figure 4 can be seen a prototype of a board 1 according to the invention. The board 1 comprises a surface covering in the form of a web 7, which here is a non-woven glass fibre web or sheet. As can be seen the board has an open, sponge-like appearance, and the board is able to withstand some compression, depending on the density, binder content etc. In some embodiments it may be advantageous that the boards deform a little, because this flexibility may be used to absorb any unevenness of the surface that the boards are applied to. Measurements on prototype boards can be seen in Table 1 below.

No.	Ignition loss	Compression EN 826										Delamination		Thermal conductivity FOX 600			Thermal conductivity FOX 200		
		No	Density (a)	Deformation at						Ec	Density (a)	Sigma d	Lambda ₁₀	density (a)	After 1 h	Lambda ₁₀	density (a)		
				2,5kN	5,0kN	7,5kN	10,0kN	12,5kN	15,0kN										
	%	mm	kg/m³	mm	mm	mm	mm	mm	mm	kPa	kg/m³	kPa	mW/mK	kg/m³	mW/mK	mW/mK	kg/m³		
2-24	13,21	0,6	167	0,88	1,49	2,00	2,45	2,92	3,51	1187	158	5,1	18,15	158	19,44	19,21	155		
2-54	11,01	1,6	153	1,50	2,44	3,15	3,70			1112	164	2,6	18,41	160	18,84	18,54	160		
2-57	12,18	0,8	154	1,44	2,22	2,90	3,81			825	155	2,2	19,38	155	19,49	19,63	152		
2-81	12,45	0,7	144	1,41	2,15	2,83	3,78			729	156	4,1	18,35	145	19,44	19,51	144		
2-82	12,09	1,1	168	1,03	1,70	2,25	2,72	3,12	3,52	1413	158	2,2	18,48	170	18,81	18,42	170		
2-89	12,55	0,7	142	1,48	2,38	3,28				653	154	3,1	19,24	148	19,44	19,79	148		
2-70	12,22	0,6	165	1,04	1,69	2,22	2,78	3,37	3,97	1012	182	5,9	18,56	174	18,83	18,46	173		
Avg	12,24	0,9	156	1,25	2,01	2,67	3,17	3,14	3,67	980	161	3,6	18,9	159	19,2	19,1	157		
Stdev	0,66	0,4	11	0,26	0,37	0,50	0,59	0,23	0,26	271	10	1,5	0,4	11	0,3	0,6	11		
n	7	7	7	7	7	7	6	3	3	7	7	7	7	7	7	7	7		

Lambda measurements are performed on 20 mm samples in the RI lambda apparatus.

Table 1

Reference_Numerals

- | | |
|----|-----------------|
| 1 | board |
| 2 | layer |
| 3 | gypsum board |
| 4 | adhesive |
| 5 | surface |
| 6 | stripes |
| 7 | web |
| 8 | surface |
| 9 | lateral surface |
| 10 | inner wall |
| 11 | shoulder |
| 12 | render |

P a t e n t C l a i m s

1. An insulating construction element made of at least one board comprising fibres, aerogel particles and at least one binder, whereby 20 to 40 per cent by weight mineral wool fibres, 45 to 70 per cent by weight aerogel particles and 8 to 12 per cent by weight binder are pressed and cured to the board having a density of 130 kg/m³ to 200 kg/m³.
2. An element according to claim 1, wherein the board has a thermal conductivity λ of less than 0.022 W/(mK).
3. An element according to any one of the claims above, wherein the board has a density of 180 kg/m³ and a thermal conductivity λ of 0.019 W/(mK) or less and wherein the board comprises up to 30 per cent by weight fibres, especially mineral wool fibres, 50 to 70 per cent by weight aerogel particles, especially hydrophobic aerogel particles and up to 10 per cent by weight binder.
4. An element according to any one of the claims above, wherein the binder is a dry binder, especially a polar binder.
5. An element according to any one of the claims above, wherein the board has a compression strength of at least 5 kPa and/or a delaminating strength of at least 1 kPa.
6. An element according to claim 1, wherein the board has a thickness of less than 30 mm, especially of 20 mm or of 10 mm.
7. An element according to claim 1, wherein the mineral wool fibres are made of glass fibres and/or stone fibres.
8. An element according to claim 1, wherein at least two boards are fixed to each other, especially by gluing.

9. An element according to claim 1, wherein at least one main surface of the board is connected to a covering layer, such as a web, especially a thin woven or non-woven web made of glass fibres.
10. An element according to claim 1, wherein the board is connected to a gypsum board providing a sandwich element, especially as an insulation composite system.
11. Use of an insulating construction element made of at least one board comprising fibres, aerogel particles and at least one binder, whereby 20 to 40 per cent by weight fibres, especially mineral wool fibres, 45 to 70 per cent by weight aerogel particles and 8 to 12 per cent by weight binder are pressed and cured to the board having a density of 130 kg/m³ to 200 kg/m³ as an insulation element for internal insulation of window and door openings, in areas behind radiators, insulation under floors and/or external insulation of building facades.
12. A method for manufacturing an insulating construction element said method comprising the steps of:
providing a mixture of 20 to 40 per cent by weight fibres, especially mineral wool fibres, 45 to 70 per cent by weight aerogel particles and 8 to 12 per cent by weight of at least one binder,
pressing the mixture into the shape of a board having a density of 130 kg/m³ to 200 kg/m³ and
curing the board.
13. A method according to claim 11, wherein the mixture is collected on a layer forming a carrier web and wherein the mixture is pressed and cure together with the layer forming the carrier web.
14. A method according to claim 11, wherein at least two boards are fixed together after pressing and curing, especially by gluing.
15. A method according to claim 11, wherein at least one board is fixed to a gypsum board to provide a thermal insulation composite system.

Fig. 1

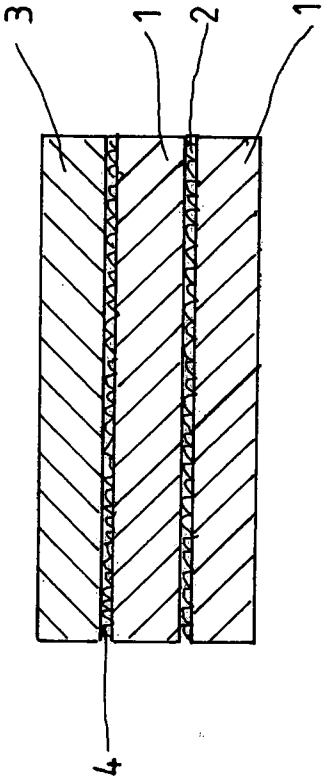


Fig. 2

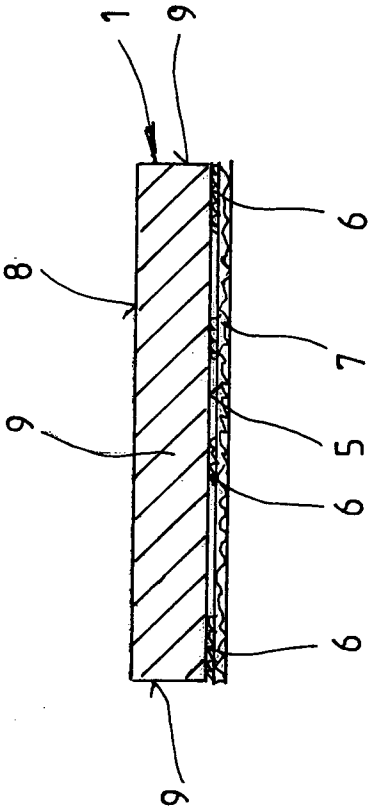
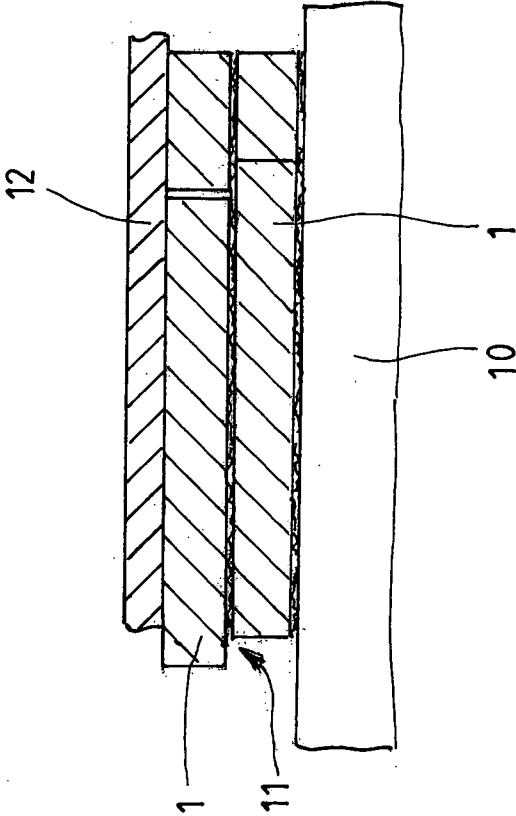


Fig. 3



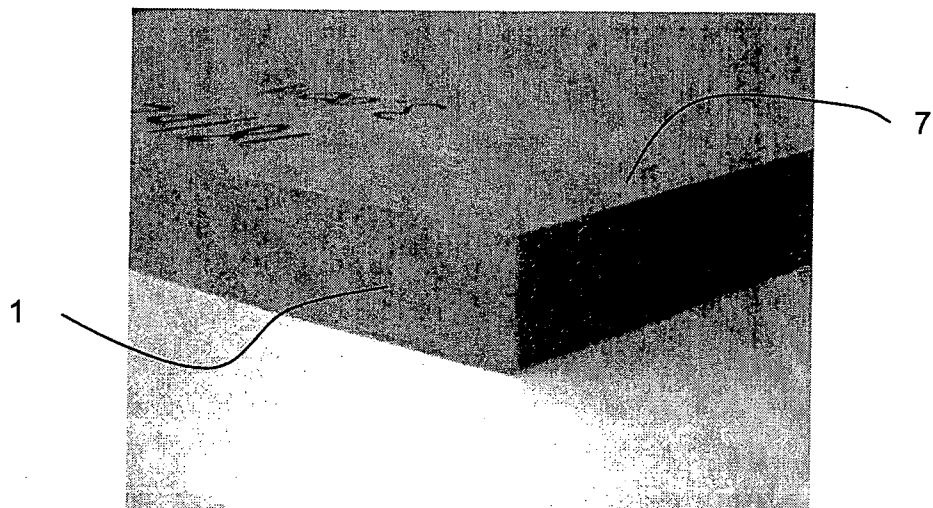


Fig. 4

INTERNATIONAL SEARCH REPORT

International application No
PCT/EP2011/002460

A. CLASSIFICATION OF SUBJECT MATTER			
INV.	B32B5/16 E04B1/80	B32B5/18 F16L59/00	B32B5/24 B32B5/26 B32B13/14
ADD.			
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) B32B E04B F16L			
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched			
Electronic data base consulted during the international search (name of data base and, where practical, search terms used) EPO-Internal , WPI Data			
C. DOCUMENTS CONSIDERED TO BE RELEVANT			
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* Special categories of cited documents : "A" document defining the general state of the art which is not considered to be of particular relevance "E" earlier document but published on or after the international filing date "L" document which may throw doubts on priority claim(s) or which is cited to establish the publication date of another citation or other special reason (as specified) "O" document referring to an oral disclosure, use, exhibition or other means "P" document published prior to the international filing date but later than the priority date claimed "T" later document published after the international filing date or priority date and not in conflict with the application but cited to understand the principle or theory underlying the invention "X" document of particular relevance; the claimed invention cannot be considered novel or cannot be considered to involve an inventive step when the document is taken alone "Y" document of particular relevance; the claimed invention cannot be considered to involve an inventive step when the document is combined with one or more other such documents, such combination being obvious to a person skilled in the art. "&" document member of the same patent family			
Date of the actual completion of the international search 12 July 2011		Date of mailing of the international search report 19/07/2011	
Name and mailing address of the ISA/ European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Fax: (+31-70) 340-3016		Authorized officer Hutton , Davi d	

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