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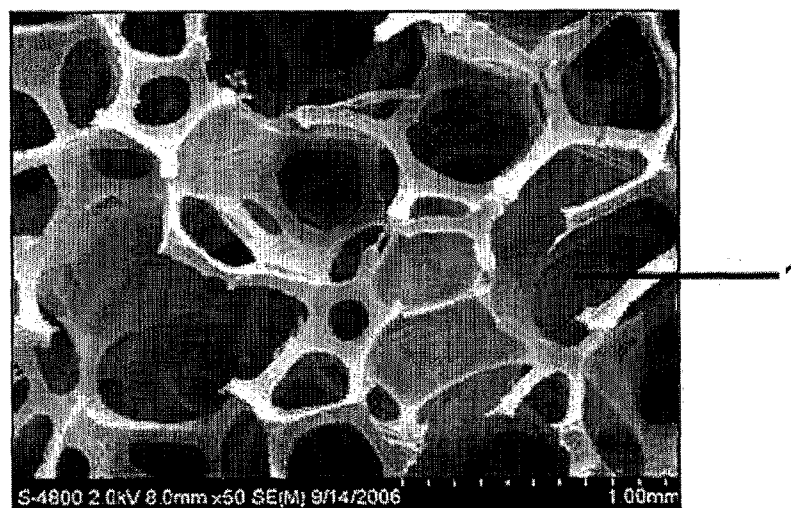
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(54) Title: AN IMPACT SOUND INSULATION MATERIAL OF FLOORS AND FLOOR CONSTRUCTION METHOD USING THE SAME

Fig.1



(57) Abstract: The present invention relates to an impact sound insulation material of floors, comprising a resin foam having a thickness of 15 mm or more and a dynamic stiffness of 0.5 to 10 MN/m³. The present invention provides the impact sound insulation material and a floor construction method using the same, which has excellent various properties such as interfloor sound proofing, shock absorption, insulation, durability and constructability by optimizing structure and properties of a resin foam included in the impact sound insulation material of floors, and also, if necessary, by forming various functional layers including a substrate sheet on one or each of both surfaces of the foam

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Description

AN IMPACT SOUND INSULATION MATERIAL OF FLOORS AND FLOOR CONSTRUCTION METHOD USING THE SAME

Technical Field

- [1] The present invention relates to an impact sound insulation material of floors and a floor construction method using the same. The impact sound insulation material of the present invention has excellent shock-absorbing property, insulation property, durability and constructability. Specially, the impact sound insulation material of the present invention can effectively absorb noise and vibration generated by impact, and then disperse and exhaust it.

[2]

Background Art

- [3] In a public dwelling multi-story building such as a multiplex house, row house-type villa, a building, an apartment, a school, a hospital and a dormitory, persons dwell in upper and lower stories. Thus, any impact applied from an upper story or any noise generated by the impact gives serious inconvenience to a person in a lower story. Such impact and noise is referred to as a floor impact sound, which means sound and shock generated by vibration of a slab caused by drop or movement of an article or walk of a person. A structure-borne sound generated in the above case is transferred to various positions with very small attenuation, and thereby vibrate a surface of a structure, so that the structure-borne sound is recognized as a directly reflected air-borne sound to a person in a lower story.
- [4] Recently, an interfloor noise caused by the floor impact sound is recognized as an important factor that determines the quality of dwelling environments. That is, while the demands of consumers on comfortable dwelling environment is continuously increased, a material used for a floor structure of a multi-story building is gradually thinner and lighter, so that an interior noise source is rather increased. As the problem caused by the floor impact sound is highlighted as an important social issue, various studies for developing a noise proofing material such as an impact sound insulation material of floors (also called as 'a material of impact sound insulation of floors' are actively made such that the material is installed to a wall or floor of a multi-story building to absorb, disperse and exhaust impact and noise applied from an upper floor to a lower floor or a side.
- [5] For example, Korean Patent Registration No. 166,993 discloses a floor construction

method, in which a rubber material mixed with an adhesive material is spread on a slab, a polyethylene foam sponge is laminated thereon to form a blocking layer, and then a floor material is formed on the foam sponge. Also, Korean Laid-open Patent Publication No. 2006-38862 discloses a thermoplastic foam material having expanded cells with a predetermined foaming magnitude and a predetermined diameter, which can be used as an impact sound insulation material of floors in a building.

[6] In the above prior arts, resin foams are used as a member for reducing the interfloor noise. The resin foams have been used for insulation or shock absorption, and examples thereof may include polyethylene foam, polystyrene foam or polyvinyl chloride foam. However, although the above conventional foam may provide insulation and shock absorption to some extent, it does not provide satisfactory effects in absorbing, dispersing and exhausting a floor impact noise that is a main cause of interfloor noise.

[7] Meanwhile, other important properties required to a noise proofing material are durability and constructability. Generally, when constructing a building floor, a noise proofing material is laminated on a concrete slab floor, and then, an autoclaved lightweight concrete layer and a mortar layer are placed and cured thereon. However, if the noise proofing material is in direct contact with the autoclaved lightweight concrete layer as mentioned above, aging of the noise proofing layer is promoted to shorten the life span thereof. In addition, hitherto known impact sound insulation materials have low supporting force but high softness and flexibility, so that it is difficult to select a construction position or handle the material. Thus, the conventional impact sound insulation material makes the construction with a large size difficult, and it takes much time for construction. Additionally, there are problems in that the conventional impact sound insulation material is weak against local load transferred from an upper story by a heavy furniture product or the like, so that it may be easily collapsed.

[8] Due to the above problems, there is need for developing an impact sound insulation material that ensures excellent sound (noise) proofing property, durability and constructability together.

[9]

Disclosure of Invention

[10] The present invention is related to an impact sound insulation material of floors comprising a resin foam with a thickness of 15 mm or more and a dynamic stiffness of 0.5 to 10 MN/m³. The present invention provides an impact sound insulation material

of floors that is capable of effectively absorbing and exhausting noise and vibration generated by impact and also ensuring excellent durability and constructability by optimizing a structure and properties of the resin foam used therein. The impact sound insulation material may be used as an inter-floor noise-proofing material.

[11] Hereinafter, the impact sound insulation material of floors according to the present invention will be explained in more detail.

[12] The impact sound insulation material according to the present invention includes a resin foam, and the resin foam may provide insulation property and shock absorbing property together with noise proofing property to the impact sound insulation material of floors. In the present invention, the resin foam has a thickness of 15 mm or more, preferably 20 to 60 mm, more preferably 20 to 40 mm, most preferably 20 to 30 mm. If the thickness is less than 15 mm, noise proofing property such as an impact noise blocking property of the material may be deteriorated. Generally, as the thickness of the resin foam is increased, impact sound and vibration may be better absorbed and dispersed. However, if the thickness is too large, constructability may be deteriorated. In this reason, a resin foam currently commercially used as an impact sound insulation material has a thickness of about 60 mm at maximum. However, in the present invention, properties of the resin foam are enhanced using a substrate sheet and other functional layers, which will be described later, so that thick resin foams can also be applied to actual construction.

[13] In the present invention, the resin foam also has a dynamic stiffness of 0.5 to 10 MN/m³, more preferably 0.5 to 7 MN/m³, most preferably 0.5 to 2 MN/m³. The dynamic stiffness of materials is a value indicating a dynamic elastic property of materials, which may be measured by a standard KS specification regulated in Korean Industrial standards (KS F 2868). If the dynamic stiffness is less than 0.5 MN/m³, a physical resistance against stress is deteriorated, so that cracks in a floor finishing surface may be generated due to deformation caused by an upper load during construction or use. In addition, if the dynamic stiffness exceeds 10 MN/m³, an impact sound decreasing effect may be deteriorated though the foam may be ensured stably.

[14] If the resin foam has the above properties, its kind is not specially limited in the present invention. However, in order to ensure more excellent noise proofing property, durability and constructability, the resin foam of the present invention is preferably an open cell-containing resin foam of which a volume percentage of open and closed cells is 20% or more, or a resin foam having a 3-dimensional net structure formed of micro fiber (also called 'a net-type resin foam').

- [15] A first aspect of the foam resin applicable in the present invention is the open cell-containing resin foam. The term “open cell” used above means a cell contained in the resin foam, and includes all kind of cells at least partially opened. The term “volume percentage of open and closed cells” means a ratio of volumes occupied by open cells to volumes occupied by the entire cell of the foam (the volume of the open cell/the volume of the entire cell). FIG. 1 shows a structure of an open cell 1 according to one aspect of the present invention. Such an open cell is included in soft foams, and, in final foam forming stage, a wall of the cell is broken to make the cell into an elastic structure in the form of a cobweb. In the present invention, the volume percentage of open and closed cells is preferably 40% or more, more preferably 60% or more, and most preferably 80% or more. In addition, an upper limit of the volume percentage of open and closed cells is not specially limited, but for example 90%. A noise proofing property is improved as the volume percentage of open and closed cells is increased. If the volume percentage of open and closed cells is less than 20%, a connection path between the cells is decreased, which may deteriorate noise proofing. If the volume percentage of open and closed cells exceeds 90%, hardness and/or durability of the foam may be deteriorated too much. Further, in the present invention, the open cell included in the open cell-containing resin foam preferably has a diameter of 0.05 to 2.0 mm. If the diameter is less than 0.05 mm, a space capable of dispersing and exhausting noise is decreased, which may deteriorate noise proofing property. If the diameter exceeds 2.0 mm, density is decreased too much, which may deteriorate mechanical properties.
- [16] The open cell-containing resin foam preferably has a density in the range of 2.0 to 30.0 Kg/m³, more preferably 10.0 to 30.0 Kg/m³, in view of mutual compensation of noise proofing, mechanical properties and shock absorption. If the density is less than 2.0 Kg/m³, mechanical properties and shock absorption may be deteriorated in spite of excellent noise proofing. If the density exceeds 30 Kg/m³, noise proofing may be deteriorated in spite of advantageous mechanical properties and shock absorption.
- [17] In addition, the open cell-containing resin foam of the present invention preferably has hardness (compression strength) in the range of 5 to 50 Kgf/314cm², more preferably 5 to 22 Kgf/314cm². If the hardness is less than 5 Kgf/314cm², the foam may have too great softness, which may cause a floor to collapse due to a load applied from an upper portion. If the hardness exceeds 50 Kgf/314cm², an impact sound blocking effect may be deteriorated though mechanical properties are ensured to some extent.

- [18] A second aspect of the resin foam applicable to the present invention is the resin foam having a 3-dimensional net structure formed by micro fibers 2 as shown in FIG. 2. In the resin foam, as shown in FIG. 2, the micro fibers 2 are collected in a 3-dimensional net structure, and spaces 3 foamed by the micro fibers 2 are not blocked but communicate with each other. Due to the 3-dimensional net structure, a specific volume (m^3/Kg) of the resin foam is increased, and a noise transmission path is lengthened to provide an excellent noise proofing property, and also insulation property and shock absorbing property are improved. Specifically, noise and vibration generated by an impact and transferred to the foam are decreased while passing through a long path along the micro fibers 2, and at the same time absorbed and dispersed into the wide spaces 3, thereby being effectively blocked. In addition, the spaces 3 foamed by the ultra fibers 2 in the net-type resin foam may gather sufficient air, and accordingly, there is an advantage in that insulation property is further improved.
- [19] The micro fiber 2 included in the net-type resin foam preferably has a diameter corresponding to 1/100 of a hair thickness of a person, specifically in the range of 0.1 to 20 μm . If the diameter is less than 0.1 μm , the mechanical property of the foam may be deteriorated, or shock absorbing property may be deteriorated due to weakening of restoring elasticity. If the diameter exceeds 20 μm , a specific volume may be decreased too much, thereby deteriorating noise proofing property. Also, the above resin foam preferably has a density of 2.0 to 30.0 Kg/m^3 , more preferably 2.0 to 25 Kg/m^3 , most preferably 2.0 to 12.0 Kg/m^3 . If the density is less than 2.0 Kg/m^3 , mechanical property or shock absorbing property of the foam may be deteriorated. If the density exceeds 30.0 Kg/m^3 , noise proofing may be deteriorated.
- [20] In the present invention, materials usable for the resin foams according to the first and second aspects are not specifically limited, if the above properties are ensured. Such resin foam may be at least one selected from the group consisting of polyurethane foam, urea foam, polyvinyl chloride foam, polypropylene foam, polyethylene foam, polystyrene foam, polyvinyl acetate foam, melamine resin foam, phenol resin foam, acrylic resin foam, ethylene vinyl acetate resin foam, and foam of derivative resin of at least one of foregoing resins. Although not specially limited, melamine or polyurethane foam is preferably used in the present invention since it provides excellent elasticity as an elastomer, allows a cell structure and/or 3-dimensional net structure to be easily formed, and ensures excellent mechanical properties and impact sound blocking property rather than other materials.

[21] The above resin foam may be made using general methods well known in the art, but not specially limited. For example, the resin foam may be made in a way of forming a foam resin composition including a base resin and additives such as a foaming agent by means of a mechanical way or UV irradiation. At this time, a foaming magnitude is preferably 500% (5 times) or more, which is not specially limited but may be suitably controlled depending on target properties such as volume percentage of open and closed cells, dynamic stiffness and/or hardness. The foaming agent usable herein may be an organic foaming agent containing sulfonyl hydrazide such as p,p'-oxybis(benzenesulfonyl hydrazide), benzenesulfonyl hydrazide, or toluenesulfonyl hydrazide; azo compound such as azodicarbonamide (ADCA) or azobisisophthalonitrile; or nitroso compounds such as N,N'-dinitrosopentamethylene tetramine or N,N'-dimethyl-N,N'-dinitrosoterephthalamide; or an inorganic foaming agent containing sodium bicarbonate or ammonium bicarbonate. In addition, the resin composition may suitably include at least one selected from the group consisting of water; phosphorus-based or halogen-based flame retardant; pigment; dye; filler such as inorganic material; dispersing agent, surfactant and other additives. In the present invention, the above foam resin composition is used to make the resin foam. At this time, the foaming process is preferably performed under inert gas atmosphere such as carbon dioxide, nitrogen, air, helium or neon, but not limited thereto. Any person having an ordinary skill in the art may easily control properties such as a cell structure, a 3-dimensional net structure, dynamic stiffness, density or compression strength of the foam by adjusting contents of components of the foam composition, an amount putting in a mold, or other conditions.

[22] The impact sound insulation material of floors according to the present invention may further include a substrate sheet formed on one or both surfaces of the resin foam and having stiffness of 150 or more. At this time, if the stiffness of the substrate sheet is less than 150, strength and supporting force of the material may be decreased to deteriorate constructability. In the present invention, an upper limit of the stiffness is not specially limited, but for example 250. In addition, forming the substrate sheet means that the substrate sheet adheres to or is laminated on one or both surfaces of the resin foam. At this time, the term

[23] 'adhesion' means a state that components are mutually coupled by means of adhesive means well known in the art (e.g., a solid adhesive, a hot-melt adhesive, or a thermal, ultrasonic or double-sided adhesive tape), including a case where surfaces facing each other are entirely or partially coupled. In addition, the term 'lamination' means a state

that components are mutually piled up without using any additional coupling means.

[24] The substrate sheet preferably has dimensional changes of 0.05% or less after heating at 80°C (2°C) for 6 hours. If the dimensional changes exceed 0.05%, dimension stability and durability of the material may be deteriorated. Also, the substrate sheet preferably has a water vapor transmission of 12 g/m²·day, which is defined as the amount of water vapor passing at a temperature of 40°C (±1°C) and a relative humidity of 90% (±2%). If the water vapor transmission exceeds 12 g/m²·day, resistance against moisture after construction may be deteriorated. Additionally, the substrate sheet preferably has dimensional changes of 0.1% or less after dipping in water or alkali solution at room temperature for 6 hours. If the dimensional changes exceed 0.1%, water-proofing property and/or alkali resistance of the material may be deteriorated, thereby lowering durability.

[25] The substrate sheet plays a role in supporting the resin foam to enhance its physical properties, and its kind is not specially limited if the above role is ensured. That is, conventional substrate sheets having the above properties may be used without limitation in the present invention. Preferably, a non-foamed sheet not including expanded cells therein is used. In the present invention, preferred examples of the substrate sheet may be a synthetic resin sheet which a woven fabric or a non-woven fabric is impregnated therein; or a woven fabric or a non-woven fabric coated (spray-coated) with synthetic resin. In the above, the woven fabric or the non-woven fabric may be a woven fabric or a non-woven fabric made of at least one selected from the group consisting of glass fiber, pulp, synthetic fiber, natural fiber and alumina fiber. The synthetic resin may be a vinyl resin such as vinyl chloride resin or vinyl chloride-acetic acid resin, as an example. In the above substrate sheet, the woven fabric or the non-woven fabric is preferably included in the amount of 20 to 80 parts by weight based on 100 parts by weight of the entire substrate sheet. If the content is less than 20 parts by weight, dimensional changes and/or strength (tensile strength, fracture strength or bending strength) may be deteriorated. If the content exceeds 80 parts by weight, hardness and/or water vapor transmission may be deteriorated.

[26] FIG. 4 and 5 shows one example of the impact sound insulation material of floors 100 of the present invention comprising the aforementioned substrate sheet. That is, the impact sound insulation material of the present invention may comprise the resin foam 10 having excellent noise proofing property, shock absorbing property, insulation property, durability and constructability solely as shown in FIG. 3,. Also, the impact sound insulation material of the present invention may comprise the resin foam 10 and

the substrate sheet(s) 20 that is formed on one or both surface of the resin foam 10 as shown in FIG. 4 or FIG. 5. At this time, in a case where the substrate sheet 20 is formed only on one surface of the foam 10, the impact sound insulation material 100 is preferably installed on a floor of a building so that the substrate sheet 20 faces upward, but not limited thereto. In the present invention, the substrate sheet(s) may be formed on one or both surfaces of the resin foam to further enhance durability and constructability of the impact sound insulation material. In addition, the substrate sheet guides a local load applied during construction or use to be uniformly distributed as a surface load, thereby preventing the impact sound insulation material from being depressed.

[27] The impact sound insulation material according to the present invention may further include a functional layer formed on one or both side of the resin foam. At this time, the functional layer may be formed in direct contact with the resin foam, or formed on the resin foam with the above substrate sheet or other functional layer being interposed therebetween.

[28] The kind of functional layer used in the present invention is not specially limited, but it may include general functional layers known in the art such as a waterproof layer, an insulator layer and a reinforced board layer. The waterproof layer may be a liquid-impermeable synthetic resin film, or a woven fabric or a non-woven fabric such as polyether fiber which synthetic resin is impregnated therein or applied (coated) thereon. The insulator layer may be a synthetic resin foam sheet such as polystyrene foam sheet, polypropylene foam sheet or polyvinyl acetate foam sheet; glass wool; rock wool; mineral wool; and non-woven fabric. The reinforced board may be an inorganic board such as plastic board or plaster board; wooden plywood; compressed wood flour board; or a composite board of wood flour and inorganic substance. The functional layers listed above may be included in the impact sound insulation material of the present invention solely, or at least two layers thereof may be included in the impact sound insulation material in a laminated or adhering multi-layered structure.

[29] The number, kind and/or forming sequence of the functional layers used in the present invention are determined depending on usage of a building or the like, but not specially limited. That is, the impact sound insulation material of the present invention may include any one of the above functional layers, or at least two different functional layers may also be formed on one or both sides of the impact sound insulation material. In addition, the impact sound insulation material having various functional layers formed on one or both sides thereof may be formed as one unit, so that such

units are subsequently repeated to make one impact sound insulation material.

- [30] In the impact sound insulation material of the present invention, various kinds of convexo-concave patterns such as wave pattern or angled pattern may be formed on one or both surfaces of the resin foam layer and/or the functional layer. The convexo-concave patterns are formed as mentioned above, so that buffer spaces are defined between laminated or adhering layers, and accordingly, the properties such as shock absorption and insulation may be further enhanced. In addition, in a case where the convexo-concave patterns is formed in a layer contacting with a slab surface where the impact sound insulation material is constructed, there is an advantage in that easy constructability can be ensured even though the slab has low smoothness.
- [31] Hereinafter, an aspect of a state where the impact sound insulation material of the present invention is used will be explained in more detail with reference to the accompanying drawings.
- [32] FIGS. 6 and 7 shows an impact sound insulation material 100 according to one aspect of the present invention in which the substrate sheets 20 are formed on both surfaces of the resin foam 10, and a waterproof layer(s) 30 is formed on one or both surfaces of the substrate sheet 20. The specific kinds of the waterproof layer 30 used here are as described above, and the layer 30 may be formed to have a single-layered or multi-layered structure. In addition, FIG 8 is a sectional view of the impact sound insulation material 100 in which the insulator layer 40 is formed on one surface of the resin foam 10. As shown in FIG. 8, a convexo-concave pattern 45 may protrude on a lower portion of the insulator layer 40 included in the impact sound insulation material according to the present invention. The convexo-concave pattern 45 defines a space (or a shock absorption space) 46 between the resin foam 10 and the insulator layer 40, thereby further enhancing shock absorption and insulation property. The impact sound insulation material of the present invention may be configured such that the insulator layer 40 and the waterproof layer 30 are subsequently formed on one surface of the foam 10 as shown in FIG. 9. FIG. 10 shows the structure of the impact sound insulation material in which the configuration of FIG. 9 is repeatedly formed two times.
- [33] FIG. 11 shows the impact sound insulation material 100 having a reinforced board 50 formed on one surface of the resin foam 10. The reinforced boards usable here are already listed above. Although not specially limited, a reinforced plate in which glass fiber with excellent dimension stability against weak alkali cement is impregnated, or a honeycomb board 50 in which predetermined shapes 55 are aggregated as shown in FIG. 11 to show a lattice pattern is preferably employed in the present invention in

aspect of enhancement of durability.

[34] Various layer structures explained above are only one aspect of the present invention, and the structure of the impact sound insulation material may be determined in various ways by suitably selecting functional layers according to a target usage while the single-layered or multi-layered resin foam 10 is used as a main substrate. In addition, in the impact sound insulation material of the present invention, paper, metal plate and/or double-sided adhesive film may be further laminated on or adhere to one or both surfaces of the resin foam, the substrate sheet or the functional layer, or an adhesive may be coated thereon. Such an impact sound insulation material may be constructed into walls, ceiling or floor of a building such as an apartment or a high-story building. Particularly, the impact sound insulation material may be useful as a material for noise proofing or shock absorption between stories of a building.

[35]

[36] The present invention also relates to a floor construction method, which includes the step of constructing the impact sound insulation material 100 according to the present invention on a slab S.

[37] The floor construction method of the present invention may further include the step of subsequently constructing a concrete layer 200, a mortar layer 300 and a floor finishing material 400 on the constructed impact sound insulation material.

[38] FIG. 12 shows one aspect of a construction structure of a floor formed by the above construction method. Specifically, FIG. 12 shows a construction state in which an insulator layer 40 with the convexo-concave pattern 45 formed thereon, the resin foam 10, the substrate sheet 20 and the waterproof sheet 30 are subsequently formed on a slab S (reference symbol W of FIG. 12 designates a wall of a building). As shown in FIG. 12, the impact sound insulation material 100 according to the present invention is installed on a surface of the slab S, thereby effectively blocking impact sound and vibration. Although not specially limited, it is preferred in the floor construction structure of the present invention that the insulator layer 40 with the convexo-concave pattern 45 formed thereon is positioned at a lowermost end to be in contact with the surface of the slab S, and the waterproof layer 30 is positioned at an uppermost end. In a case where the convexo-concave pattern 45 is in contact with the slab S as mentioned above, there is an advantage in that easy construction is ensured although the slab S has low smoothness.

[39] Also, the construction method of the present invention may further include the steps of forming the concrete layer 200, preferably by placing and curing autoclaved

lightweight concrete; and forming the mortar layer 300 subsequently. In general cases, pipes P for heating and/or gas supply are installed in the mortar layer 300. After the impact sound insulation material, the concrete layer and the mortar layer are subsequently formed as mentioned above, the construction method is finished using a floor material 400. The specific construction manner of each step of the above method is not specially limited, but may be performed using the impact sound insulation material of the present invention and general construction manners in the art.

[40]

Brief Description of the Drawings

[41] FIG. 1 is a scanned electronic microscope (SEM) photograph showing a polyurethane foam used in one embodiment of the present invention.

[42] FIG. 2 is a view showing a 3-dimensional net structure of the resin foam according to one embodiment of the present invention.

[43] FIGS. 3 to 11 are sectional views respectively showing states of the impact sound insulation materials according to various embodiments of the present invention.

[44] FIG. 12 is a sectional view showing a construction state of the impact sound insulation material according to one embodiment of the present invention.

[45] [Explanation of Reference Numerals for Major Portions Shown in Drawings]

[46] 1: Open cell 2: Micro fiber

[47] 3: Space of 3-dimensional net structure formed by the micro fiber

[48] 10: Resin foam 20: Substrate sheet

[49] 30: Waterproof layer 40: Insulator layer

[50] 45: Convexo-concave pattern 46: Shock absorbing space

[51] 50: Reinforced board 100: impact sound insulation material

[52]

Best Mode for Carrying Out the Invention

[53] Hereinafter, the present invention will be explained in more detail by comparing embodiments of the present invention and comparative examples, but the scope of the present invention is not limited to the following embodiments.

[54]

Examples 1 to 15 and Comparative Examples 1 to 5

[56] Open cell containing resin foams having properties shown in the following Tables 1 and 2 were selected as resin foams of examples and comparative examples, and they were tested.

[57] Table 1

[Table 1]

[Table]

	dynamic stiffness (MN/m ³)	Material
Example 1	0.9	Polyurethane resin foam
Example 2	1.3	
Example 3	1.5	
Example 4	2	
Example 5	2.3	
Example 6	2.6	
Example 7	6.6	
Example 8	7.6	
Example 9	7.9	
ComparativeExample 1	11.5	
ComparativeExample 2	16	
ComparativeExample 3	20.5	
ComparativeExample 4	35.4	

[58] Table 2

[Table 2]

[Table]

	Volume percentage of open and closed cells (%)	Thickness (mm)	Hardness(kgf/3 14cm ²)	Material
Example 10	80	20	8	Polyurethane foam
Example 11	80	30	8	
Example 12	80	40	8	
Example 13	80	50	8	
Example 14	80	60	8	
Example 15	60	30	8	
ComparativeExample 5	80	10	8	

[59] Properties of the resin foams according to the examples and the comparative examples were evaluated as follows.

[60]

[61] **Method for Evaluating Properties**

[62] (1) Volume percentage of open and closed cells

[63] A volume percentage of open and closed cells of the resin foam was measured according to ASTM (American Society for Testing and Materials) D 6226 and ASTM D 2856. Specifically, any cell at least partially opened among cells contained in the resin foam was defined as an open cell, and then the volume percentage was indicated as a volume percentage of open cell volume to the entire cell volume.

[64]

[65] (2) Dynamic stiffness and hardness

[66] A dynamic stiffness of the resin foam used in the test was evaluated by a method regulated in KS F 2868, and hardness was evaluated by a method regulated in KS M 6579.

[67]

[68] **Embodiment 16**

[69] A substrate sheet having properties listed in the following Table 3 was made, and then it was laminated on one surface of each of the resin foams according to Examples 1 to 15. Thereafter, they were used for evaluating constructability. Specifically, a glass fiber tissue having a weight per unit area (basis weight) of 100 g/m² was impregnated into PVC, and heat of 150°C was applied thereto to make a substrate sheet in which PVC sheets of 0.5 mm adhere to both surfaces of the glass fiber tissue. The manufactured substrate sheet was laminated on one surface of the resin foam using a general adhesive.

[70] Table 3

[Table 3]

[Table]

	Physical properties of substrate sheet
Water vapor transmission	7 g/m ² ·day
Stiffness	L: 220, R: 180
Dimensional changes after heating	0%
Dimensional changes after dipping in water	- 0.01%
Dimensional changes after dipping in NaOH solution	- 0.01%

[71] The properties of the substrate sheet listed in Table 3 were measured in the following manners.

[72]

[73] **Method for Measuring Properties**

[74] (1) dimensional changes after heating

[75] ① The manufactured substrate sheet was cut at left, center and right portions thereof respectively by a size of 300 mm 300 mm (length width) to make three samples in total.

[76] ② The prepared samples were positioned on a glass plate, and then put into an oven at 80°C (±2°C) and heated for 6 hours.

[77] ③ After the heating process is completed, the samples were left along at room temperature for 1 hour, and then their lengths (lengths after heating) were measured, respectively. At this time, a suitable load was applied to a portion curled by heating in order for the curled portion to be flat, and then the length was measured.

[78] ④ The length after heating, measured in the step ③, and the length before heating

were substituted into the following Equation (1) to calculate a dimensional changes. To obtain the length after and before heating, lengths of long and short sides of the three samples were respectively measured and averaged, and then average values of three samples were applied to the Equation (1).

[79]

[80] Equation (1): Dimensional changes (%) = {(length of sample before heating length of sample after heating)/length of sample before heating} 100

[81]

[82] (2) Water vapor transmission

[83] A water vapor transmission of the substrate sheet was measured according to a test method regulated in KS A 1013. In more detail, the amount of water vapor passing through the substrate sheet at a temperature of 40°C (±1°C) and a relative humidity of 90% (±2%) for one day (24 hours) was calculated according to the follow Equation (2) to measure the water vapor transmission.

[84]

[85] Equation (2): Water vapor transmission = {weight of sample after 24 hours (g)-initial weight of sample (g)} / water vapor permeable area (m²)

[86]

[87] (3) Stiffness

[88] A Taber tester generally used as a stiffness measurer was used to measure stiffness (values of “L” and “R” of the substrate sheet.

[89]

[90] ① The manufactured substrate sheet was cut at left, center and right portions thereof respectively by a size of 300 mm 300 mm (length width) to make three samples in total.

[91] ② The prepared samples were dipped in water and NaOH solution (with a concentration of 3 wt%) at room temperature, and then taken out and dried. Thereafter, a length after dipping was measured.

[92] ③ The length after dipping, measured in the step ②, and the length before dipping were substituted into the following Equation (3) to calculate dimensional changes after dipping. To obtain the length after and before dipping, lengths of long and short sides of the three samples were respectively measured and averaged, and then, average values of three samples were applied to the Equation (3).

[93]

[94] Equation (3): Dimensional changes (%) = {(length of sample before dipping length

of sample after dipping)/length of sample before dipping} ×100%

[95]

[96] **Test Example 1: Impact sound decreasing effect according to dynamic stiffness of the resin foam**

[97] The resin foams according to Examples 1 to 9 and Comparative Examples 1 to 4 were used to measure an impact sound decreasing effect. Specifically, a floor impact sound (A) when the foam is not constructed on a concrete base and a floor impact sound (B) after construction were measured, and then, the impact sound decreased amount (C) was evaluated according to the following Equation (4). In the above, the floor impact sound was measured according to method regulated in KS F 2810-2.

[98]

[99] Equation (4): Impact sound decreasing amount (C) = floor impact sound (A) before construction - floor impact sound (B) after construction

[100]

[101] The impact sound decreasing effect according to the change of dynamic stiffness measured as above is shown in the following Table 4.

[102] Table 4

[Table 4]

[Table]

	Impact sound decreasing amount (dB)
Example 1	13
Example 2	16
Example 3	15
Example 4	11
Example 5	6
Example 6	8
Example 7	3
Example 8	2
Example 9	1
Comparative Example 1	-2
Comparative Example 2	-3
Comparative Example 3	-2
Comparative Example 4	-4

[103] As noted from the results of Table 3, Examples 1 to 9 according to the present invention show the greatly excellent impact sound decreasing effect in comparison with Comparative Examples 1 to 4. In addition, when comparing the results of Examples 1 to 4 with the results of Examples 5 to 9, it could be understood that the impact sound decreasing effect is more excellent when the dynamic stiffness is 2 MN/m³ or less.

[104]

[105] **Text Example 2: Impact sound decreasing effect according to volume percentage of open and closed cells**

[106] Using Examples 11 and 15, an impact sound decreasing effect according to the change of volume percentage of open and closed cells was measured in the same manner as Text Example 1, when the other conditions are the same. As a result, the floor impact sound decreasing amount was 2 dB in case of Example 15 wherein the volume percentage of open and closed cells is 60%, while the floor impact sound decreasing amount was 4 dB in case of Example 11 wherein the volume percentage of

open and closed cells is 80%. Accordingly, it could be understood that the impact sound decreasing effect is improved as the volume percentage of open and closed cells of the resin foam is increased.

[107]

[108] **Test Example 3: Impact sound decreasing effect according to thickness**

[109] Using Examples 10 to 14 and Comparative Example 5, an impact sound decreasing effect according to thickness was measured in the same manner as Text Example 1, and its results are listed in the following Table 5.

[110] Table 5

[Table 5]

[Table]

	Impact sound decreasing amount (dB)
Example 10	1
Example 11	4
Example 12	10
Example 13	14
Example 14	16
Comparative example 5	-1

[111] As seen from Table 5, it could be understood that the floor impact sound decreasing effect is improved as the thickness of the used resin foam is increased.

[112]

[113] **Test Example 4: Property evaluation according to lamination of substrate sheet**

[114] An impact sound insulation material including the substrate sheet made in Example 16 was used to evaluate constructability. As a result, it could be understood that the above sound proof material has good supporting force, the arrangement (positioning) to a floor and other handling are superior.

[115]

Industrial Applicability

[116] The present invention provides an impact sound insulation material and a floor construction method using the same. The impact sound insulation material of the present invention is excellent in various properties such as interfloor sound proofing, shock absorbing, insulation, durability and constructability by optimizing structure and properties of the resin foam included in the material, and also, if necessary, by forming

various functional layers including the substrate sheet having specific stiffness, water vapor transmission and/or dimensional changes on one or both sides of the resin foam.

Claims

- [1] An impact sound insulation material of floors, comprising:
a resin foam having a thickness of 15 mm or more and a dynamic stiffness of 0.5 to 10 MN/m³.
- [2] The impact sound insulation material as claimed in claim 1, wherein the resin foam has a thickness of 20 to 60 mm.
- [3] The impact sound insulation material as claimed in claim 1, wherein the resin foam has a dynamic stiffness of 0.5 to 7 MN/m³.
- [4] The impact sound insulation material as claimed in claim 1, wherein the resin foam is an open cell-containing resin foam having a volume percentage of open and closed cells of 20% or more.
- [5] The impact sound insulation material as claimed in claim 4, wherein the open cell-containing resin foam has a volume percentage of open and closed cells of 40% or more.
- [6] The impact sound insulation material as claimed in claim 4, wherein the open cell-containing resin foam has a density of 2.0 to 30.0 Kg/m³.
- [7] The impact sound insulation material as claimed in claim 4, wherein the open cell-containing resin foam has a hardness of 5 to 50 Kgf/314cm².
- [8] The impact sound insulation material as claimed in claim 1, wherein the resin foam has a 3-dimensional net structure formed by micro fiber.
- [9] The impact sound insulation material as claimed in claim 8, wherein the micro fiber has a diameter of 0.1 to 20 mm.
- [10] The impact sound insulation material as claimed in claim 1, wherein the resin foam is selected from the group consisting of polyurethane foam, urea foam, polyvinyl chloride foam, polypropylene foam, polyethylene foam, polystyrene foam, polyvinyl acetate foam, melamine resin foam, phenol resin foam, acrylic resin foam, ethylene vinyl acetate resin foam, and foam of derivative resin of at least one of the foregoing.
- [11] The impact sound insulation material as claimed in claim 1, further comprising a substrate sheet formed on one or both surfaces of the resin foam, the substrate sheet having a stiffness of 150 or more.
- [12] The impact sound insulation material as claimed in claim 11, wherein the substrate sheet is a synthetic resin sheet in which a woven fabric or a non-woven fabric is impregnated; or a woven fabric or a non-woven fabric coated with a

synthetic resin.

- [13] The impact sound insulation material as claimed in claim 12, wherein the woven fabric or the non-woven fabric is a woven fabric or a non-woven fabric made of at least one selected from the group consisting of glass fiber, pulp, synthetic fiber, natural fiber and alumina fiber.
- [14] The impact sound insulation material as claimed in claim 12, wherein the synthetic resin is a vinyl resin.
- [15] The impact sound insulation material as claimed in claim 1, further comprising a functional layer formed on one or both sides of the resin foam.
- [16] The impact sound insulation material as claimed in claim 15, wherein the functional layer is at least one selected from the group consisting of a waterproof layer, an insulator layer and a reinforced board layer.
- [17] The impact sound insulation material as claimed in claim 16, wherein the waterproof layer is at least one selected from the group consisting of a liquid impermeable synthetic resin film, a woven fabric to which synthetic resin is impregnated or applied, and a non-woven fabric to which synthetic resin is impregnated or applied.
- [18] The impact sound insulation material as claimed in claim 16, wherein the insulator layer is at least one selected from the group consisting of foamed sheet, glass wool, rock wool, mineral wool and woven fabric.
- [19] The impact sound insulation material as claimed in claim 16, wherein the reinforced board is at least one selected from the group consisting of plastic board, inorganic board, wooden plywood, compressed wood flour board, and a composite board of wood flour and inorganic substance.
- [20] A floor construction method, comprising the step of constructing the impact sound insulation material according to any one of claims 1 to 19.
- [21] The floor construction method as claimed in claim 20, further comprising the step of subsequently constructing a concrete layer, a mortar layer and a floor finishing material on the constructed impact sound insulation material.

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Fig.1

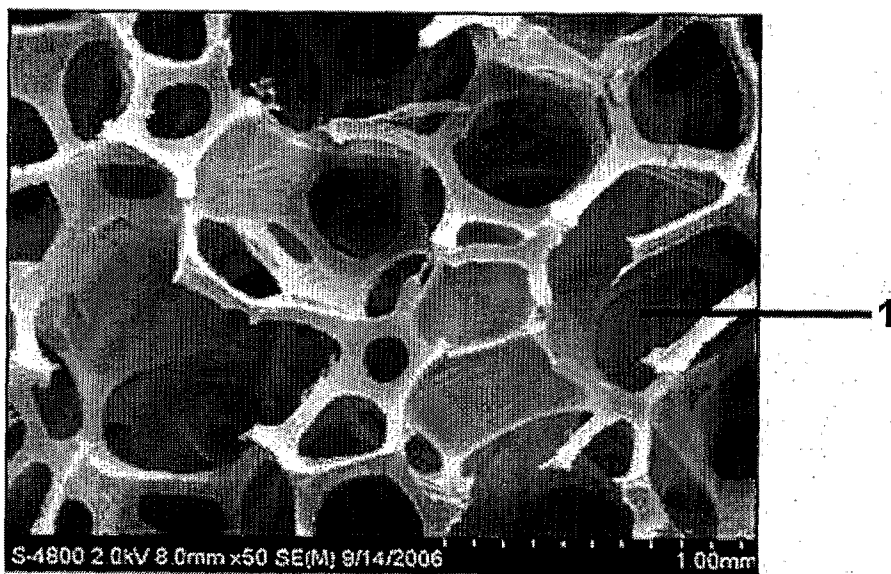
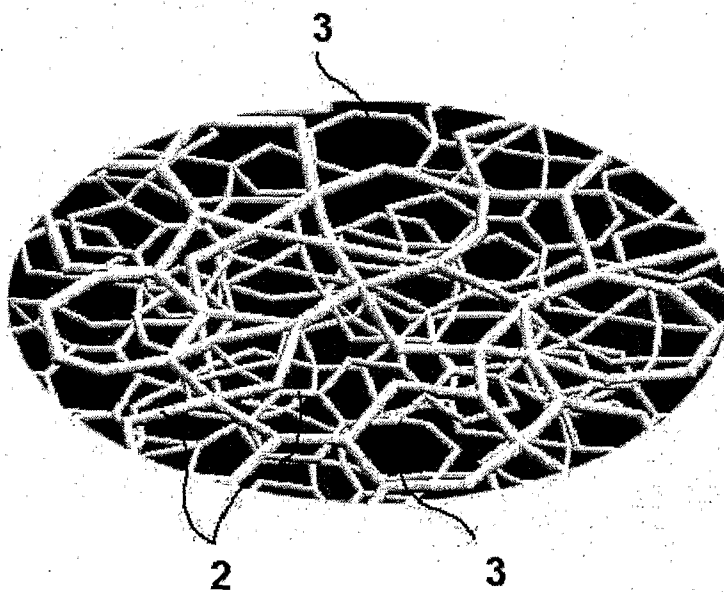


Fig.2



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Fig.3

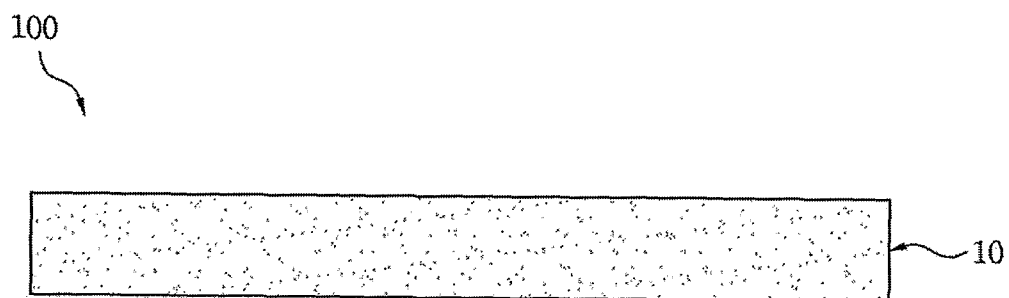


Fig. 4

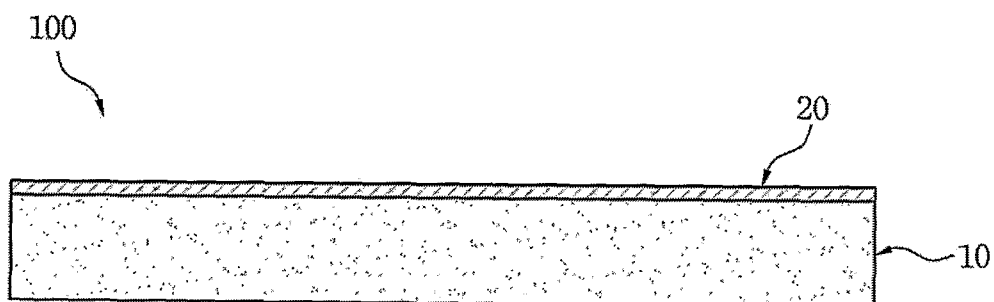


Fig.5

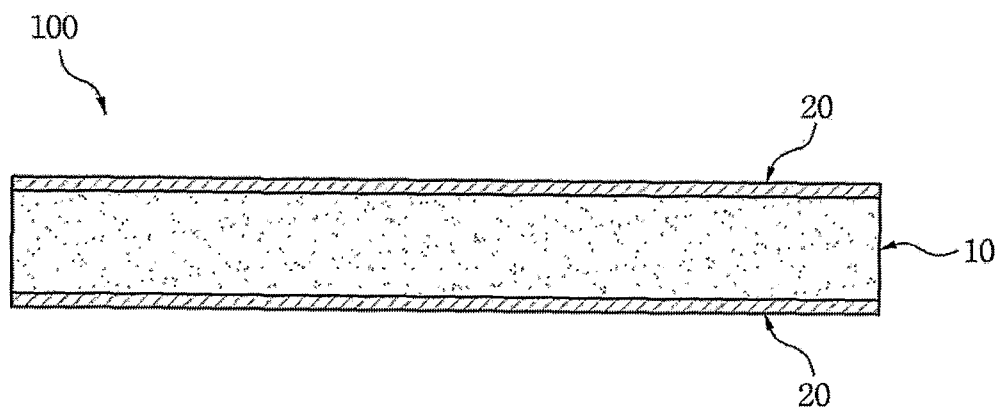


Fig.6

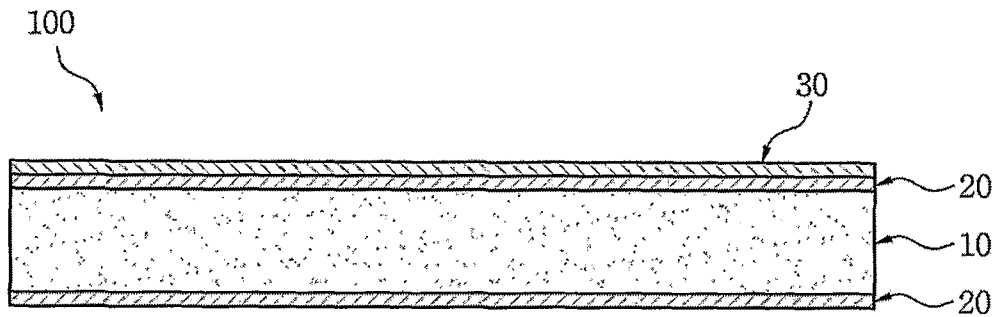


Fig.7

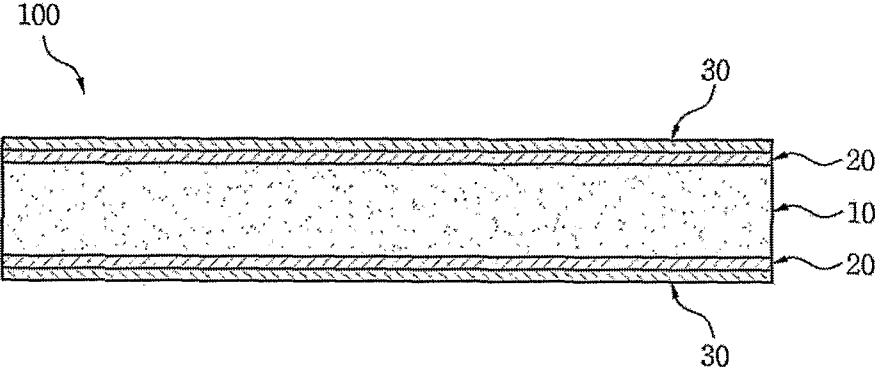
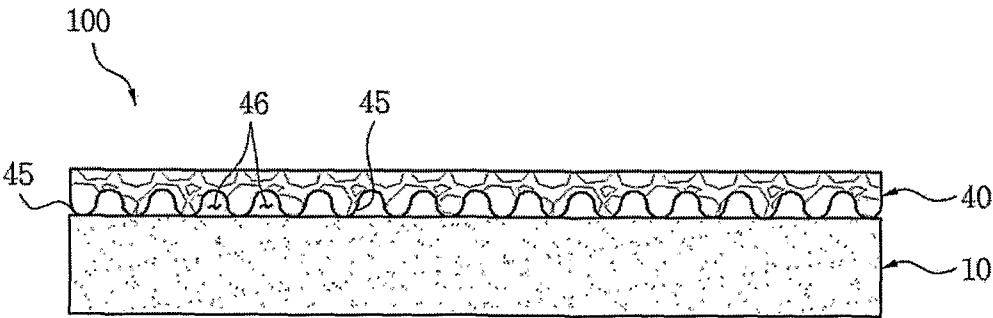


Fig.8



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Fig.9

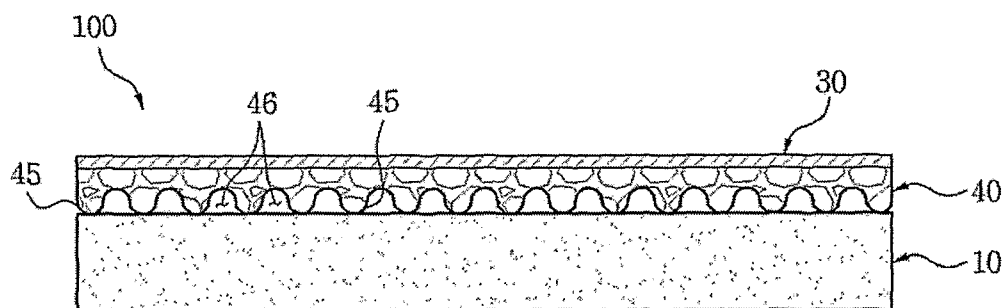


Fig.10

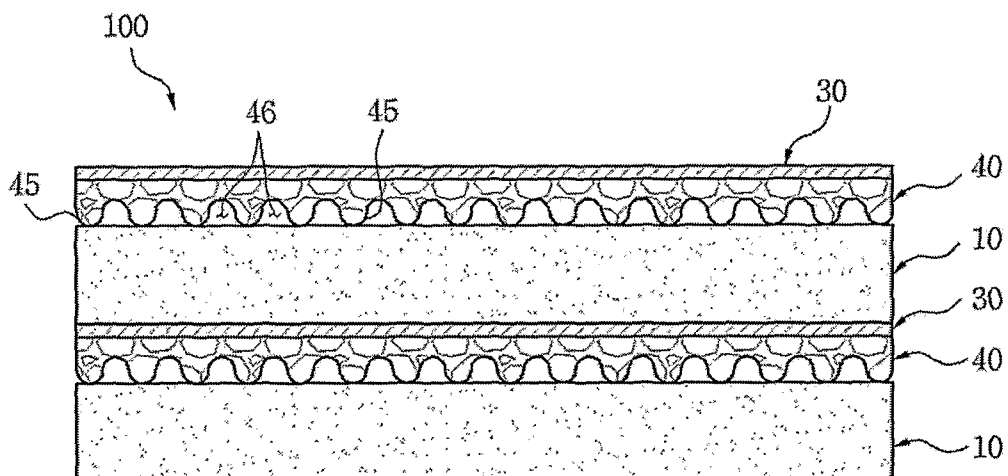
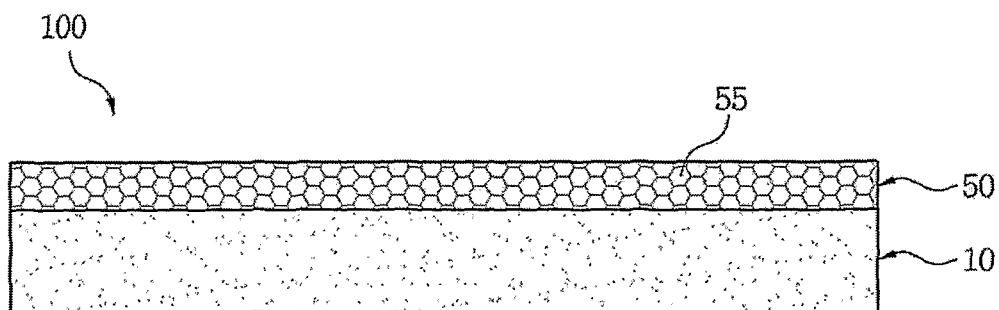
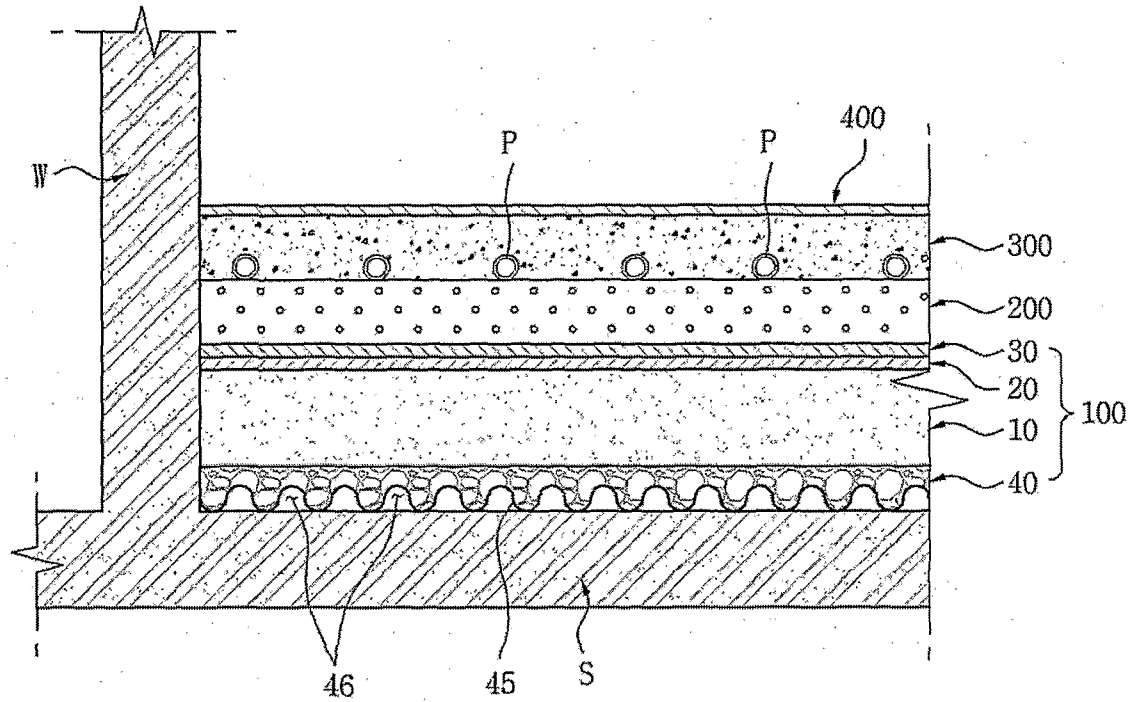


Fig.11



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Fig.12



INTERNATIONAL SEARCH REPORT

International application No.
PCT/KR2008/001746**A. CLASSIFICATION OF SUBJECT MATTER****E04B 1/86(2006.01)i**

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

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)

IPC 8 : E04B 1/86

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched
KR,JP IPC as aboveElectronic data base consulted during the international search (name of data base and, where practicable, search terms used)
eKIPASS(KIPO internal) "resin", "insulation"**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	JP 06017493 A (ASAHI CHEM IND CO LTD) 25 JANUARY 1994	1-11
A	JP 11141009 A (NISSHINBO IND INC , MESCO INC) 25 MAY 1999	1-21
A	US 6487822 B1 (JORG HAACK, ANDRESS GRADINGER) 03 DECEMBER 2002	1

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

* Special categories of cited documents:

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Date of the actual completion of the international search

06 AUGUST 2008 (06.08.2008)

Date of mailing of the international search report

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INTERNATIONAL SEARCH REPORT

Information on patent family members

International application No.

PCT/KR2008/001746

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