The composite material multilayered membrane of the present invention is sound insulating and sound-absorbent, acting as sound deadening insulation for noise impacts, mainly but not exclusively to be used in flooring, and in particular under the slab in floating floors, with the aim of reducing the transmission of noise into the below room. This membrane includes several layers, which include at least one polymeric monofilament three dimensional mat, at least one resilient mat, and at least one topping layer of waterproofing, breathable or not, tissue. This multilayered membrane with a thickness under a weight of 2 kPa of at least 8 and maximum 15 mm, preferably 10-12 mm, so as to achieve a normalized noise level in the disturbed room $L_{nw}$ below 50 dB, or an impact insulation class of at least 60 points.

![Diagram of the composite material multilayered membrane](image-url)
Fig. 1

301
201
101

Fig. 2

302
202
102

Fig. 3

303
203a
103
203b
COMPOSITE MATERIAL MULTILAYERED MEMBRANE WITH SOUND INSULATING AND SOUND ABSORBING TO MITIGATE IMPACT NOISE

CROSS-REFERENCE TO RELATED APPLICATIONS

[0001] Not applicable.

STATEMENT REGARDING FEDERALLY SPONSORED RESEARCH OR DEVELOPMENT

[0002] Not applicable.

NAMES OF THE PARTIES TO A JOINT RESEARCH AGREEMENT

[0003] Not applicable.

INCORPORATION-BY-REFERENCE OF MATERIALS SUBMITTED ON A COMPACT DISC

[0004] Not applicable.

BACKGROUND OF THE INVENTION

[0005] 1. Field of the Invention
[0006] The invention relates to a composite material multilayered membrane, which acts as sound insulating and sound absorbent barrier to mitigate impact noise in construction, more particularly in floating floors construction.
[0008] Definitions. The term "floating floor" indicates a floor formed by a floating, at least 1 inch thick, slab, resting on top of a generally elastic panel which separates it from the subfloor, in order to form an oscillating system which absorbs the impact energy. The term "impact noise" refers to:
[0009] a percussion on vertical walls or floors caused mainly by pounding or falling objects;
[0010] a friction caused by furniture moving or other;
[0011] a vibration due to machinery or equipment that are in direct contact with the walls or the floors.

This impact noise spreads directly through the solid structures of the building, not only in the underlying room which is the most exposed, but also in the other ones, more or less distant from the one in which the phenomenon occurred, according to the structural characteristics of the building.

FIELD OF APPLICATION

[0012] Conventionally, users of spaces in residential buildings, feel the need to isolate themselves from the noise of their neighbors, in particular from the impact noise from upper floors. Although many engineers, designers and manufacturers in recent years have adopted sound control systems, using materials readily available on the market, such as rubber rolls or panels, cork rolls or panels, woven polypropylene or polyethylene rolls and other similar products, only a few of these solutions are technically adequate and in compliance with tests and certifications relating to sufficient dynamic stiffness. Indeed, very often this parameter, that is the value which defines the ability of an insulating membrane subjected to a dynamic solicitation to deform elastically, is unknown, or these values are not supplied by the manufacturers, and then on continue to take not technically correct application systems. It must be considered that any source of sound is transformed into a source of noise if it becomes a source of disturbance to other people, so insufficient acoustic soundproofing is considered a defect of the building. Under the civil law relating to business, it is the vendor that must repair the defect or reduce the price of the building.

[0013] In order to decrease the transmission of noise impact, as known, various elastic acoustic products were then developed, predominantly to completely isolate and solidify the floor from the rest of the rigid structures. There are numerous examples of national legislation laying down restrictions on the transmission of noise between consecutive rooms, using the parameters defined by organizations and groups to measure the noise in the disturbed room when a specific tapping machine is running into the room above. The legislature has thus defined the limits of noise to be observed and then the acoustic requirements of buildings, especially of the floors between two consecutive levels. Over the years, legislative limits have become gradually more restrictive and as seen, several devices have been developed by different companies to solve this problem. These devices will function when their elasticity is energized by a mass that acts on them, and thus are preferably used under floating floors. However, in some cases, such as in building renovation, it is not always possible to make a floor for space or load matters, so some devices may be used directly under the ceramic tile or wood parquet.

DESCRIPTION OF PRIOR ART

[0014] A search has been conducted in the field of acoustic membranes and impact noise insulation devices, which made it possible to trace at least the following documents:

[0015] D1 ITTV 2006A000054 (Cais et al.)
[0016] D2 DE 1224020 (Mueller)
[0017] D3 FR153907 (Saint Gobain)
[0018] D4 FR2056275 (Saint Gobain)
[0019] D5 FR2517728 (Strati France)
[0020] D6 FR2824094 (Silplast)
[0021] D7 FR2775013 (Nortene Technologies)
[0022] D8 JP1766617 (Terryama et al.)
[0023] D9 JP2013656 (Kuroda)
[0024] D1 describes a soundproof membrane for floors, intended to be used directly below the slab in floating floors or directly under the floor finishing to reduce the transmission of impact noise between two consecutive levels of a building, which consists of a set of mats, made from monofilament fibers or polymers, or alveolar materials with at least one protective waterproofing film and characterized by the fact that this multilayer of mats defines a space for the most part filled with air, called "air foil", with a thickness of at least 6 and at most 20 mm, and preferably 10-15 mm. The main purpose is to develop a sound-floor membrane through which it is possible to obtain a particularly effective soundproofing between consecutive levels of a building by allowing to contain noise from the upper floors within a tolerance level to be provided under 58 dB, conventionally calculated, by maintaining the advantages of a single product to be used directly under the floor finishing or under the slab in floating floors.
[0025] D2 describes the same principle with one layer of soundproofing panels, made up of a glass fiber felt of at least 130 grams per square meter, topped by a rigid layer of bitumen or resin.
[0026] D3 introduces the use of felt in a glass fiber with specific characteristics such as fiber length of at least ten
centimeters, fiber diameter from 10 to 40 μm, to form an insulating felt weighing from 150 to 300 g/m², and D4 describes the use of a felt in a glass fiber under a floating floor to isolate the tapping noise.

D5 introduces the use of felt in a glass fiber with specific characteristics, combining an elastic material to a load bearing and sound waves distributor panel, to be used directly below the floor finishing, avoiding to use the floating floor.

D6 includes a lower support and an upper surface comprising a felt or other material with characteristics of resilience, possibly associated with an impermeable film and a thin metal foil with density of at least 150 g/m².

D7 describes a sound material comprising a first layer of fabric weighing between 200 and 1000 g/m², preferably between 350 and 400 g/m², a second layer of non woven fabric weighing between 40 and 200 g/m², preferably between 60 and 150 g/m², where both the two layers are bonded by a plastic reticular structure.

D8 suggests a material to reduce impact noise on a floor. It is made up of accommodation cavities forecast in a plane next to the other in a net of non woven polypropylene or polyester, and silica particles internally distributed in such a way to form a structure with damping effect.

D9 describes a structure to isolate the noise between floors. It is a layered structure, in which below the top layer it is coated a three-dimensional layer of synthetic threads.

In the market, there are also known materials in monofilaments mats used to mitigate the impact noise between floors. For example, in the site www.colbond usa.com, Colbond company describes the product Acoustic Mat II™ and III and the product Enkasonic E™. These are products in nylon filaments three dimensional mats, with thickness comprised between 6 mm and 20 mm, and with density between 42.6 kg/m² and 88 kg/m².

In the site www.keenebuilding.com, Keene Building Products, describes sound mats for floating floors named Quiet Qrl 55-025™, 6 mm thick, and Quiet Qrl 60-040™, 10 mm thick, with a polyester topping joined to a three dimensional polypropylene extruded threads mat.

It is therefore reasonable to consider as known a flooring impact sound deadening membrane, or the membrane or the multilayered structure, suitable to reduce the impact sound, which is comprised of at least:

- a non woven polymeric material;
- a felt joined to a waterproofing film.

DISADVANTAGES

The opinion of the applicant is that the above described devices unlikely meet the requirements to achieve an optimum level of acoustic comfort.

More specifically, the state of the art shows like all known solutions by themselves are not exempt from drawbacks and limitations in relation to the specified parameters and user requirements. More in detail, the above described solutions, while suitable to contain the impact noise level in the disturbed room to values lower than 70 dB, in the opinion of the applicant, those solutions are sufficient in itself to reduce the intensity of the noise levels prescribed by legislation; however, the solutions are not sufficient to reduce it at levels lower than 55 dB, which correspond to an optimum acoustic comfort. As to the products used directly under the floor, there are no solutions that meet the needs of acoustic comfort.

It is certainly true that the solution described in D1, proposed a sound deadening membrane with which it is possible to obtain normalized impact sound levels of 51 dB in the disturbed room, with thicknesses between 6 and 20 mm, preferably from 10 to 15 mm. It is defined in particular a critical thickness between 10 and 12 mm, composed by many layers of fibrous materials with low rigidity containing a great amount of air. These values satisfy the legislative limits, but they don’t allow an adequate margin of safety like the one obtainable, with thicknesses between 10 and 12 mm, with the object of this invention. In particular for the light wooden floors, which are the most difficult to solve acoustically, it is necessary to provide products that can get, in a standard test, noise levels Lnw below 50 dB in the disturbed room, or an impact insulation class of at least 60 points.

For the above described reasons, there is a need for new products, particularly in the specific field, to find out alternative solutions, more effective, compared to the solutions present in current time market. One purpose of this is invention is also to overcome the above described disadvantages.

BRIEF SUMMARY OF THE INVENTION

This and other aims are achieved with this invention according to the features of the attached claims solving the above exposed problems by means of a composite material multilayered membrane, being sound insulating and sound absorbent, which acts as sound deadening insulation for noise impacts, mainly not exclusively designed to be used in the flooring, and in particular under the slab in floating floors, with the aim of reducing the transmission of noise into the below room. This membrane comprises several layers, which are at least one polymeric monofilament three dimensional mat, at least one resilient mat, at least one topping layer of waterproofing, breathable or not, tissue. This multilayered membrane with a thickness under a weight of 2 kPa of at least 8 and maximum 15 mm, preferably 10-12 mm, so as to achieve a normalized noise level in the disturbed room Lnw below 50 dB, or an impact insulation class of at least 60 points.

Aims:

In this way, through the considerable creative contribution whose effect has achieved a considerable technical progress, some goals and benefits can be reached.

A first aim is to achieve a particular impact noise insulating membrane that can achieve the sound insulation between consecutive levels of a building, allowing to reduce the disturbing noises coming from the above room within a level that complies with the constraints imposed by legislation with a wide safety margin.

A second purpose is to provide a solution that can be used in every application that requires impact noise insulation, where the weight which urges the structure is less than 500 kg/m².

A third purpose of the invention is to achieve a very effective impact sound insulating membrane in a single product obtained directly in the factory of production without the need for installation of more materials or carriages of more layers of membrane itself.

A fourth aim is to achieve an effective impact noise insulating membrane with a waterproofing finishing fabric that can prevent the penetration of liquid cement or gypsum
concrete through the product during the slab pouring phase, which otherwise might affect the sound insulation properties of the membrane.

[0049] A fifth goal is to create a membrane, effectively insulating towards impact noise, with a waterproofing and breathable finishing fabric, which could bring through its breathability to a more rapid drying of the slab, lowering the perfection time of the work.

[0050] A sixth objective is to achieve a multilayered membrane, effectively insulating towards impact noise, with a finishing fabric larger than the below layers along the entire length of the roll, with a bituminous or butyl or bi-adhesive curb, protected by a silicone release paper, which would seal the connections between different rolls in opera, without the need to give to jobsite staff specific instructions for installation, or to use more tapes. The sealing between two consecutively laid down rolls is ensured in order to avoid, during slab pouring phase, liquid cement or gypsum penetrating through the joints and affecting the sound deadening features of the membrane.

[0051] A seventh aim is to achieve a multilayered membrane, effectively insulating towards impact noise, that can contribute to thermal insulation of the assembly.

[0052] In particular, it has been possible to obtain a more integrated and compact structure, with a good technologic content and relatively low cost. These and other advantages will appear with the subsequent detailed description of some preferential solutions, with the help of the attached schematic drawings, whose details are not to be intended restrictive but only illustrating.

BRIEF DESCRIPTION OF THE SEVERAL VIEWS OF THE DRAWINGS

[0053] FIG. 1 is a perspective view of a first solution of multilayer composite materials membrane.

[0054] FIG. 2 is a perspective view of a second solution of multilayer composite materials membrane.

[0055] FIG. 3 is another perspective view of a third solution of multilayer composite materials membrane.

DETAILED DESCRIPTION OF THE INVENTION

[0056] The invention relates to a multilayered composite material membrane (10, 20, 30), which acts as an insulating barrier towards impact noise, which is composed by multiple layers and in particular of at least one polymeric monofilament three dimensional mat (101, 102, 103), at least one resilient mat (201, 202, 203), with at least one layer of waterproofing, breathable or not, layer (301, 302, 303), permeable to vapor or not, with a total thickness under a weight of 2 kPa of at least 8 mm and maximum 15 mm, preferably between 10 and 12 mm.

[0057] The demonstration of the effectiveness of the solutions covered by this invention can be easily demonstrated using a semi-anechoic chamber equipped with sound level meter. The ceiling of this room consists of a brick cement floor 200 mm thick, the walls of this room are in 200 mm thick full bricks. The multilayered impact sound deadening membrane is laid down on the top of this ceiling, over it is applied a 50 mm sand cement slab, metal lathe reinforced, top finished with ceramic tiles. Over the tiles a normalized tapping machine working. The test is performed according to EN ISO 717-2 and EN ISO 140-8, adapted in relation to the size of the receiving room (1000 mm per 1000 mm per 1000 mm) and the size of the sample in analysis (600 per 600 mm).

[0058] The acoustic performance of the material is measured by the normalized noise level (L\text{nw}) transmitted in the receiving room or impact insulation class (IIC). These parameters are calculated according to the standard on the basis of interpretation of data acquired by the sound level meter, connected to a microphone positioned at the center of the receiving room at half of its height.

[0059] In a first preferred embodiment of the invention (FIG. 1), it is foreseen that under the 50 mm tiled floating slab weighing 170 kg/m², corresponding to a pressure of 1.67 kPa on lay down the multilayered membrane (10), which is composed by one three dimensional polypropylene monofilaments, entangled and welded where they cross, wavy shaped with parallel channels structure mesh (101), weighing 550 g/m², by a needled and resin polyester mat, with 6 to 18 dtex polyester fibers, (201) weighing 250 g/m² and top finished with a low density polyethylene (301) weighing 50 g/m². In such conditions, the transmission of tapping noise that in the absence of an interposed material is greater than 80 dB, is reduced to a normalized sound level L\text{nw} of 48 dB, corresponding to an Impact Insulation Class of 62. In this configuration the multilayered membrane has an apparent dynamic stiffness of 12 MN/m² according to EN 29052.

[0060] In a second preferred embodiment of the invention, (FIG. 2) it is foreseen that under the 50 mm (1.5") tiled floating slab weighing 170 kg/m², corresponding to a pressure of 1.67 kPa or 34.82 psf on lay down the multilayered membrane (20), which is composed by one three dimensional polypropylene threads mesh (102), entangled and welded where they cross, cusped shaped, weighing 550 g/m², by a needled and resin polyester mat, with 6 to 18 dtex polyester fibers, (202) weighing 250 g/m², and top finished with polypropylene breathable waterproofing membrane (302) weighing 150 g/m². In such conditions, the transmission of tapping noise that in the absence of an interposed material is greater than 80 dB, is reduced to a normalized sound level L\text{nw} of 45 dB, corresponding to an Impact Insulation Class of 65. In this configuration the multilayered membrane has an apparent dynamic stiffness of 9 MN/m² according to EN 29052.

[0061] In a third preferred embodiment of the invention, (FIG. 3) it is foreseen that under the 50 mm (1.5") tiled floating slab weighing 170 kg/m², corresponding to a pressure of 1.67 kPa or 34.82 psf on lay down the multilayered membrane (30) which is composed by one three dimensional polypropylene threads mesh (103), entangled and welded where they cross, cusped shaped, weighing 550 g/m². This three dimensional mesh is comprised between a sandwich of two mats made up of needled and resin polyester (203a and 203b), whose polyester fibers are from 6 to 18 dtex, weighing each one 250 g/m², and in which at least one of the polyester mats are coupled with a waterproofing breathable polypropylene membrane (303a) 100 g/m² weighing. In such conditions, the transmission of tapping noise that in the absence of an interposed material is greater than 80 dB, is reduced to a normalized sound level L\text{nw} of 42 dB, corresponding to an Impact Insulation Class of 68. In this configuration the multilayered membrane has an apparent dynamic stiffness of 8 MN/m² according to EN 29052.

[0062] In the described solutions, multilayered impact sound deadening membrane (10, 20, 30) is composed by the resilient mat (201, 202, 203a, 203b) that is a needled and
resined polyester synthetic fibers mat, with 3.3 to 20 dtex fibers and preferably 6 to 17 dtex fibers, and with a total weight comprised between 150 e to 450 g/m², preferably comprised between 200 and 300 g/m². As for at least one of the finishing layers, (301 302, 303), it is in low density polyethylene weighing from 10 to 100 g/m².

[0063] Multilayered membrane (10, 20, 30) can have a finishing layer (301, 302, 303), in waterproofing breathable polypropylene membrane, weighing from 50 to 200 g/m², preferably from 80 to 160 g/m² with water penetration resistance higher than 2 meters (m) of water column according to EN 20811, with a vapor diffusion coefficient sd comprised between at least 0.01 and at most 0.05 according to EN ISO 12572.

[0064] Finishing breathable waterproofing layer (301, 302, 303) can besides be in polyester.

[0065] Furthermore the impact sound deadening membrane (10, 20, 30) can have a finishing layer in waterproofing breathable membrane (301, 302, 303) at least 8 cm larger than the other layers along the entire length of the roll, forming a selvedge equipped with a minimum 15 mm wide bituminous or butyl or bi-adhesive strip, protected by a silicone release paper, which is used to seal the connections between different rolls in opera.

**LEGEND**

[0066] (10, 20, 30) multilayer impact sound deadening membrane

[0067] (101, 102, 103) three dimensional polypropylene threads mesh entangled and welded where they cross

[0068] (201, 202, 203a, 203b) resilient mat in polyester fibers

[0069] (301, 302, 303) finishing waterproofing membrane

1. A multilayered composite material membrane, being sound insulating and sound absorbent towards impact noise in flooring and thermal insulation auxiliary, the membrane comprising:

- at least one 3-dimensional polymeric monofilaments mat;
- at least one resilient mat; and
- at least one waterproofing, finishing layer, wherein said resilient mat is a synthetic fibers mat coupled with at least one waterproofing finishing layer, the mats and layer having a total thickness, under a weight of 2 kPa, comprised between at least 8 mm and at most 15 mm.

2. The multilayered composite membrane according to claim 1, having a thickness under a weight of 2 kPa between at least 10 mm and 12.5 mm.

3. The multilayered composite material membrane according to claim 1, wherein the 3-dimensional polymeric monofilaments mat is comprised of polypropylene based extruded filaments, entangled and welded at crossings, having a weight comprised between 400 g/m² and 700 g/m² and having a thickness under a weight of 2 kPa comprised between at least 8 and at most 10 mm.

4. The multilayered composite material membrane according to claim 1, wherein the 3-dimensional polymeric monofilaments mat is comprised of polypropylene based extruded filaments, entangled and welded at crossings, being wavy shaped with parallel channels structure.

5. The multilayered composite material membrane according to claim 1, wherein the three dimensional polymeric monofilaments mat is comprised of polypropylene based extruded filaments, entangled and welded at crossings and having a cusped shape.

6. The multilayered composite material membrane according to claim 1, wherein the three dimensional polymeric monofilaments mat is comprised of polyester based extruded filaments, entangled and welded at crossings.

7. The multilayered composite material membrane according to claim 1, wherein the three dimensional polymeric monofilaments mat is comprised of polyamide based extruded filaments, entangled and welded at crossings.

8. The multilayered composite material membrane according to claim 1, wherein the resilient mat is comprised of a non woven fabric of synthetic fibers.

9. The multilayered composite material membrane according to claim 1, wherein the resilient mat is comprised of 3.3 to 20 dtex synthetic polyester fibers, needled and resined.

10. The multilayered composite material membrane according to claim 1, wherein the resilient mat is comprised of 6 to 17 dtex synthetic polyester fibers, needled and resined.

11. The multilayered composite material membrane according to claim 1, wherein at least one resilient mat is comprised of synthetic polyester needled and resined fibers, having a weight between at least 150 g/m² and at most 450 g/m².

12. The multilayered composite material membrane according to claim 1, wherein the at least one resilient mat is comprised of synthetic polyester needled and resined fibers, having a weight between at least 200 g/m² and at most 300 g/m².

13. The multilayered composite material membrane according to claim 1, wherein the at least one waterproofing finishing layer is comprised of low density polyethylene, weighing between at least 10 g/m² and at most 80 g/m².

14. The multilayered composite material membrane according to claim 1, wherein the at least one waterproofing finishing layer is comprised of a waterproofing and vapor permeable synthetic spun bonded tissue.

15. The multilayered composite material membrane according to claim 1, wherein the at least one waterproofing finishing layer is comprised of waterproofing and vapor permeable synthetic spun bonded tissue weighing between at least 90 g/m² and at most 160 g/m², with water penetration resistance higher than 2 meters of water column according to EN 20811, with a vapor diffusion coefficient sd comprised between at least 0.01 and at most 0.05 according to EN ISO 12572.

16. The multilayered composite material membrane according to claim 1, wherein the at least one waterproofing finishing layer is comprised of waterproofing and vapor permeable polypropylene based spun bonded tissue.

17. The multilayered composite material membrane according to claim 1, wherein the at least one waterproofing finishing layer is comprised of waterproofing and vapor permeable polyester based spun bonded tissue.

18. The multilayered composite material membrane according to claim 1, wherein the at least one waterproofing finishing layer is comprised of a waterproofing and vapor permeable synthetic spun bonded tissue at least 8 cm larger than the monofilament mat and the resilient mat, forming a selvedge equipped with a minimum 15 mm wide butyl strip, protected by a release silicone paper.