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(54) Panels with antinoise and antifragmentation properties on the basis of acrylic glass, process for their preparation and use thereof

Tafel mit Lärm- und Splitterschutzeigenschaften auf der Basis von Kunstglas, Verfahren zu ihrer Herstellung und Verwendung dafür

Panneaux avec propriétés anti-bruit et anti-fragmentation sur la base de verre acrylique, leur processus de préparation et utilisation correspondante

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Description

Technical field of the invention

[0001] The present invention relates to panels on the basis of polymethylmethacrylate (so called acrylic glass) with embedded reinforcing polymer monofilament fibres in the form of a three-dimensional fibre entanglement, wherein the reinforcing polymer monofilament fibres are embedded into the polymethylmethacrylate matrix in such a manner that they are oriented in all directions and distributed apparently uniformly in all directions, so that the fibres are apparently uniformly distributed essentially throughout the entire cross-section of the panel i.e. throughout its entire volume. The present invention also relates to a process for manufacturing such panels and to the use thereof.

[0002] The present invention particularly relates to transparent panels on the basis of polymethylmethacrylate (PMMA), into which polyacryl monofilament fibres in the form of a three-dimensional entanglement or a non-woven fabric are embedded apparently uniformly essentially throughout the entire cross-section of the panel or throughout its entire volume. These panels are particularly suitable as antinoise elements for noise barriers on highways, bridges, viaducts and similar as they also have, due to the built-in reinforcing polymer monofilament fibres, good antibreaking and antifragmentation properties in addition to antinoise properties.

Prior Art

[0003] Antinoise panels on the basis of acrylic glass with embedded reinforcing monofilament threads and their preparation have already been described in EP 0407852 A2. This document describes panels having, in relation to their cross-section, approximately centrally placed monofilament threads of plastic material (polyamide) or a grid netting made of such monofilament threads. These panels are manufactured in such a manner that monofilament threads with a preferred diameter of 0.2 mm to 2 mm are strained across a mould, whereupon a prepolymer on the basis of acrylates is poured into the mould. According to one embodiment the threads are placed parallel to each other with a distance between the threads from 8 mm to 100 mm, and the threads may also be in the form of a net (i.e. the threads are placed at an angle of 90°).

[0004] The document EP 0826832 A2 describes antinoise panels with antifragmentation properties made of acrylic polymers and with embedded monofilament threads which, however, are not placed centrally with respect to the cross-section of the panel. It is described in the document that the threads are placed at a thickness between 20 and 35% of the total thickness of the panel and towards the surface opposite to the surface exposed to vehicles running into it. Thus, due to the position of the fibres, it is important which surface of the panel is exposed to crashes and impacts and the panel can be defined as a "two-sided" one with regard to its mechanical properties - one side of the panel is essentially more reinforced against mechanical stresses than the other. It is also described that monofilament threads generally have a diameter between 0.1 and 4 mm, preferably between 2 and 3 mm. Threads or bands made of threads are placed at a distance from 10 to 100 mm. Also in this case the included threads have an essentially planar structure (the threads are in one level) i.e. it is about strained threads, net or bands. The monofilament threads are strained across the mould either parallelly or in the form of bands or of a net. In the case of bands, they have a width of 5-25 mm and a thickness equal to that of the monofilament threads they are made of. The document neither describes in which manner the threads are built-in into the panel nor in which manner an appropriate position of the built-in threads in the course of the manufacturing process or at the polymerisation of PMMA is achieved.

[0005] Also EP 1119662 B1 (WO 00/20690 A1) describes antinoise panels made of acrylic glass with monofilament threads embedded into the acrylic matrix with the aim of improving the antifragmentation properties of the panels and which have a maximal deviation of 1 mm or more, preferably 5 mm from an imaginary line running through the ends of this thread. The polyamide or polypropylene threads can be inserted into the panel transversely or parallelly to the plane of the panel. The threads can be embedded into the panel in such a way that they are parallel to each other and run in one direction, yet they can also run parallel to each other in several directions. The diameter of the threads used is from 0.2 to 2.0 mm and the distance between them can be in a range between 8 and 100 mm. In one of the embodiments the threads are placed in such a manner that a wavy arrangement of the threads is visible in the cross-section. Also in this case the threads are arranged parallelly and essentially planarly. From the examples it is evident that also in this process of manufacturing the panels the threads are inserted into the panel in such a manner that they are strained through the mould.

[0006] Thus, in the hitherto known prior art solutions threads are embedded into a panel on the basis of acrylic polymers in such a manner that they are strained through a mould, whereupon the prepolymer forming a polymer matrix (e.g. PMMA) is poured into the mould. For straining the threads there is required a mechanism for inserting the threads and maintaining them in the position from the construction of the mould up to the end of the curing of polymethylmethacrylate. The threads are strained in a specific exactly defined order or arrangement, which depends, *inter alia,* also on the straining tools, which results in non-enforced parts between parallelly arranged threads i.e. in places where only PMMA is present. In addition, in the process of manufacturing the reinforced acrylic panel the straining of the monofilament threads or net or bands also requires some additional time. Neither is it evident that monofilament threads would be apparently uniformly arranged throughout the cross-section of the panel and thus throughout the entire volume of the panel.

Solution to the technical problem and a detailed description of the invention

[0007] The present invention relates to panels on the basis of polymethylmethacrylate with embedded reinforcing polymer monofilament fibres in the form of a three-dimensional fibre entanglement, the fibres being embedded into the polymethylmethacrylate matrix in such a manner that they are oriented in all directions and distributed apparently uniformly in all directions, so that the fibres are apparently uniformly distributed essentially throughout the entire cross-section of the panel i.e. its entire volume, as defined in claim 1.

[0008] The distribution throughout the essentially entire cross-section of the panel i.e. its entire volume means that the fibre entanglement is distributed throughout at least 90% of its entire cross-section or volume.

[0009] The reinforcing polymer monofilament fibres are embedded into the panel according to the invention in the form of a three-dimensional fibre entanglement or non-woven fabric. Thus the panels according to the invention are reinforced in all (three) directions. So far there have neither been known the existence of panels made of acrylic glass with embedded three-dimensional fibre entanglements nor the use of three-dimensional entanglements of polymer fibres in the process for manufacturing reinforced panels made of acrylic glass in order to reinforce and improve their antifragmentation properties.

[0010] The panels according to the present invention are especially suitable as antinoise elements (sound barriers) e.g. on highways, bridges, viaducts, they can also be used in facade building systems, for separation walls, balustrades and similar. Due to the monofilament fibres embedded into the panel throughout its entire cross-section, the panels according to the invention have improved antibreaking or antifragmentation properties as they can, e.g. in case of a vehicle crashing into the antinoise element along the road, prevent the falling off of any, even small broken particles of the antinoise element onto the roadway or into the surroundings. The panels according to the invention may also be used in devices and machines where protection against the impact of particles is required and where panels made of non-reinforced PMMA or polycarbonate have hitherto been used for such protection. If a panel with embedded polymer, preferably polyamide fibres according to the invention should break, the built-in fibres prevent the formation and the falling-off of any, even small broken particles since these adhere to the built-in polyamide fibres.

[0011] The present invention also relates to a novel process for manufacturing panels on the basis of polymethylmethacrylate with embedded reinforcing polymer monofilament fibres in the form of a three-dimensional fibre entanglement, as defined in claim 10.

[0012] Accordingly, the process for manufacturing the panels according to the invention runs in such a manner that

- into a partly completed mould, which, on one side, is formed by a tempered glass plate onto which an appropriate seal is placed,
- reinforcing polymer monofilament fibres in the form of a three-dimensional fibre entanglement capable of retaining its form over a long time period are placed, whereat the fibres in this entanglement are oriented in all directions and arranged apparently uniformly in such a manner that the fibre entanglement is placed across the entire surface of the partly completed mould,
- whereupon onto thus prepared construction a second tempered glass plate is placed and the mould is fixed,
- and then into the prepared mould a pre-prepared suitable prepolymer on the basis of methylmethacrylate is poured,
- which is followed by polymerization and de-moulding phases known in the art so that finally a polymethylmethacrylate panel with embedded fibres is obtained.

[0013] In the process according to the invention there is no need for holding the inserted fibres in the mould in order to provide a uniform distribution of the fibres throughout the entire volume of the final panel since the used three-dimensional fibre entanglement has a sufficiently high strength for the fibres to remain fixed and not to subside due to their own weight. A suitable arrangement of the fibres throughout the entire cross-section of the final panel is achieved by itself due to the thickness of the entanglement of the polyamide fibres (which is essentially the same as the thickness of the final product), which are thus distributed essentially throughout the entire volume of the panel. The process according to the invention does not require additional straining mechanisms for straining the reinforcing polymer monofilament threads, which makes the process simpler and also shorter because it does not comprise the phase of straining the threads.

[0014] Suitable reinforcing monofilament polymer fibres used according to the present invention can be polyethylene, polycarbonate, polyamide or polypropylene fibres that are previously formed, e.g. by extrusion, into a three-dimensional fibre entanglement or non-woven fabric having the capability to retain the shape (thickness and width) throughout a long period of time. The entanglement is essentially made of endless fibres.

[0015] In a preferred embodiment of the present invention, polyamide monofilament fibres in the form of three-dimensional entanglement, which is a self-standing three-dimensional formation, are embedded into a panel on the basis of polymethylmethacrylate. The fibres, preferably polyamide fibres may have a diameter of 0.2 to 2 mm, preferably from 0.5 to 0.8 mm, particularly preferably 0.7 mm.

[0016] The mass of the three-dimensional entanglement of polymer monofilament fibres, preferably polyamide fibres, which can be used according to the invention, may range from 50 to 1000 g/m^2. In a preferred embodiment the three-dimensional entanglement of polyamide fibres has a mass between 300 and 500 g/m^2.

[0017] Depending on the final purpose of use of the panels according to the invention, the panels may have thickness from 3 mm to 100 mm, preferably from 3 to 25 mm.

[0018] In a particularly preferred embodiment of the panel according to the invention, a fibre entanglement is embedded into the panel with the polyamide fibres having a diameter of 0.7 mm, the entanglement having a thickness of 13.5 $\pm$ 0.5 mm and a weight of 380 $\pm$ 20 g/m^2, and the final panel having a thickness about 15 mm. In such a case the mass of the embedded fibres represents about 2.5% of the total mass of the final product.

[0019] Into the panels according to the invention a reinforcing three-dimensional entanglement made of fibres of all colours can be embedded, which depends on the final purpose of the use of the product and also on the desired decorative effects. Preferably, an entanglement of fibres made of colourless (transparent) polyamide fibres is embedded into the panels. By including an entanglement made of colourless polyamide fibres into the panel, it is provided that at least 90% of the incident light flow is passed through the panel since the light may also pass through the reinforcing fibres.

[0020] Due to the different refractive indices of the PMMA matrix and the polyamide fibres in the product, the light passing through the panel refracts differently. Depending on the diameter and the interweaving of the fibres in the entanglement embedded into the PMMA matrix, a sufficient visibility of the reinforcing entanglement in the panel can be provided by a suitable thickness and density of the fibres, whereby e.g. the probability for birds crashing into an otherwise transparent antinoise road element is diminished.

[0021] Due to the uniform distribution of the fibres in all directions and essentially throughout its entire volume, the panel according to the invention has the two sides with essentially the same mechanical properties. No so-called two-sidedness i.e. a difference in the properties of either side of the panel occurs, for which reason at setting up the panels onto the final object such as an antinoise road element, there is no need for taking care which side of the panel is directed towards the roadway.

[0022] Due to the uniform distribution of the threads throughout the entire volume of the panel and the more uniform density of the fibres in each cubic centimetre of the panel, the tensions occurring in the material at an impact against the panel can be transferred to a larger number of fibres. Further, we believe that the panel has a higher strength also due to the fact that the fibres are not "over-strained" i.e. there is no tension in them as a consequence of previous straining of the threads onto a framework or a mould in order to incorporate them into the panel. Therefore such a panel can withstand higher pressures and it can be expected that also small particles forming at a breakage of the panel will be left hanging on the embedded reinforcing fibres and at panel brake and will not fall into the surroundings, e.g. onto the roadway if the panels are used as noise barriers on the road.

[0023] If compared with prior art panels, the panels according to the invention contain more reinforcing fibres, which are more uniformly distributed throughout the entire volume of the panel, the impact strength of the panels is improved. The impact strength takes more uniform values across the entire surface of the panel in comparison to the hitherto known panels where large non-reinforced gaps are present between parallelly arranged threads.

[0024] The novel process of manufacturing polymethylmethacrylate panels with embedded reinforcing polyamide monofilament fibres according to the invention runs, according to a preferred embodiment of the invention, in such a manner that first a methylmethacrylate monomer and additives commonly used in the art are dosed into a suitable reactor. The additives that are used in small amounts and determine the properties of the acrylic glass or aid in the synthesis are azo and peroxy initiators, redox initiators, plasticizers, colourants (pigments, colours), de-moulding agents, optical whitening agents, UV stabilizers and other acrylates and methacrylates, especially butylacrylate, ethylacrylate, 2-ethylhexylacrylate, acrylic and methacrylic acid.

[0025] In the reactor a prepolymer is prepared in such a way that a polymeryzation reaction of methylmethacrylate is set off up to a suitable conversion e.g. 10-30%, preferably 15-20%. Usually the reaction is completed in 1.5 hours. The formed prepolymer of high viscosity is poured into mixing vessels and optionally also colourants and other additives such as peroxy initiators and cross-linkers are added. Now the prepolymer is prepared for casting.

[0026] The mould for casting the prepolymer is put together on a mould composing line. First tempered glass plates, which may be of various dimensions, are appropriately cleaned and dried. Then on a table for laying the seal, which is preferably on the basis of polyvinylchloride (PVC), at 3-5 cm from the edge of the glass plate a polyvinylchloride profile of a suitable thickness is placed. Onto the glass a self-standing three-dimensional reinforcing entanglement of polymer monofilament fibres is placed and, in the next phase, onto this construction another tempered glass plate is placed. Thus, a glass mould with an inserted reinforcing three-dimensional fibre entanglement, preferably of polyamide fibres, and with a sealing placed at the edge is obtained.

[0027] The prepared prepolymer is gravimetrically dosed and poured into the composed moulds depending on the desired and required amount. Filled moulds are placed vertically into special stands. As the three-dimensional entanglement has a sufficient fibre strength (i.e. is selfstanding), the fibres remain in the original position and do not subside or move. The stands are placed into water basins with a temperature of 45-60°C. At this temperature the greatest part of polymerisation takes place within in a period of 5-15 hours.

[0028] The synthesis of the panels is finished in an air oven at a temperature of 100-130°C. In this phase the polymerisation is completed within a period of 2-5 hours. After the completed process the moulds are cooled and the panels are taken from the moulds.

[0029] The mechanical properties of the panels are determined by standard tests and methods established in the art.

[0030] The impact properties of the panels were determined by determining the Charpy impact toughness according to ISO 179 standard representing the energy required to break the material.

[0031] Our measurements of toughness according to this standard for the panels according to the invention and made according to the above novel process showed a 1.7 times higher value of toughness than for non-reinforced PMMA material. The measurements of Road and Bridge Institute IBDiM (IBDiM, Instytut Badawczy Dróg I Mostów), Warsaw, Poland showed, on average, 1.52 times higher values of toughness in comparison to that of usual PMMA panels. The absolute value of toughness ranged from 19.8 to 22.3 kJ/m^2.

[0032] Due to the improved impact properties of the panels it can be concluded that the panels according to the invention stand higher impact stresses. This means that they compensate a higher energy released at impact or crash of vehicles. In our measurements performed according to the standard EN 1794-1 Annex C - "Test on resistance against impact of stones", a three times higher value of stone energy was determined than the one required according to the standard and with regard to non-reinforced PMMA panels.

[0033] In Figure 1 a panel with embedded reinforcing monofilament polyamide fibres in the form of a three-dimensional fibre entanglement is illustrated.

[0034] The following examples merely serve to illustrate the present invention and in by no means represent a limitation of the scope of the invention.

Example 1

Synthesis of a panel on a laboratory scale

[0035] We prepared a mould made of two tempered glasses having a thickness of 5 mm, a width of 275 mm and a height of 350 mm and of a PVC seal having a thickness of 17 mm. The seal was laid only at three sides so that the mould was still open at the top. It was compressed by fix clamps. Into the mould a three-dimensional entanglement of colourless polyamide fibres Geomat Italgrimp, producer Greenvision Ambiente divizione Italdreni, Italy was inserted in such a manner that the entanglement essentially covered the entire surface/volume of the mould. The entanglement had a thickness of 13.5 $\pm$ 0.5 mm and a surface of 200 mm x 200 mm. The thickness of single fibres was 0.5 $\pm$ 0.03 mm, the mass of the entanglement was 350 $\pm$ 20 g/m^2.

[0036] In a reactor a prepolymer was prepared from 1.5 kg of a mixture of monomers of methylmethacrylate (MMA) and 2-ethylhexylacrylate (2-EHA) and commercially available azo initator. The mixture was heated under constant stirring to the temperature 92°C and this temperature was maintained for the entire time of the reaction. After 15 minutes at reaction temperature, the mixture was cooled to room temperature under constant stirring. The viscosity of the prepolymer was measured according to Ford: Ford cup ϕ = 4 mm, prepolymer flow time at 23°C was 154 s.

[0037] The prepared prepolymer was poured into a cup and, during constant stirring, commercially available peroxy initiators and the cross linker 1,4-butanedioldimethacrylate (1,4-BDDMA) were added. The well-stirred mixture was filtered and poured into the prepared mould. The mould was set into a water bath at 52°C for 12 hours for polymerization to occur.

[0038] Then it was transferred into an air oven at 130°C where postpolymerization took place for 1 hour. After the completed reaction the mould was cooled to room temperature, dismantled and a polymethylmethacrylate panel with an embedded reinforcement of polyamide fibres was taken out. The finished panel had a thickness of 15 mm.

[0039] From this panel a test tube was cut out and the toughness was measured by Charpy test according to ISO 179. The toughness value was 19.8 $\pm$ kJ/m^2.

Example 2

Synthesis of a panel on industrial scale

[0040] Moulds were prepared in a mould-preparation line from two tempered glass plates having a thickness of 10 mm and a size of 2600 mm x 2100 mm and a PVC seal having a thickness of 19 mm. The seal was placed on the edge of the bottom glass at approximately 30 mm from the edge and onto the glass a three-dimensional entanglement of colourless polyamide fibres Geomat Italgrimp, producer Greenvision Ambiente divizione Italdreni, Italy was placed so that the entanglement essentially covered the entire surface of the mould. The entanglement had a thickness of 13.5 $\pm$ 0.5 mm and a surface of 2000 mm x 2500 mm. The thickness of single fibres was 0.4 $\pm$ 0.03 mm, and the mass of the entanglement was 300 $\pm$ 20 g/m^2. Partially finished moulds were covered by the second tempered glass and the moulds were compressed by fix clamps.

[0041] In a 400L-reactor a prepolymer was prepared from 360 kg of a mixture of monomers of methylmethacrylate (MMA) and ethylacrylate (EA) and a commercially available azo initator. The mixture was heated under constant stirring to the temperature 93°C and this temperature was maintained for the entire time of the reaction. After 10 minutes at the reaction temperature the mixture was cooled to room temperature under constant stirring. The viscosity of the prepolymer was measured according to Ford: Ford cup ϕ = 4 mm, prepolymer flow time at 23°C was 88 s.

[0042] The prepared prepolymer was poured into a mixing vessel and, during constant stirring, commercially available azo and redox initiators and the cross linker 1,4-butanedioldimethacrylate (1,4-BDDMA) were added.

[0043] In a dosing line the well-stirred mixture was poured into the prepared moulds open at one side. Several moulds were placed together into a stand and set into a water bath at 54°C for 11 hours for polymerization to occur.

[0044] Then they were transferred into an air oven where postpolymerization according to a temperature programme was carried out during 3 hours. After the completed reaction the moulds were cooled to room temperature, dismantled and the panels with polyamide reinforcement were taken out. The finished panel had thickness of 15 mm.

[0045] The panels were used for testings according to standards EN 1793 and EN 1794. The panels correspond to values prescribed by the standards. Test on resistance against impact of stones showed that the panel remained undamaged even above 90 kJ (simulation of energy of stones).

Claims

1. A panel on the basis of polymethylmethacrylate with embedded reinforcing polymer monofilament fibres having antinoise properties and improved antifragmentation properties **characterized in that** reinforcing polymer monofilament fibres in the form of a three-dimensional fibre entanglement are embedded into the polymethylmethycrylate matrix, the fibres being embedded into the polymethylmethacrylate matrix in such a manner that they are oriented in all directions and distributed apparently uniformly in all directions, so that the fibres are apparently uniformly distributed essentially throughout the entire cross-section of the panel i.e. throughout its entire volume.

2. A panel according to claim 1, **characterized in that** embedded polymer monofilament fibres are polyethylene, polycarbonate, polyamide or polypropylene fibres.

3. A panel according to any of the claims 1 to 2, **characterized in that** polymer monofilamet fibres are polyamide fibres.

4. A panel according to any of the claims 1 to 3, **characterized in that** fibres have a diameter from 0.2 to 2 mm.

5. A panel according to any of the claims 1 to 4, **characterized in that** fibres have a diameter from 0.5 to 0.8 mm.

6. A panel according to any of the claims 1 to 5, **characterized in that** three-dimensional fibre entanglement has a mass from 50 to 1000 g/m^2.

7. A panel according to any of the claims 1 to 6, **characterized in that** three-dimensional fibre entanglement has a mass from 300 to 500 g/m^2.

8. A panel according to any of the claims 1 to 7, **characterized in that** it has a thickness from 3 to 100 mm.

9. A panel according to any of the claims 1 to 8, **characterized in that** embedded three-dimensional fibre entanglement has a thickness of 13.5 $\pm$ 0.5 mm and mass 380 $\pm$ 20 g/m^2 and the panel has final thickness of about 15 mm.

10. A process for manufacturing polmethylmethacrylate panels with embedded reinforcing polymer monofilament fibres, **characterized in that**

- into a partly completed mould which is on one side represented by a tempered glass plate onto which an appropriate seal is placed,
- reinforcing polymer monofilament fibres in a form of three-dimensional fibre entanglement capable of retaining its form over long time period are placed, whereby the fibres in this entanglement are directed in all directions and are arranged apparently uniformly in such a manner that fibre entanglement is placed across the entire surface of partly completed mould,
- whereupon onto thus prepared construction the second tempered glas plate is placed and the mould is fixed,
- then into so prepared mould pre-prepared suitable prepolymer on the basis of methylmethacrylate is poured,
- followed by in the art known polymerization and de-moulding phases so that finally polymethylmethacrylate panel with embedded fibres is obtained.

11. A process for manufacturing the panel according to claim 10, **characterized in that** polymer monofilament fibres are polyethylene, polycarbonate, polyamide or polypropylene fibres.

12. A process for manufacturing the panel according to any of the claims from 10 to 11, **characterized in**

that polymer monofilament fibres are polyamide fibres.

13. A process for manufacturing the panel according to any of the claims from 10 to 12, **characterized in that** fibres have a diameter from 0.2 to 2 mm.

14. A process for manufacturing the panel according to any of the claims from 10 to 13, **characterized in that** fibres have a diameter from 0.5 to 0.8 mm.

15. A process for manufacturing the panel according to any of the claims from 10 to 14, **characterized in that** three-dimensional fibre entanglement has a mass from 50 to 1000 g/m^2.

16. A process for manufacturing the panel according to any of the claims from 10 to 15, **characterized in that** three-dimensional fibre entanglement has a mass from 300 to 500 g/m^2.

17. A process for manufacturing the panel according to any of the claims from 10 to 16, **characterized in that** embedded three-dimensional fibre entanglement has a thickness of 13.5 $\pm$ 0.5 mm and mass 380 $\pm$ 20 g/m^2 and the panel has final thickness of about 15 mm.

18. A use of the panel according to any of the claims from 1 to 9 as antinoise element along roads, bridges and/or viaducts, in façade systems, separating walls or as protection panel in devices and machines.

Patentansprüche

1. Platte auf der Basis von Polymethylmethacrylat mit eingebetteten verstärkenden Polymer-Monofilamentfasern mit lärmdämpfenden Eigenschaften und verbesserten Bruchverhinderungseigenschaften, **dadurch gekennzeichnet, dass** verstärkende Polymer-Monofilamentfasern in Form eines dreidimensionalen Fasergeflechts in die Polymethylmethacrylatmatrix eingebettet sind, wobei die Fasern derart in die Polymethylmethacrylatmatrix eingebettet sind, dass sie in alle Richtungen orientiert sind und in alle Richtungen anscheinend gleichmäßig verteilt sind, so dass die Fasern im Wesentlichen über den gesamten Querschnitt der Platte, d.h. über ihren gesamten Rauminhalt, anscheinend gleichmäßig verteilt sind.

2. Platte nach Anspruch 1, **dadurch gekennzeichnet, dass** die eingebetteten Polymer-Monofilamentfasern Polyethylen-, Polycarbonat-, Polyamid- oder Polypropylenfasern sind.

3. Platte nach einem der Ansprüche 1 bis 2, **dadurch gekennzeichnet, dass** die Polymer-Monofilamentfasern Polyamidfasern sind.

4. Platte nach einem der Ansprüche 1 bis 3, **dadurch gekennzeichnet, dass** die Fasern einen Durchmesser von 0,2 bis 2 mm haben.

5. Platte nach einem der Ansprüche 1 bis 4, **dadurch gekennzeichnet, dass** die Fasern einen Durchmesser von 0,5 bis 0,8 mm haben.

6. Platte nach einem der Ansprüche 1 bis 5, **dadurch gekennzeichnet, dass** das dreidimensionale Fasergeflecht eine Masse von 50 bis 1000 g/m^2 hat.

7. Platte nach einem der Ansprüche 1 bis 6, **dadurch gekennzeichnet, dass** das dreidimensionale Fasergeflecht eine Masse von 300 bis 500 g/m^2 hat.

8. Platte nach einem der Ansprüche 1 bis 7, **dadurch gekennzeichnet, dass** sie eine Dicke von 3 bis 100 mm hat.

9. Platte nach einem der Ansprüche 1 bis 8, **dadurch gekennzeichnet, dass** das eingebettete dreidimensionale Fasergeflecht eine Dicke von 13,5 $\pm$ 0,5 mm und eine Masse von 380 $\pm$ 20 g/m^2 hat und die Platte eine Enddicke von etwa 15 mm hat.

10. Verfahren zum Herstellen von Polymethylmethacrylatplatten mit eingebetteten verstärkenden Polymer-Monofilamentfasern, **gekennzeichnet durch** folgende Schritte:

- Einbringen, in eine teilweise fertige Form, die auf einer Seite **durch** eine getemperte Glasplatte gegeben ist, auf der eine geeignete Dichtung angeordnet ist, von verstärkenden Polymer-Monofilamentfasern in Form eines dreidimensionalen Fasergeflechts, welches seine Form über einen langen Zeitraum halten kann, wobei die Fasern in diesem Geflecht in alle Richtungen orientiert werden und derart anscheinend gleichmäßig angeordnet werden, dass das Fasergeflecht über der gesamten Oberfläche der teilweise fertigen Form angeordnet wird,
- anschließendes Anordnen der zweiten getemperten Glasplatte auf der so präparierten Anordnung und Befestigen der Form,
- darauf folgendes Gießen eines geeigneten vorbereiteten Prepolymers auf der Basis von Methylmethacrylat in die so präparierte Form und
- nachfolgendes auf dem Fachgebiet bekanntes Polymerisieren und Entformen der Phasen, so dass schließlich eine Polymethylmethacrylatplatte mit eingebetteten Fasern erhalten wird.

11. Verfahren zum Herstellen der Platte nach Anspruch 10, **dadurch gekennzeichnet, dass** die Polymer-Monofilamentfasern Polyethylen-, Polycarbonat-, Polyamid- oder Polypropylenfasern sind.

12. Verfahren zum Herstellen der Platte nach einem der Ansprüche 10 bis 11, **dadurch gekennzeichnet, dass** die Polymer-Monofilamentfasern Polyamidfasern sind.

13. Verfahren zum Herstellen der Platte nach einem der Ansprüche 10 bis 12, **dadurch gekennzeichnet, dass** die Fasern einen Durchmesser von 0,2 bis 2 mm haben.

14. Verfahren zum Herstellen der Platte nach einem der Ansprüche 10 bis 13, **dadurch gekennzeichnet, dass** die Fasern einen Durchmesser von 0,5 bis 0,8 mm haben.

15. Verfahren zum Herstellen der Platte nach einem der Ansprüche 10 bis 14, **dadurch gekennzeichnet, dass** das dreidimensionale Fasergeflecht eine Masse von 50 bis 1000 g/m^2 hat.

16. Verfahren zum Herstellen der Platte nach einem der Ansprüche 10 bis 15, **dadurch gekennzeichnet, dass** das dreidimensionale Fasergeflecht eine Masse von 300 bis 500 g/m^2 hat.

17. Verfahren zum Herstellen der Platte nach einem der Ansprüche 10 bis 16, **dadurch gekennzeichnet, dass** das eingebettete dreidimensionale Fasergeflecht eine Dicke von 13,5 $\pm$ 0,5 mm und eine Masse von 380 $\pm$ 20 g/m^2 hat und die Platte eine Enddicke von etwa 15 mm hat.

18. Verwendung der Platte nach einem der Ansprüche 1 bis 9 als lärmdämpfendes Element entlang Straßen, Brücken und/oder Viadukten, in Fassadensystemen, Trennwänden oder als Schutzplatte in Vorrichtungen und Maschinen.

Revendications

1. Panneau à base de polyméthacrylate de méthyle avec des fibres de renfort noyées en monofilament de polymère ayant des propriétés antibruit et des propriétés améliorées d'antifragmentation, **caractérisé en ce que** des fibres de renfort en monofilament de polymère sous la forme d'un enchevêtrement de fibres tridimensionnel sont noyées dans la matrice de polyméthacrylate de méthyle, les fibres étant noyées dans la matrice de polyméthacrylate de méthyle d'une manière telle qu'elles sont orientées dans toutes les directions et réparties d'une manière apparemment uniforme dans toutes les directions, de telle sorte que les fibres sont réparties de manière apparemment uniforme essentiellement dans toute la section transversale du panneau, c'est-à-dire dans tout son volume.

2. Panneau selon la revendication 1, **caractérisé en ce que** les fibres noyées en monofilament de polymère sont des fibres de polyéthylène, de polycarbonate, de polyamide ou de polypropylène.

3. Panneau selon l'une quelconque des revendications 1 à 2, **caractérisé en ce que** les fibres en monofilament de polymère sont des fibres de polyamide.

4. Panneau selon l'une quelconque des revendications 1 à 3, **caractérisé en ce que** les fibres ont un diamètre de 0,2 à 2 mm.

5. Panneau selon l'une quelconque des revendications 1 à 4, **caractérisé en ce que** des fibres ont un diamètre de 0,5 à 0,8 mm.

6. Panneau selon l'une quelconque des revendications 1 à 5, **caractérisé en ce que** l'enchevêtrement de fibres tridimensionnel a une masse de 50 à 1000 g/m^2.

7. Panneau selon l'une quelconque des revendications 1 à 6, **caractérisé en ce que** l'enchevêtrement de fibres tridimensionnel a une masse de 300 à 500 g/m^2.

8. Panneau selon l'une quelconque des revendications 1 à 7, **caractérisé en ce qu'**il a une épaisseur de 3 à 100 mm.

9. Panneau selon l'une quelconque des revendications 1 à 8, **caractérisé en ce que** l'enchevêtrement de fibres tridimensionnel noyé a une épaisseur de 13,5 $\pm$ 0,5 mm et une masse de 380 $\pm$ 20 g/m^2 et le panneau a une épaisseur finale d'environ 15 mm.

10. Procédé de fabrication de panneaux de polyméthacrylate de méthyle avec des fibres de renfort noyées en monofilament de polymère, **caractérisé en ce que** dans un moule en partie terminé qui est représenté sur un côté par une plaque de verre trempé sur laquelle un joint approprié est placé,
des fibres de renfort en monofilament de polymère sous la forme d'un enchevêtrement de fibres tridimensionnel capable de conserver sa forme sur une longue durée sont placées, de sorte que les fibres dans cet enchevêtrement sont orientées dans toutes les directions et sont disposées d'une manière apparemment uniforme d'une manière telle que l'enchevêtrement de fibres est placé sur toute la surface du moule en partie terminé,
à la suite de quoi, sur la construction ainsi préparée,

la deuxième plaque de verre trempé est placée et le moule est fixé,
puis, dans le moule ainsi préparé, un pré-polymère préalablement préparé de manière appropriée à base de méthacrylate de méthyle est versé,
suivi par des phases de polymérisation et de démoulage connues dans le domaine de telle sorte que finalement un panneau de polyméthacrylate de méthyle avec des fibres noyées est obtenu.

11. Procédé de fabrication de panneau selon la revendication 10, **caractérisé en ce que** les fibres en monofilament de polymère sont des fibres de polyéthylène, de polycarbonate, de polyamide ou de polypropylène.

12. Procédé de fabrication de panneau selon l'une quelconque des revendications 10 à 11, **caractérisé en ce que** les fibres en monofilament de polymère sont des fibres de polyamide.

13. Procédé de fabrication de panneau selon l'une quelconque des revendications 10 à 12, **caractérisé en ce que** les fibres ont un diamètre de 0,2 à 2 mm.

14. Procédé de fabrication de panneau selon l'une quelconque des revendications 10 à 13, **caractérisé en ce que** les fibres ont un diamètre de 0,5 à 0,8 mm.

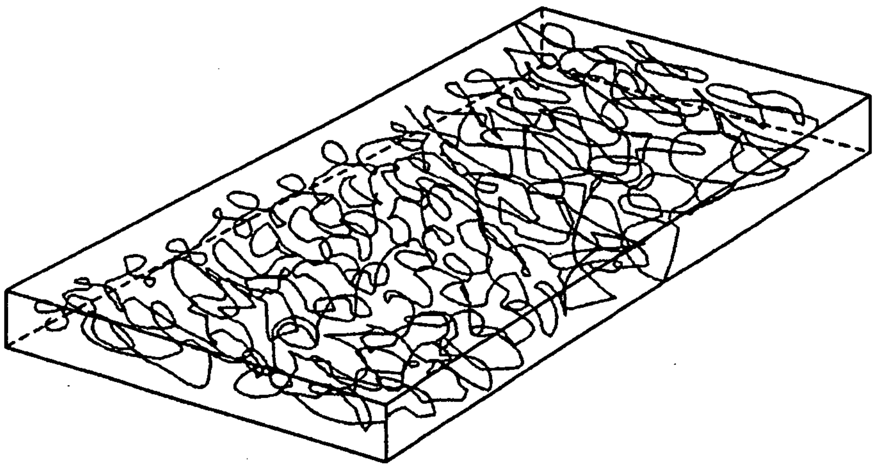
15. Procédé de fabrication de panneau selon l'une quelconque des revendications 10 à 14, **caractérisé en ce que** l'enchevêtrement de fibres tridimensionnel a une masse de 50 à 1000 g/m^2.

16. Procédé de fabrication de panneau selon l'une quelconque des revendications 10 à 15, **caractérisé en ce que** l'enchevêtrement de fibres tridimensionnel a une masse de 300 à 500 g/m^2.

17. Procédé de fabrication de panneau selon l'une quelconque des revendications 10 à 16, **caractérisé en ce que** l'enchevêtrement de fibres tridimensionnel noyé a une épaisseur de 13,5 $\pm$ 0,5 mm et une masse de 380 $\pm$ 20 g/m^2 et le panneau a une épaisseur finale d'environ 15 mm.

18. Utilisation du panneau selon l'une quelconque des revendications 1 à 9 en tant qu'élément antibruit le long de routes, de ponts et/ou de viaducs, dans des systèmes de façade, des murs de séparation ou comme panneau de protection dans des dispositifs et des machines.

Fig.1



REFERENCES CITED IN THE DESCRIPTION

Patent documents cited in the description

- EP 0407852 A2 **[0003]**
- EP 0826832 A2 **[0004]**
- EP 1119662 B1 **[0005]**
- WO 0020690 A1 **[0005]**