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(54) **A METHOD FOR MANUFACTURING BAMBOO SCRIMBERBOARD, AND BAMBOO SCRIMBERBOARD**

VERFAHREN ZUR HERSTELLUNG EINER BAMBUS-SCRIMBER-PLATTE, UND BAMBUS-SCRIMBER-PLATTE

PROCÉDÉ DE FABRICATION DE PANNEAU EN BAMBOU SCRIMBER, ET PANNEAU EN BAMBOU SCRIMBER

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(56) References cited:
WO-A2-2019/093898 US-A1- 2011 027 529

- **Anonymous: "Effects of particle size and orientation on properties of particleboard made from Ethiopian highland bamboo (Yushania alpina) - INBAR", Using Wood Composites as a Tool for Sustainable Forestry, Volume 163,, 31 December 2005 (2005-12-31), pages 65-71, XP055791708, Internet Retrieved from the Internet:
URL:<https://www.inbar.int/resources/article/effects-of-particle-size-and-orientation-on-properties-of-particleboard-made-from-ethiopian-highland-bamboo-yushania-alpina/> [retrieved on 2021-03-30]**
- **HUANG YUXIANG ET AL: "Development of bamboo scrimber: a literature review", JOURNAL OF WOOD SCIENCE, SPRINGER JAPAN KK, JP, vol. 65, no. 1, 21 June 2019 (2019-06-21), pages 1-10, XP036815339, ISSN: 1435-0211, DOI: 10.1186/S10086-019-1806-4 [retrieved on 2019-06-21]**

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Description

Background of the invention

[0001] The present invention relates to a method for manufacturing bamboo scrimberboard. Manufacturing bamboo scrimberboard is well known. E.g., documents CN 1970259 A, CN 101607411 A, US 2011 / 027 529 A1, WO 2019 / 093 898 A2 and Huang Yuxiang et al: "Development of bamboo scrimber: a literature review". Journal of Wood Science, Springer Japan KK, KP, vol. 65, no. 1, 21 June 2019, pages 1 - 10 disclose production methods for bamboo plates. Or in "Effects of particle size and orientation on properties of particleboard made from Ethiopian highland bamboo (*Yushania alpina*) INBAR", Using Wood Composites as a Tool for sustainable Forestry, Vol. 163, 31 December 2005, pages 65-71, XP055791708. Bamboo scrimberboard is usually manufactured using Asian bamboo, especially Chinese Moso bamboo, known as *Phyllostachys pubescens*. *Phyllostachys pubescens* is easy to handle and offers good properties for manufacturing scrimberboard. However, locally concentrating the production of bamboo scrimberboard to Asia for worldwide supplying with bamboo scrimberboard causes problems. Besides geopolitical problems, intensively exploiting resources usually leads to damages caused to the environment.

[0002] In Africa, huge bamboo resources have not been considered for being used for the production of scrimberboard. The unique characteristics of African bamboo species caused long-standing technical problems for utilizing African bamboo. In comparison to the well-known manufacturing process using Asian bamboo, the whole manufacturing process has to be modified to produce bamboo scrimberboard with bamboo of African origin.

Detailed description of the invention

[0003] The present invention was made in view of the prior art described above, and the object of the present invention is to provide an alternative method for the production of bamboo scrimberboard not utilizing Asian bamboo, while addressing the problems expressed above. The result is a bamboo scrimberboard with preferable mechanical and durability properties that is more environmentally friendly and cost-effective to produce and consumes less energy, and it enables to utilize bamboo of African origin.

[0004] To solve the problem, the present invention provides a method according to the independent method claim 1.

[0005] The method allows for utilizing bamboo of African origin for the production of scrimberboard. The fourth step and the fifth step have the surprising effect of producing low moisture content bamboo fiber bundles and therewith save a significant amount of energy and time. In particular, drying the fiber bundles without changing the chemical makeup of the fibers is also a possible embodiment of thermally modifying the fiber bundles. Drying the fiber bundles without changing the chemical makeup of the fibers includes particularly a physical drying process.

[0006] Further benefits and advantages of the present invention will become apparent after a careful reading of the detailed description with appropriate reference to the accompanying drawing.

[0007] According to the invention, the bamboo is *Yushania alpina* (African Highland Bamboo) and/or *Oxytenanthera abyssinica* (African Lowland Bamboo). *Yushania alpina* and *Oxytenanthera abyssinica* offer great characteristics for being used for manufacturing scrimberboard. Compared to *Phyllostachys pubescens*, one surprisingly finds that *Yushania alpina* is 74% more water resistant (after 2 h boiling, EN 1087-1 standard), offers 17% more stiffness (EN 310 standard) and 6% more strength (EN 310 standard). It is thinkable that the present disclosure is applicable to other bamboo species with comparable properties to *Yushania alpina* and/or *Oxytenanthera abyssinica* that are of African or non-African origin. It is further thinkable that those other bamboo species with comparable properties are found in comparable proveniences and/or climates as *Yushania alpina* and/or *Oxytenanthera abyssinica*. Preferably, the bamboo is of Ethiopian origin.

[0008] Advantageously, the used bamboo is 4 to 7 years old and/or the used bamboo culms have a diameter of 40 mm to 85 mm and/or the used bamboo culms have a wall thickness of 7.5 mm to 15 mm. It has been found, that 4 to 7 year old bamboo with a culm diameter of 40 mm to 85 mm and a wall thickness of 7.5 mm to 15 mm is suited for manufacturing of bamboo scrimberboard very well.

[0009] Advantageously, the outer arc length of the splits is a fraction of the bamboo pole circumference, wherein the poles are preferably split into 2 to 10 splits, wherein the poles are more preferably split into 3 to 5 splits. This allows for an effective disintegrating of the splits into fiber bundles. The anatomical features of African bamboo differ from those of Asian bamboo. Therefore, adapting process parameters is crucial for manufacturing high-quality bamboo scrimberboard.

[0010] In another preferable embodiment of the method of this invention, in the third step, disintegrating and the splits and removing the waxy layers and siliceous layers is carried out such, that the fiber bundles have a spatial structure that is favourable for the penetration of fluid. This enables an effective drying process of the bamboo fiber bundles.

[0011] Advantageously, the fourth and the fifth step are performed in the same apparatus. This allows for saving time and energy, and for preventing the dehumidified bamboo fiber bundles from getting wet before being thermally modified or during the modification.

[0012] In another preferable embodiment of the method of this invention, in the fifth step, a temperature of 150°C to 230°C, preferably 160°C to 180°C, is applied to the fiber bundles for thermal modification. With this, the hemicellulose content is significantly reduced.

[0013] Advantageously, in the fifth step, the temperature is applied for 2 hours to 7 hours to the fiber bundles, wherein the temperature is preferably applied for 3 hours to the fiber bundles. It was surprisingly found, that after applying 160°C for 3 hours to the fiber bundles, the hemicellulose content is reduced to approximately 20.7%. Compared to that, the hemicellulose content of *Phyllostachys pubescens* fiber bundles is reduced to approximately 23.5%.

[0014] Advantageously, in the sixth step, a phenolic adhesive is used as adhesive. It has surprisingly been found that a phenolic adhesive is best suited for forming a layered mat from the bamboo fiber bundles. Advantageously, the used adhesive contains an accessory agent, wherein the accessory agent preferably is a wax. This advantageously supports the effect of the adhesive.

[0015] Advantageously, the adhesive is applied such, that the adhesive content is 10% to 16% of the mass of the layered mat reduced by the mass of water therein, preferably 12% to 14%, more preferably 12%. It has been surprisingly found, that said parameters offer a firm and stable scrimberboard. Advantageously, in the sixth step, the adhesive is applied such, that the accessory agent is 0.5% to 3% of the mass of the layered mat reduced by the mass of water therein, preferably 1%. This improves the stability of the manufactured scrimberboard even more.

[0016] In another preferable embodiment of the method of this invention, in the sixth step, the adhesive is atomized for application, wherein the adhesive is preferably directed through a nozzle. Typically, the adhesive is applied by dipping. This increases the level of moisture content of resinated fibers to a high level, thus necessitating a further drying step. Furthermore, the application by dipping and subsequent dripping off is creating an uneven adhesive distribution. The application by atomizing offers a greatly reduced moisture content of the resinated fibers, a reduced adhesive consumption and a reduction of consumed energy and time.

[0017] Advantageously, in the seventh step, the fiber bundles are placed in parallel into the press mold. Placing the fiber bundles parallel into the press mold improves the structure of the scrimberboard advantageously.

[0018] In another preferable embodiment of the method of this invention, in the eighth step, the applied heat and pressure are adjusted to a certain heat-value and a certain pressure-value to obtain a certain thickness of the scrimberboard, wherein the thickness is preferably chosen to be 12 mm to 25 mm, preferably 15 mm to 25 mm, more preferably about 23 mm. 23 mm is found to be an ideal thickness for bamboo scrimberboard. Advantageously, the heat-value is 110°C to 160°C, preferably 120°C to 140°C, more preferably about 135°C and/or the pressure-value is 4 MPa to 10 MPa.

[0019] In another preferable embodiment of the method of this invention, in the eighth step, the heat is applied with the heat-value for 2 minutes to 15 minutes to the layered mat and/or in the eighth step, the pressure is applied with the pressure-value for 2 minutes to 15 minutes to the layered mat. Advantageously, in the eighth step, the heat and the pressure are applied for 30 minutes to 60 minutes to the layered mat, preferably 45 minutes.

[0020] In another preferable embodiment of the method of this invention, the method furthermore comprises the following step: ninth step: applying heat and pressure to the scrimberboard, wherein the applied heat and pressure are preferably adjusted to a certain further heat-value and a certain further pressure-value. This further curing step improves the quality of the scrimberboard even more and/or decreases the cycle time.

[0021] In another preferable embodiment of the method of this invention, the further heat-value is 60°C to 160°C, preferably 80°C, and/or the further pressure-value is 0.5 MPa to 2 MPa, preferably 1.2 MPa. Advantageously, in the ninth step, the heat is applied with the further heat-value for 15 minutes to 60 minutes, preferably for 45 minutes, to the scrimberboard and/or in the ninth step, the pressure is applied with the further pressure-value for 15 minutes to 60 minutes, preferably 45 minutes, to the scrimberboard. It is thinkable, that wherein in the ninth step, the heat and the pressure are applied for the same duration as the application of heat and pressure in the eighth step. Advantageously, in the ninth step, heat and pressure are applied to the scrimberboard in two separate apparatuses. The separation of the hotpressing and curing requires the right timing and control of moisture to prevent blow-outs. Said parameters for temperature, pressure, and time enable to depressurize prematurely and safely proceed following manufacturing steps.

[0022] In another preferable embodiment of the method of this invention, wherein the method furthermore comprises the following step: tenth step: conditioning the scrimberboard at a temperature and a relative humidity, wherein the temperature is preferably constant and/or wherein the relative humidity is preferably constant. This helps improving the quality of the scrimberboard. Advantageously, the temperature is 20°C to 80°C, preferably 60°C to 80°C and/or the relative humidity is 20% to 80%, preferably 50% to 65%. It is thinkable, that the scrimberboard is conditioned for 2 days to 5 days, preferably 3 days. It is furthermore thinkable, that the temperature and/or the relative humidity are amended during the conditioning.

[0023] Advantageously, the scrimberboard is cut to a predetermined length and a predetermined width after the eighth step. It is thinkable, that the scrimberboard is profiled after the eighth step. Moreover, it is thinkable, that that a paint and/or a coating and/or a finish is applied to the scrimberboard.

[0024] It is clear to the person skilled in the art, that the method for manufacturing scrimberboard is advantageously carried out in the following order: first step, second step, third step, fourth step, fifth, step, sixth step, seventh step, eighth

step. It is also clear to the person skilled in the art, that the ninth step is advantageously carried out after the eighth step. Furthermore, it is clear to the person skilled in the art, that the tenth step is advantageously carried out after the eighth step and/or after the ninth step.

[0025] Another object of the invention is a bamboo scrimberboard manufactured using a method according to the present invention. The scrimberboard made from bamboo of African origin offers an alternative to scrimberboards made from Asian bamboo. The scrimberboard according to the present invention is defined in claim 14 and has unique features that are grounded by the special anatomy of the African bamboo. In particular, the scrimberboard according to the present invention offers a better biological durability due to its lower content of hemicellulose, an improved stiffness, an improved strength and an improved water resistance, here, always compared to scrimberboard made of *Phyllostachys pubescens*.

[0026] According to the invention, the bamboo is bamboo of African origin, wherein the bamboo is *Yushania alpina* and/or *Oxytenanthera abyssinica*. Preferably, the bamboo is of Ethiopian origin.

[0027] In a preferable embodiment of the method of this invention, the scrimberboard has a density of 1,000 kg/m³ to 1,250 kg/m³; and/or wherein the adhesive content is 10% to 16% of the mass of the scrimberboard reduced by the mass of water therein, preferably between 12% and 14%; and/or wherein the scrimberboard has a modulus of rupture between 130 MPa and 250 MPa, preferably between 200 MPa and 250 MPa; and/or wherein the scrimberboard has a modulus of elasticity between 18 GPa and 30 GPa, preferably between 26 GPa and 30 GPa; and/or wherein the scrimberboard has a Brinell hardness between 60 MPa and 150 MPa, preferably between 120 MPa and 150 MPa; and/or wherein the scrimberboard has a durability class of 1 or 2, preferably of 1. This allows for a robust and solid scrimberboard that can be used also in heavy-duty and/or weathered environments, such as outdoor and indoor furniture, outdoor and indoor floor coverings, or wall coverings. It is also thinkable to use scrimberboard for structural and/or load-bearing applications due to its preferable mechanical and durability properties, preferably in those applications with exposure to humidity or water, or high wear and tear. Table 1 below illustrates the mechanical performance of the scrimberboard as a product of the present invention.

Table 1: Comparison of Mechanical Properties of Different Construction Materials

	Density in kg/m ³	Modulus of Rupture in MPa	Modulus of Elasticity in GPa	Brinell Hardness in MPa*
Wood-plastic composites	500-1,500	10-40	2-4	50-145
Modified softwoods (aggregate of Pine, Larch)	500-700	55-100	10-14	15-25
Tropical hardwood (aggregate of Teak, Ipé, Wengé, Merbau, Cumaru)	700-1,150	100-175	12-22	45-60
Prior-art bamboo scrimberboard	900-1,200	100-140	14-20	50-70
Present-invention scrimberboard	1,000-1,250	130-250	18-30	60-150
*Conversion from Brinell scale (HB) to MPa by multiplying with gravity acceleration g=9.80665				

[0028] Advantageously, the bamboo is 4 to 7 years old and/or the bamboo culms have a diameter of 40 mm to 85 mm and/or the bamboo culms have a wall thickness of 7.5 mm to 15 mm. It has been found, that African bamboo that is 4 to 7 years old is best suited for the scrimberboard according to the present invention. Bamboo culms having a diameter of 40 mm to 85 mm and a wall thickness of 7.5 mm to 15 mm are found to be best suited for being split processed to the scrimberboard according to the present invention. Another advantage of the culms in this age/diameter class is that the culms are suitable to be used for producing up to 6-meter long scrimberboards, while the standard sizes available on the market are 1.8 to 2.2 meters only.

[0029] In a preferable embodiment of the method of this invention, the scrimberboard has a length of more than 3 meters, preferably more than 4 meters and more preferably 4.8 meters. It is thinkable, that the scrimberboard has a length of more than 5 meters and preferably 6 meters.

[0030] Advantageously, the outer arc length of the splits is a fraction of the bamboo pole circumference, wherein the poles are preferably split into 2 to 10 splits, wherein the poles are more preferably split into 3 to 5 splits. Advantageously, the adhesive is a phenolic adhesive, wherein the adhesive preferably contains an accessory agent, wherein the accessory agent more preferably is a wax. It is thinkable, that the accessory agent is 0.5% to 3% of the mass of the scrimberboard reduced by the mass of water therein, preferably 1%.

[0031] Advantageously, the thickness of the scrimberboard is 12 mm to 25 mm, preferably 15 mm to 25 mm, more

preferably about 23 mm. 23 mm is found to be an ideal thickness for the scrimberboard according to the present invention. It is thinkable, that the scrimberboard is cut to a predetermined length and a predetermined width. This allows for an effective storage, transport and further processing of the scrimberboard. Advantageously, the scrimberboard is profiled width after the eighth step.

[0032] Moreover, a bamboo fiber bundle is disclosed, wherein the fiber bundle is obtained by segmenting bamboo culms into poles, splitting the poles longitudinally into splits, disintegrating the splits into fiber bundles, wherein waxy layers and siliceous layers of the bamboo are removed, wherein the bamboo are of African origin, wherein the bamboo preferably is of Ethiopian origin, wherein the bamboo more preferably is, in line with the claimed invention, *Yushania alpina* and/or *Oxytenanthera abyssinica*. These bamboo fiber bundles have unique features that are grounded by the special anatomy of the African bamboo. In particular, scrimberboard manufactured from fiber bundles according to the present invention offers a better biological durability due to its lower content of hemicellulose, an improved stiffness, an improved strength and an improved water resistance, here, always compared to scrimberboard made of *Phyllostachys pubescens*.

[0033] Advantageously, the width of the fiber bundle is 2 to 5 times the arc length of the splits. It is thinkable, that the thickness of the fiber bundle is 2 mm to 8 mm.

[0034] Moreover, an apparatus for disintegrating bamboo splits into fiber bundles is disclosed, wherein the apparatus for disintegrating comprises a first part and a second part, wherein the first part is configured to disintegrate the bamboo splits and remove waxy layers and siliceous layers from the disintegrated splits, wherein the second part is configured to further disintegrate the splits that have been disintegrated and wherefrom the waxy layers and siliceous layers have been removed in the first part. This apparatus allows for an ideal treatment of African bamboo to be treated in a manufacturing process to manufacture scrimberboard.

[0035] Moreover, an apparatus for applying adhesive to bamboo fiber bundles is disclosed, wherein the apparatus for applying adhesive comprises a belt conveyor to transport the fiber bundles along a transport direction, a glue spreader and a scale unit, wherein the glue spreader is configured to atomize adhesive to the fiber bundles in a spray direction, wherein the spray direction is arranged under an oblique angle to the transport direction. Typically, adhesive is applied by dipping. Using a dipping apparatus increases the level of moisture content of resonated fibers to a high level, thus necessitating a further drying of the bamboo fiber bundles. Furthermore, the application by dipping and subsequent dripping off is creating an uneven adhesive distribution. The application of an apparatus for applying adhesive to bamboo fiber bundles offers a greatly reduced moisture content of the resinated fibers, a reduced adhesive consumption and a reduction of consumed energy and time.

[0036] Advantageously, the oblique angle is 1° to 45°, preferably 10° to 30°, more preferably 20°. It has been surprisingly found, that said oblique angle improves the application of the adhesive. Under an oblique angle of 1° to 45°, preferably 10° to 30°, more preferably 20°, the adhesive is best incorporated by the bamboo fiber bundles.

[0037] Moreover a system for manufacturing bamboo scrimberboard using a method according to the present invention is disclosed, wherein the system comprises an apparatus for disintegrating bamboo splits and an apparatus for applying adhesive to bamboo fiber bundles.

[0038] It is also conceivable to produce a bamboo particleboard, wherein the bamboo particleboard comprises bamboo of African origin wherein the bamboo is *Yushania alpina* and/or *Oxytenanthera abyssinica*. Preferably, the bamboo particleboard comprises bamboo fiber bundles with a length of 10 mm or less.

[0039] It is also conceivable to produce a bamboo oriented strand board, wherein the bamboo oriented strand board comprises bamboo of African origin wherein the bamboo is *Yushania alpina* and/or *Oxytenanthera abyssinica*. Preferably, the bamboo oriented strand board comprises bamboo fiber bundles with a length of 350 mm or less and wherein the fiber bundles have the form of strands.

[0040] The bamboo fiber bundles can vary in length and width, which differentiates the products scrimberboard, particleboard and oriented strand board. Scrimberboard is the product wherein fiber bundles have the same length as the board. Particleboard (or fibreboard) are products wherein fiber bundles have a length of 10 mm or less, and fiberboard further contains predominantly singular fibers. Oriented strand board is the product wherein fiber bundles have the form of strands with a length of 350 mm or less.

[0041] The person skilled in the art understands that all disclosed features herein are disclosed in relation to the method according to the present invention, the scrimberboard according to the present invention, the bamboo particleboard according to the present disclosure, and the bamboo oriented strand board according to the present disclosure.

[0042] Further details, advantages, and features can be found from the following figures together with the following description of the figures. The shown figures only illustrate preferable embodiments of the invention, wherein the scope of the invention is defined by the appended claims.

Short description of the figures

[0043]

Figure 1 shows a schematic sketch of the method for manufacturing bamboo scrimberboard according to a preferred embodiment of the present invention.

Figure 2 shows a schematic sketch of the bamboo scrimberboard according to a preferred embodiment of the present invention.

Figure 3 shows a schematic sketch of the bamboo fiber bundle.

Figure 4 shows a schematic sketch of an apparatus for disintegrating bamboo splits into fiber bundles.

Figure 5 shows a schematic sketch of an apparatus for applying adhesive to bamboo fiber bundles.

Figure 6 shows a schematic sketch of the bamboo scrimberboard according to alternative embodiments of the present invention in possible applications as outdoor decking and wall cladding.

Description of the figures

[0044] Figure 1 shows a schematic sketch of the method for manufacturing bamboo scrimberboard A (see figure 2) according to a preferred embodiment of the present invention. In the first step 1, *Yushania alpina* culms are segmented into poles. The used *Yushania alpina* is 4 to 7 years old and the culms have a diameter of 40 mm to 85 mm and a wall thickness of 7.5 mm to 15 mm. In a following second step 2, the poles are longitudinally split into splits. The outer arc length of the splits is a fraction of the bamboo pole circumference. Each pole is split into 3 to 5 splits. Afterwards, in a third step 3, the splits are disintegrated into fiber bundles B by an apparatus C (see figure 3), wherein waxy layers and siliceous layers of the bamboo are removed. The disintegrating and removing the waxy layers and siliceous layers is carried out such, that the fiber bundles B have a spatial structure that is favourable for the penetration of fluid. This makes it easier to dry the bamboo fiber bundles B in the following fourth step 4. In a subsequent fifth step 5, the bamboo fiber bundles B are thermally modified at a temperature of 160°C to 180°C for 3 hours in a deoxygenated and unsaturated atmosphere.

[0045] After this, in a sixth step 6, an adhesive D2 is directed through a nozzle D1 to the bamboo fiber bundles B in an apparatus D for applying adhesive D2 to bamboo fiber bundles B (see figure 4) and thereby atomized. A phenolic adhesive containing wax as an accessory agent is used as the adhesive D2. The adhesive D2 is applied such, that the adhesive D2 is 12% and the wax is 1% of the mass of the layered mat, formed in a subsequent seventh step 7, reduced by the mass of water therein. In said seventh step 7, the fiber bundles B are placed in parallel into a press mold. Afterwards, scrimberboard A is obtained by applying temperature of 110°C to 160°C for between 2 and 15 minutes at a pressure of 4 MPa to 10 MPa to the layered mat in an eighth step 8. During the eighth step 8, heat and pressure is applied to the layered mat for 30 minutes to 60. The scrimberboard A obtained by the eighth step 8 is about 23 mm thick. Afterwards, the scrimberboard A is cured in a ninth step 9 at a temperature of 80°C at a pressure of 1.2 MPa for 45 minutes. In a subsequent tenth step 10, the scrimberboard is conditioned at a temperature of 60°C to 80°C at a relative humidity of 50% to 65% for 3 days, before the scrimberboard A to a predetermined length and a predetermined width and is profiled and painted.

[0046] Figure 2 shows a schematic sketch of the bamboo scrimberboard A according to a preferred embodiment of the present invention. The scrimberboard A is 23 mm thick, has a density of 1,000 kg/m³ to 1,250 kg/m³, a modulus of rupture between 130 MPa and 250 MPa, a modulus of elasticity between 18 GPa and 30 GPa, a Brinell hardness between 60 MPa and 150 MPa, and a durability class of 1 or 2. The scrimberboard A is made from 4 to 7-year-old *Yushania alpina* or *Oxytenanthera abyssinica* and contains a phenolic adhesive and wax as an accessory agent for the adhesive D2.

[0047] Figure 3 shows a schematic sketch of a bamboo fiber bundle B. The fiber bundle B is obtained by segmenting bamboo culms from *Yushania alpina* or *Oxytenanthera abyssinica* into poles, splitting the poles longitudinally into splits and afterwards disintegrating the splits into fiber bundles B. Waxy layers and siliceous layers of the *Yushania alpina* or *Oxytenanthera abyssinica* are removed. The width of the fiber bundle B is 2 to 5 times the arc length of the splits and the thickness of the fiber bundle B is 2 mm to 8 mm.

[0048] Figure 4 shows a schematic sketch of an apparatus C for disintegrating bamboo splits into fiber bundles B. The apparatus C for disintegrating bamboo splits into fiber bundles B comprises a first part C' and a second part C". In the first part C' the bamboo splits are disintegrated and waxy layers and siliceous layers are removed from the disintegrated splits. In the second part C" the splits that have been disintegrated and wherefrom the waxy layers and siliceous layers have been removed in the first part C' are further disintegrated.

[0049] Figure 5 shows a schematic sketch of an apparatus D for applying adhesive D2 to bamboo fiber bundles B. The apparatus D comprises a belt conveyor D3 with which the fiber bundles B are transported along a transport direction.

The apparatus D furthermore comprises a glue spreader, in which the adhesive D2 is guided through a nozzle D1 such, that the adhesive D2 is atomized and sprayed on the fiber bundles B under an oblique angle of 20° to the transport direction.

[0050] Figure 6 shows a schematic sketch of the bamboo scrimberboard A according to alternative embodiments of the present innovation. The scrimberboard A can be given such a shape that makes it more suitable for outdoor decking E1 and E2, or wall cladding E3 and E4. In particular, E1 features longitudinal surface profiling E1-1 and longitudinal grooves on both narrow edges E1-2. E2 features tongue E2-1 and groove E2-2 on the short edges for successive joining of decking boards. E3 features rabbets E3-1 on both longitudinal edges to join cladding boards side by side. E4 features tongue E4-1 and groove E4-2 on the longitudinal edges, respectively.

[0051] Figure 7 shows a schematic sketch of the bamboo particleboard F.

[0052] Figure 8 shows a schematic sketch of the bamboo oriented strand board G.

Claims

1. A method for manufacturing bamboo scrimberboard (A), wherein the method comprises following steps:

- first step (1): segmenting bamboo culms into poles,
- second step (2): splitting the poles longitudinally into splits,
- third step (3): disintegrating the splits into fiber bundles (B), wherein waxy layers and siliceous layers of the bamboo are removed,
- fourth step (4): drying the bamboo fiber bundles (B),
- fifth step (5): thermally modifying the fiber bundles (B) in a deoxygenated and unsaturated atmosphere,
- sixth step (6): applying an adhesive (D2) to the thermally modified fiber bundles (B),
- seventh step (7): forming a layered mat from the adhesive applied fiber bundles (B) using a press mold,
- eighth step (8): obtaining scrimberboard (A) from the layered mat by applying heat and pressure to the layered mat,

wherein the bamboo used is bamboo of African origin wherein the bamboo is *Yushania alpina* and/or *Oxytenanthera abyssinica*.

2. A method according to claim 1, wherein the outer arc length of the splits is a fraction of the bamboo pole circumference, wherein the poles are preferably split into 2 to 10 splits, wherein the poles are more preferably split into 3 to 5 splits.

3. A method according to any of the preceding claims, wherein in the third step (3), disintegrating the splits and removing the waxy layers and siliceous layers is carried out such, that the fiber bundles (B) have a spatial structure that is favourable for the penetration of fluid.

4. A method according to any of the preceding claims, wherein in the fifth step (5), a temperature of 150°C to 230°C, preferably 160°C to 180°C, is applied to the fiber bundles (B) for thermal modification, wherein in the fifth step (5), the temperature is preferably applied for 2 hours to 7 hours to the fiber bundles (B), wherein the temperature is more preferably applied for 3 hours to the fiber bundles (B).

5. A method according to any of the preceding claims, wherein in the sixth step (6), the adhesive (D2) is atomized for application, wherein the adhesive (D2) is preferably directed through a nozzle (D1).

6. A method according to any of the preceding claims, wherein in the eighth step (8), the applied heat and pressure are adjusted to a certain heat-value and a certain pressure-value to obtain a certain thickness of the scrimberboard (A), wherein the heat-value is preferably 110°C to 160°C and/or the pressure-value is preferably 4 MPa to 10 MPa.

7. A method according claim 6, wherein in the eighth step (8), the heat is applied with the heat-value for 2 minutes to 15 minutes to the layered mat and/or in the eighth step (8), the pressure is applied with the pressure-value for 2 minutes to 15 minutes to the layered mat.

8. A method according to any of the preceding claims, wherein in the eighth step (8), the heat and the pressure are applied for 30 minutes to 60 minutes to the layered mat.

9. A method according to any of the preceding claims, wherein the method furthermore comprises the following step:

- ninth step (9): applying heat and pressure to the scrimberboard (A), wherein the applied heat and pressure are preferably adjusted to a certain further heat-value and a certain further pressure-value.

10. A method according to claim 9, wherein the further heat-value is 60°C to 160°C, preferably 80°C, and/or the further pressure-value is 0.5 MPa to 2 MPa, preferably 1.2 MPa, wherein in the ninth step (9), the heat is preferably applied with the further heat-value for 15 minutes to 60 minutes, more preferably for 45 minutes, to the scrimberboard (A) and/or in the ninth step (9), the pressure is preferably applied with the further pressure-value for 15 minutes to 60 minutes, more preferably 45 minutes, to the scrimberboard (A).

11. A method according to any of the claims 9 to 10, wherein in the ninth step (9), the heat and the pressure are applied for the same duration as the application of heat and pressure in the eighth step (8).

12. A method according to any of the preceding claims, wherein the method furthermore comprises the following step:

- tenth step (10): conditioning the scrimberboard (A) at a temperature and a relative humidity, wherein the temperature is preferably constant and/or wherein the relative humidity is preferably constant.

13. A method according to claim 12, wherein in the tenth step (10) the scrimberboard (A) is conditioned with a temperature of 20°C to 80°C, preferably 60°C to 80°C and/or with a relative humidity of 20% to 80%, preferably 50% to 65%.

14. A bamboo scrimberboard (A) manufactured using a method according to any of the preceding claims, wherein the bamboo is bamboo of African origin, wherein the bamboo is *Yushania alpina* and/or *Oxytenanthera abyssinica*.

15. A bamboo scrimberboard according (A) to claim 14, wherein the scrimberboard (A) has a density of 1,000 kg/m³ to 1,250 kg/m³, and /or wherein the adhesive content (D2) is 10% to 16% of the mass of the scrimberboard (A) reduced by the mass of water therein, and/or wherein the scrimberboard (A) has a modulus of rupture between 130 MPa and 250 MPa, and/or wherein the scrimberboard (A) has a modulus of elasticity between 18 GPa and 30 GPa, and/or wherein the scrimberboard (A) has a Brinell hardness between 60 MPa and 150 MPa, and/or wherein the scrimberboard (A) has a durability class of 1 or 2.

Patentansprüche

1. Verfahren zur Herstellung einer Bambus-Scrimber-Platte (A), wobei das Verfahren die folgenden Schritte umfasst:

- erster Schritt (1): Segmentieren der Bambushalme in Stangen,
- zweiter Schritt (2): Spalten der Stangen in Längsrichtung in Spalten,
- dritter Schritt (3): Zerlegen der Spalten in Faserbündel (B), wobei Wachsschichten und Silikatschichten des Bambus entfernt werden,
- vierter Schritt (4): Trocknen der Bambusfaserbündel (B),
- fünfter Schritt (5): thermisches Modifizieren der Faserbündel (B) in einer sauerstoffarmen und ungesättigten Atmosphäre,
- sechster Schritt (6): Auftragen eines Klebstoffs (D2) auf die thermisch modifizierten Faserbündel (B),
- siebter Schritt (7): Ausbilden einer Schichtmatte aus den mit Klebstoff versehenen Faserbündeln (B) mittels einer Pressform,
- achter Schritt (8): Erhalten einer Scrimber-Platte (A) aus der Schichtmatte durch Anwenden von Wärme und Druck auf die Schichtmatte,

wobei der verwendete Bambus Bambus afrikanischen Ursprungs ist, wobei der Bambus *Yushania alpina* und/oder *Oxytenanthera abyssinica* ist.

2. Verfahren nach Anspruch 1, wobei die äußere Bogenlänge der Spalten einen Bruchteil des Bambusstangenumfangs beträgt, wobei die Stangen vorzugsweise in 2 bis 10 Spalten geteilt werden, wobei die Stangen stärker bevorzugt in 3 bis 5 Spalten geteilt werden.

3. Verfahren nach einem der vorhergehenden Ansprüche, wobei im dritten Schritt (3) das Zerlegen der Spalten und das Entfernen der Wachsschichten und Silikatschichten so durchgeführt wird, dass die Faserbündel (B) eine für das Eindringen von Fluid günstige räumliche Struktur aufweisen.

4. Verfahren nach einem der vorhergehenden Ansprüche, wobei im fünften Schritt (5) eine Temperatur von 150 °C bis 230 °C, vorzugsweise 160 °C bis 180 °C, zum thermischen Modifizieren auf die Faserbündel (B) angewendet wird, wobei im fünften Schritt (5) die Temperatur vorzugsweise 2 Stunden bis 7 Stunden lang auf die Faserbündel (B) angewendet wird, wobei die Temperatur stärker bevorzugt 3 Stunden lang auf die Faserbündel (B) angewendet wird.
5. Verfahren nach einem der vorhergehenden Ansprüche, wobei im sechsten Schritt (6) der Klebstoff (D2) zum Auftragen zerstäubt wird, wobei der Klebstoff (D2) vorzugsweise durch eine Düse (D1) geleitet wird.
6. Verfahren nach einem der vorhergehenden Ansprüche, wobei im achten Schritt (8) die angewendete Wärme und der angewendete Druck auf einen bestimmten Wärmewert und einen bestimmten Druckwert eingestellt werden, um eine bestimmte Dicke der Scrimber-Platte (A) zu erhalten, wobei der Wärmewert vorzugsweise 110 °C bis 160 °C und/oder der Druckwert vorzugsweise 4 MPa bis 10 MPa beträgt.
7. Verfahren nach Anspruch 6, wobei im achten Schritt (8) die Wärme mit dem Wärmewert 2 Minuten bis 15 Minuten lang auf die Schichtmatte angewendet wird und/oder im achten Schritt (8) der Druck mit dem Druckwert 2 Minuten bis 15 Minuten lang auf die Schichtmatte angewendet wird.
8. Verfahren nach einem der vorhergehenden Ansprüche, wobei im achten Schritt (8) die Wärme und der Druck 30 bis 60 Minuten lang auf die Schichtmatte angewendet werden.
9. Verfahren nach einem der vorhergehenden Ansprüche, wobei das Verfahren ferner den folgenden Schritt umfasst:
 - neunter Schritt (9): Anwenden von Wärme und Druck auf die Scrimber-Platte (A), wobei die angewendete Wärme und der angewendete Druck vorzugsweise auf einen bestimmten weiteren Wärmewert und einen bestimmten weiteren Druckwert eingestellt werden.
10. Verfahren nach Anspruch 9, wobei der weitere Wärmewert 60 °C bis 160 °C, vorzugsweise 80 °C, beträgt und/oder der weitere Druckwert 0,5 MPa bis 2 MPa, vorzugsweise 1,2 MPa, beträgt, wobei im neunten Schritt (9), die Wärme vorzugsweise mit dem weiteren Wärmewert 15 Minuten bis 60 Minuten lang, stärker bevorzugt 45 Minuten lang, auf die Scrimber-Platte (A) angewendet wird.
 - und/oder im neunten Schritt (9) der Druck vorzugsweise mit dem weiteren Druckwert 15 Minuten bis 60 Minuten lang, stärker bevorzugt 45 Minuten lang, auf die Scrimber-Platte (A) angewendet wird.
11. Verfahren nach einem der Ansprüche 9 bis 10, wobei im neunten Schritt (9) die Wärme und der Druck über den gleichen Zeitraum angewendet werden wie die Anwendung von Wärme und Druck im achten Schritt (8).
12. Verfahren nach einem der vorhergehenden Ansprüche, wobei das Verfahren ferner den folgenden Schritt umfasst:
 - zehnter Schritt (10): Konditionieren der Scrimber-Platte (A) bei einer Temperatur und einer relativen Luftfeuchtigkeit, wobei die Temperatur vorzugsweise konstant ist und/oder wobei die relative Luftfeuchtigkeit vorzugsweise konstant ist.
13. Verfahren nach Anspruch 12, wobei im zehnten Schritt (10) die Scrimber-Platte (A) mit einer Temperatur von 20 °C bis 80 °C, vorzugsweise 60 °C bis 80 °C und/oder mit einer relativen Luftfeuchtigkeit von 20 % bis 80 %, vorzugsweise 50 % bis 65 % konditioniert wird.
14. Bambus-Scrimber-Platte (A), hergestellt unter Verwendung eines Verfahrens nach einem der vorhergehenden Ansprüche, wobei der Bambus Bambus afrikanischen Ursprungs ist, wobei der Bambus *Yushania alpina* und/oder *Oxytenanthera abyssinica* ist.
15. Bambus-Scrimber-Platte (A) nach Anspruch 14, wobei die Scrimber-Platte (A) eine Dichte von 1.000 kg/m³ bis 1.250 kg/m³ aufweist, und/oder wobei der Klebstoffgehalt (D2) 10 % bis 16 % der Masse der Scrimber-Platte (A) abzüglich der Masse des darin enthaltenen Wassers beträgt, und/oder wobei die Scrimber-Platte (A) einen Bruchmodul zwischen 130 MPa und 250 MPa aufweist, und/oder wobei die Scrimber-Platte (A) einen Elastizitätsmodul zwischen 18 GPa und 30 GPa aufweist, und/oder wobei die Scrimber-Platte (A) eine Brinellhärte zwischen 60 MPa und 150 MPa aufweist, und/oder wobei die Scrimber-Platte (A) eine Dauerhaftigkeitsklasse von 1 oder 2 aufweist.

Revendications

1. Procédé destiné à fabriquer un panneau Scrimber en bambou (A), le procédé comprenant les étapes suivantes :

- première étape (1) : segmentation de chaumes de bambous en perches,
- deuxième étape (2) : division longitudinale des perches en bandes,
- troisième étape (3) : désagrégation des bandes en faisceaux de fibres (B), les couches cireuses et les couches siliceuses du bambou étant éliminées,
- quatrième étape (4) : séchage des faisceaux de fibres de bambou (B),
- cinquième étape (5) : modification thermique des faisceaux de fibres (B) dans une atmosphère désoxygénée et insaturée,
- sixième étape (6) : application d'un adhésif (D2) aux faisceaux de fibres (B) modifiés thermiquement,
- septième étape (7) : formation d'un mat stratifié à partir des faisceaux de fibres (B) enduits d'adhésif au moyen d'un moule à compression,
- huitième étape (8) : obtention d'un panneau Scrimber (A) à partir du mat stratifié par application de chaleur et de pression au mat stratifié,

dans lequel le bambou utilisé est du bambou d'origine africaine, le bambou étant *Yushania alpina* et/ou *Oxytenanthera abyssinica*.

2. Procédé selon la revendication 1, dans lequel la longueur d'arc externe des bandes est une fraction de la circonférence de perche de bambou, de préférence dans lequel les perches sont divisées en 2 à 10 bandes, mieux encore dans lequel les perches sont divisées en 3 à 5 bandes.

3. Procédé selon l'une quelconque des revendications précédentes, dans lequel, dans la troisième étape (3), la désagrégation des bandes et l'élimination des couches cireuses et des couches siliceuses sont réalisées de telle sorte que les faisceaux de fibres (B) ont une structure spatiale qui est favorable à la pénétration d'un fluide.

4. Procédé selon l'une quelconque des revendications précédentes, dans lequel, dans la cinquième étape (5), une température de 150 °C à 230 °C, de préférence 160 °C à 180 °C, est appliquée aux faisceaux de fibres (B) pour la modification thermique, de préférence dans lequel, dans la cinquième étape (5), la température est appliquée pendant 2 heures à 7 heures aux faisceaux de fibres (B), mieux encore dans lequel la température est appliquée pendant 3 heures aux faisceaux de fibres (B).

5. Procédé selon l'une quelconque des revendications précédentes, dans lequel, dans la sixième étape (6), l'adhésif (D2) est atomisé pour l'application, de préférence dans lequel l'adhésif (D2) est dirigé à travers une buse (D1).

6. Procédé selon l'une quelconque des revendications précédentes, dans lequel, dans la huitième étape (8), la chaleur et la pression appliquées sont réglées à une certaine valeur de chaleur et une certaine valeur de pression pour obtenir une certaine épaisseur du panneau Scrimber (A), dans lequel la valeur de chaleur est de préférence de 110 °C à 160 °C et/ou la valeur de pression est de préférence de 4 MPa à 10 MPa.

7. Procédé selon la revendication 6, dans lequel, dans la huitième étape (8), la chaleur est appliquée avec la valeur de chaleur pendant 2 minutes à 15 minutes au mat stratifié et/ou dans la huitième étape (8), la pression est appliquée avec la valeur de pression pendant 2 minutes à 15 minutes au mat stratifié.

8. Procédé selon l'une quelconque des revendications précédentes, dans lequel, dans la huitième étape (8), la chaleur et la pression sont appliquées pendant 30 minutes à 60 minutes au mat stratifié.

9. Procédé selon l'une quelconque des revendications précédentes, le procédé comprenant en outre l'étape suivante :

- neuvième étape (9) : application de chaleur et de pression au panneau Scrimber (A), dans lequel la chaleur et la pression appliquées sont de préférence réglées à une certaine autre valeur de chaleur et une certaine autre valeur de pression.

10. Procédé selon la revendication 9, dans lequel l'autre valeur de chaleur est de 60 °C à 160 °C, de préférence 80 °C,

et/ou l'autre valeur de pression est de 0,5 MPa à 2 MPa, de préférence 1,2 MPa, dans lequel, dans la neuvième étape (9), la chaleur est de préférence appliquée avec l'autre valeur de chaleur pendant 15 minutes à 60 minutes, mieux encore pendant 45 minutes, au panneau Scrimber (A)

et/ou dans la neuvième étape (9), la pression est de préférence appliquée avec l'autre valeur de pression pendant 15 minutes à 60 minutes, mieux encore 45 minutes, au panneau Scrimber (A).

11. Procédé selon l'une quelconque des revendications 9 à 10, dans lequel, dans la neuvième étape (9), la chaleur et la pression sont appliquées pendant la même durée que l'application de chaleur et de pression dans la huitième étape (8).

12. Procédé selon l'une quelconque des revendications précédentes, le procédé comprenant en outre l'étape suivante :

- dixième étape (10) : conditionnement du panneau Scrimber (A) à une température et une humidité relative, dans lequel la température est de préférence constante et/ou dans lequel l'humidité relative est de préférence constante.

13. Procédé selon la revendication 12, dans lequel, dans la dixième étape (10), le panneau Scrimber (A) est conditionné avec une température de 20 °C à 80 °C, de préférence 60 °C à 80 °C et/ou avec une humidité relative de 20 % à 80 %, de préférence 50 % à 65 %.

14. Panneau Scrimber en bambou (A) fabriqué au moyen d'un procédé selon l'une quelconque des revendications précédentes, dans lequel le bambou est du bambou d'origine africaine, le bambou étant *Yushania alpina* et/ou *Oxytenanthera abyssinica*.

15. Panneau Scrimber en bambou (A) selon la revendication 14, le panneau Scrimber (A) ayant une masse volumique de 1000 kg/m³ à 1250 kg/m³, et/ou la teneur en adhésif (D2) étant de 10 % à 16 % de la masse du panneau Scrimber (A) réduite de la masse d'eau à l'intérieur, et/ou le panneau Scrimber (A) ayant un module de rupture compris entre 130 MPa et 250 MPa, et/ou le panneau Scrimber (A) ayant un module d'élasticité compris entre 18 GPa et 30 GPa, et/ou le panneau Scrimber (A) ayant une dureté Brinell comprise entre 60 MPa et 150 MPa, et/ou le panneau Scrimber (A) ayant une classe de durabilité de 1 ou 2.

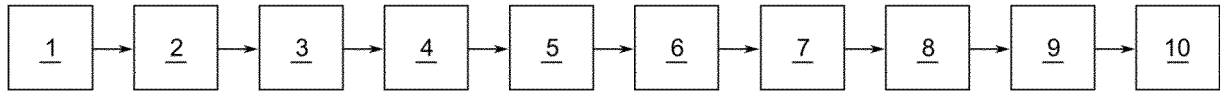


Fig. 1

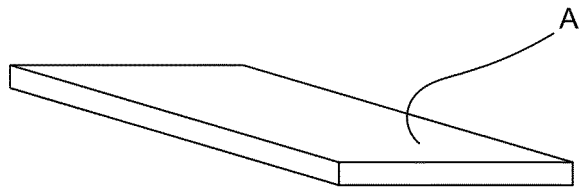


Fig. 2

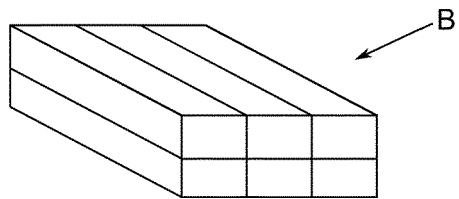


Fig. 3

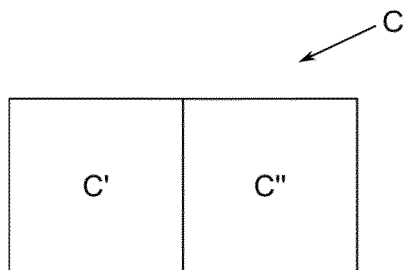


Fig. 4

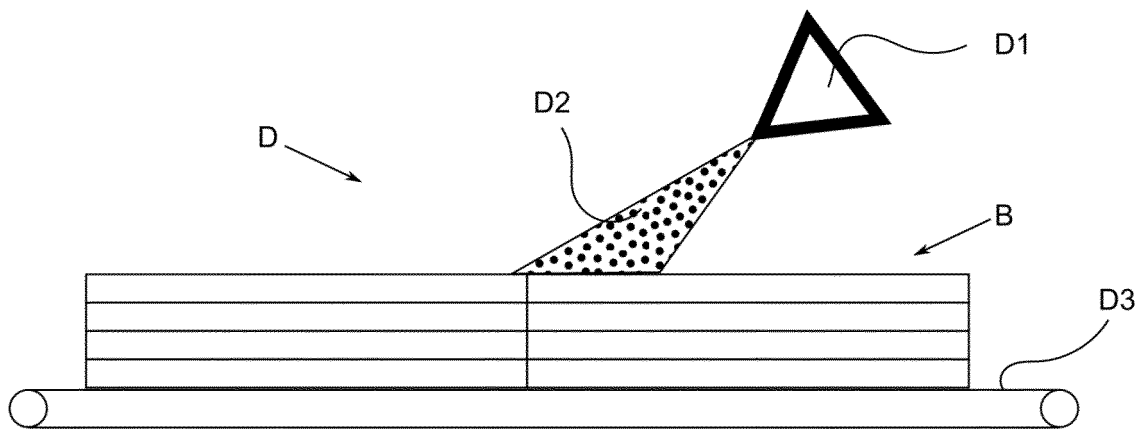


Fig. 5

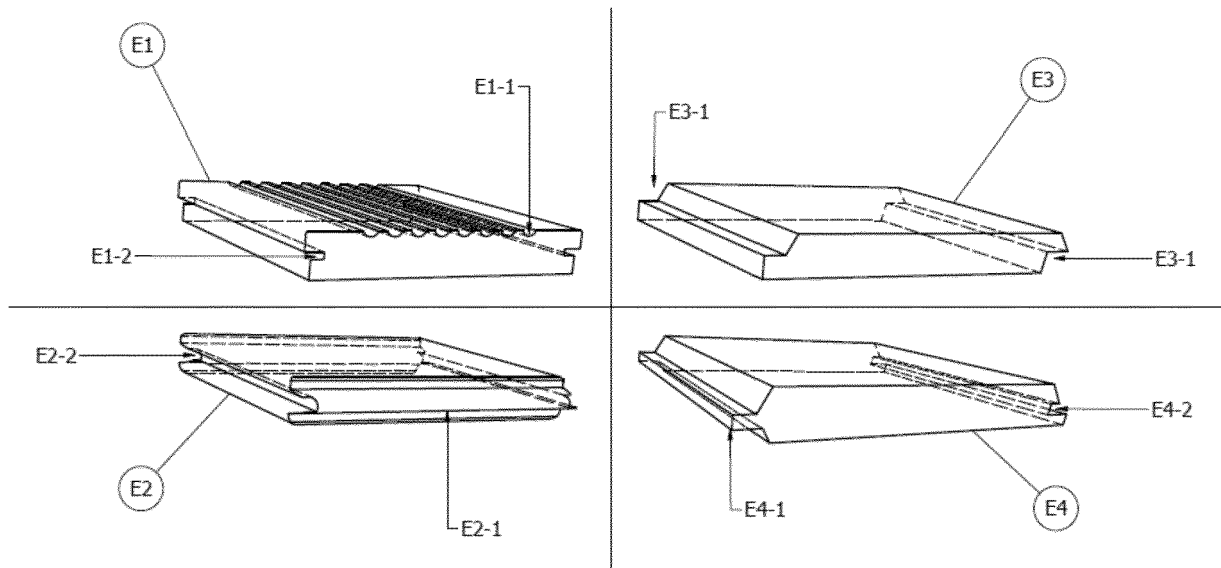


Fig. 6

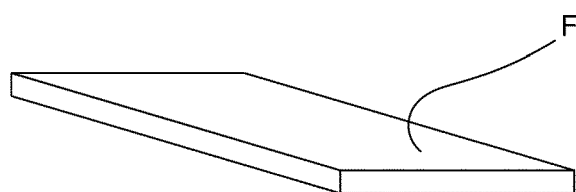


Fig. 7

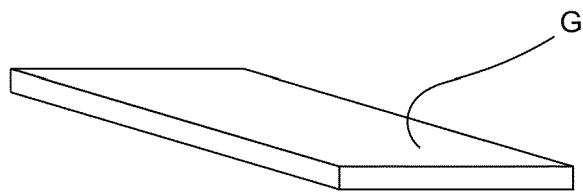


Fig. 8

REFERENCES CITED IN THE DESCRIPTION

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Patent documents cited in the description

- CN 1970259 A [0001]
- CN 101607411 A [0001]
- US 2011027529 A1 [0001]
- WO 2019093898 A2 [0001]

Non-patent literature cited in the description

- Development of bamboo scrimber: a literature review. **HUANG YUXIANG et al.** Journal of Wood Science. Springer Japan, 21 June 2019, vol. 65, 1-10 [0001]
- Effects of particle size and orientation on properties of particleboard made from Ethiopian highland bamboo (*Yushania alpina*) INBAR. *Using Wood Composites as a Tool for sustainable Forestry*, 31 December 2005, vol. 163, 65-71 [0001]