(19) Europäisches Patentamt
European Patent Office
Office européen des brevets

(11) EP 1 645 697 A1

(12) EUROPEAN PATENT APPLICATION

(43) Date of publication:
12.04.2006 Bulletin 2006/15

(51) Int Cl.:
E04C 2/296 *(2006.01)* ***B29C 70/86*** *(2006.01)*
B32B 5/18 *(2006.01)*

(21) Application number: **04292392.0**

(22) Date of filing: **08.10.2004**

(84) Designated Contracting States:
AT BE BG CH CY CZ DE DK EE ES FI FR GB GR HU IE IT LI LU MC NL PL PT RO SE SI SK TR
Designated Extension States:
AL HR LT LV MK

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(54) Method and apparatus for producing construction panels, construction panels obtained thereby, method of construction using said panels and constructions obtained therewith

(57) A composite construction panel, comprising a synthetic resin expanded polymer core and a resin impregnated fibre-reinforced envelope in intimate contact with an outer surface of the expanded polymer core, wherein the fibres of the envelope are basalt.

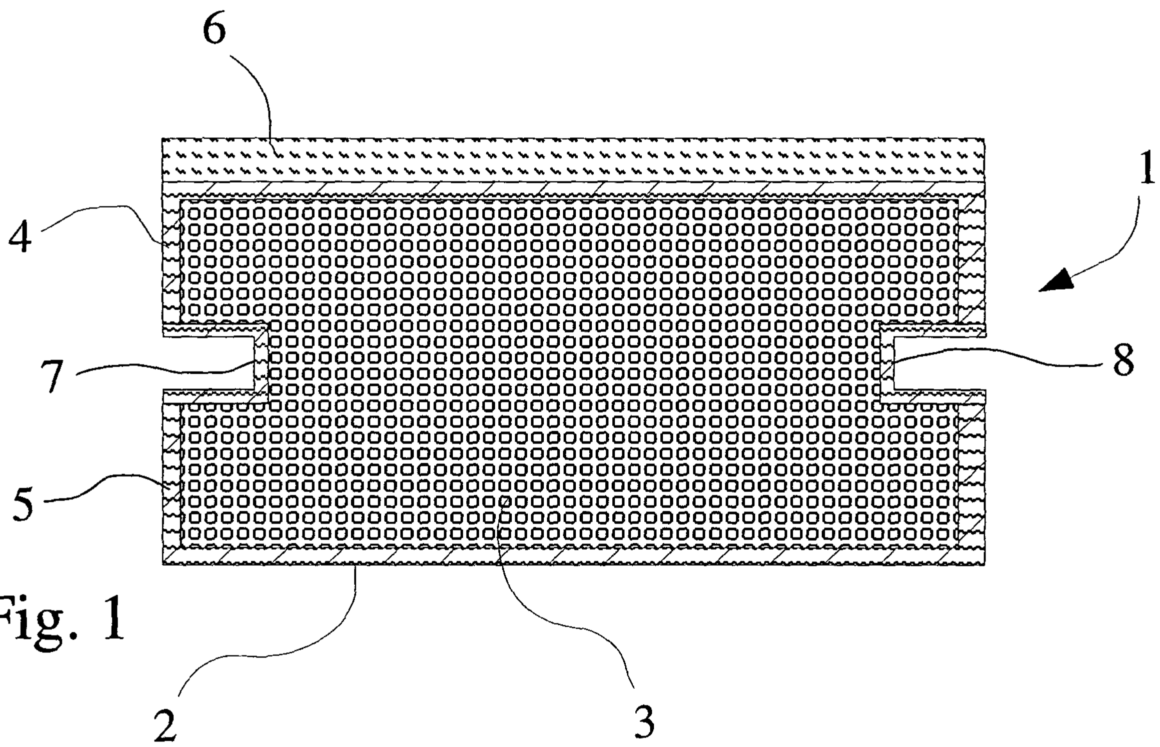

Fig. 1

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Description

[0001] The present invention relates to lightweight and mechanically resistant construction panels, in particular composite construction panels. In general, such composite panels are well known in the art, and often comprise an expanded synthetic polymer core surrounded by a solid envelope, wherein the envelope often comprises a mat of woven or unwoven reinforcing fibres impregnated with a synthetic polymer resin, which when set form a hardened and unified surface imparting mechanical resistance to the panel. Many patents and patent applications have been filed on this principle, examples of which follow.

[0002] A French Certificate of Addition, published in 1980 as FR 2 481 412, attempts to deal with the problem of manufacturing impact resistant elements, particularly for reinforcing struts for automobiles or weight bearing beams, or even vehicle bumpers. The core is made of alveolar material, and is surrounded by a polyester resin prepeg that is reinforced with glass fibres and low pressure moulded around the core.

[0003] A United Kingdom patent, published in 1971 as GB 1 227 668, describes the manufacture by moulding of reinforced composite structures having an expanded polystyrene core, around which a resin envelope is moulded that is reinforced with an unwoven mat.

[0004] A Swiss patent, filed in 1996, and published in 2001 as CH 691 319, describes a moulded element, having an expanded polystyrene core, which has been densified at outer surfaces of the core by moulding at 180°C, and a reinforcing glass fibre mat that is integrated into the compressed polystyrene during the moulding step at 180°C. The first moulding step is followed by a second low temperature moulding step at 30°C. The aim of the patent is to provide a preformed element that is sufficiently rigid to be able to sustain the weight of a person walking on it, for example, when it is used as a flooring, without the element breaking under the dynamics of movement of the person. An example is given on page 3, column 3, lines 1 to 35 of the published patent. The expanded polystyrene core is 1895 mm long, 645 mm wide, and is 120 mm thick, and has a density of 30 kg/m3. A mat of glass fibres is laid on each face of the core and the various elements are heated at a temperature of 180°C, at 1 bar, for 75 seconds. Then, the moulded structure obtained in the first step is placed into a low pressure moulding system at a temperature of 30°C and a pressure of 1 bar, until a thickness of 60 mm is obtained. The panel is removed from the moulding system and a groove formed in the edges of the panel.

[0005] A PCT patent application, published as WO 99/50059, describes sandwich panels that are intended to replace panels in freight containers or in traditional refrigerated trucks or lorries. The panels must be relatively rigid whilst being lightweight, and also be capable of bearing important ground loads, loads placed on shelves attached to the panels which are used as walls or partitions, and loads suspended from the panels when they are used as roofing. Another aim of the panels in this patent application is to maintain constant interior temperature during transport, when outside temperatures are a lot higher. The sandwich panels comprise a core of expanded polymer foam and a low pressure SMC envelope (sheet molding component), comprising a polyester or vinylester resin, and an unwoven mat of reinforcing fibres. The reinforcing fibres can be made of Kevlar®, glass, carbon, aramide, flax, hemp, banana or coconut. The expanded polymer core is preferably a polyurethane.

[0006] A United Kingdom patent, published as GB 936 232, describes composite sandwich elements comprising an outer envelope made of polyester resin that impregnates a mat of fibres, for example, glass, nylon, ou asbestos, and a polystyrene core. The composite element also comprises reinforcing elements made of synthetic hardenable resin. The composite sandwich elements can be curved and used in the manufacture of boat hulls, vehicle bodies, or for the manufacture of aircraft. The examples in the patent describe the use of expanded PVC for the core.

[0007] Another PCT patent application, published as WO 02/09934, describes a composite panel, comprising an expanded polystyrene core, and an envelope made of a mat of Kevlar® fibres impregnated with a polyester or epoxy resin. The aim of the patent is to reduce the thermal contraction and bending of the usual composite panels, which occur due to fluctuations in temperature and the load being applied to the panels. The panels can be used to make flooring and partitions for vehicles and containers.

[0008] The problems with such aramide or Kevlar® fibre-reinforced composites are numerous :

- generally a rather low fusion temperature, about 400°C, making them unsuitable for industries where fire and flame resistance are of great importance, such as in the building industry ;
- relatively weak adhesion between the impregnated fibre coating and the core, enabling the envelope to be stripped off under stress ;
- difficulty of choosing a suitable impregnation resin for the reinforcing fibre mat in order to get it to adhere correctly to the core ;
- relatively low shear resistance to weight bearing anchors or fixation means that are introduced into the elements to support other structures or loads ;
- high cost ;
- weak resistance to pressure ;
- a high rate of water take up, about 4% by weight, requiring autoclaving before impregnation ;
- sensitivity to ultraviolet emissions ;
- difficult work up and finishing.

[0009] The present applicant has discovered that the selection of a particular reinforcing fibre that is impregnated with a chosen resin in association with a synthetic polymer core leads to a product that not only does not suffer from the apparent defects of the known elements, but also has other unexpected advantages that make the elements particularly suited to an application in the building industry, particularly for use as building elements.

[0010] Accordingly, the invention provides for a composite construction panel, comprising a synthetic resin expanded polymer core and a resin impregnated fibre-reinforced envelope in intimate contact with an outer surface of the expanded polymer core, wherein the fibres of the envelope are basalt.

[0011] The invention also provides for an apparatus and a method of manufacturing said construction panels, as well as a method of construction of a building that uses said panels for the entire building structure. More details of the various facets and advantages of the invention will become clear with the description of the preferred embodiments and detailed description of the examples.

[0012] In one preferred embodiment, the basalt fibres are present as roving. The term "roving" is well known to the skilled person. Roving is produced either directly from bushing of fibres by drawing a large number of filaments (direct roving), or by assembling several strands in parallel, with no twisting (assembled roving). Roving, consisting of filaments from mostly 10 to 24 microns in diameter, is most often used in linear weights (counts) of 600, 1200, 2400 and 4800 tex. Preferably, the roving of the present invention has a linear weight of from about 100 to about 600. Presented as "cheese" or "spool" (winding on a tube), roving unwinds very easily. The characteristics of roving such as stiffness, equal tension of fibres, lubricity, ease of cutting, etc., depend on the process for which it is intended to be used : weaving, continuous impregnation, chopping and the like. In addition, the roving can be used to make a mat, which can be woven, tressed, knitted or preferably unwoven, and it is this mat that can be impregnated with a synthetic resin that will cause the mat to adhere to the expanded synthetic polymer core. Insofar as the present invention is concerned, woven roving fabrics are made of roving basalt strands. The fabrics are manufactured mostly as fabrics with a uniform warp and weft setting but also as unidirectional fabrics and as tapes. They are ideally suited to hand lay-up, injection moulding, and press moulding. Where a woven roving mat is used, it preferably has a weight of between about 200 g/m2 and about 800 g/m2. Continuous filament mats, which can also be used, for example, are felts of continuous filaments distributed in uniform layers as they leave the bushing and held together by a binder. The type and content of the binder depend on the envisaged application. These mats are particularly well suited to moulding between matched moulds, and to the production of continuous profiles, circuit boards, etc. They are also used for foam reinforcement. They are easy to draw and are a simple way to obtain "preforms" that are reinforced in the shape of the part to be moulded. Another type of mat is a chopped strand mat. This is a felt or mat consisting of basalt strands chopped to lengths of mostly 50 mm and held together by a binder which is soluble in styrene. The binder content may vary from 3 to 6%, depending on the requirements in terms of processing of the mat and the characteristics of the finished product. Chopped strand mat in general is particularly suited to contact moulding and to continuous moulding between layers of film. Additionally, basalt tissue or basalt mat is a non-woven material, composed of uniformly distributed basalt strands. These are bound by means of organic additives, such as thermosetting resins. These form a tissue which, after polymerisation, is rolled up and packaged ready for dispatch. Basalt mat is not susceptible to atmospheric agents or to UV rays, is supple and traction-resistant, will not rot and is dimensionally stable. Its porosity makes it easy to impregnate, while it also demonstrates good chemical resistance, anti-corrosion and fire protection characteristics. Basalt fibres are far superior to glass fibres in terms of fire resistance, and even more so with respect to aramide or synthetic fibres that are known from the prior art. Most preferred is a basalt roving of 330 tex.

[0013] In particular, the basalt fibres used in the composite panel of the present invention are capable of withstanding heat to a temperature of about 900 to 1000° Celsius, which is at least double that of aramide and other similar synthetic polymers such as Kevlar®. The consequence of this is that the panels of the invention do not substantially lose their structural integrity, even if the resin that has impregnated the fibres has melted, which tends to occur around 400°C, the basalt mat will remain structurally viable. Obviously, this is a distinct advantage over the prior art solutions, and is one of the reasons why the composite panel of the invention is particularly suited to an application as a building element in the building industry, more details of which will be described further on in this application.

[0014] The composite panel of the invention comprises a resin impregnated envelope, which can be organic or inorganic. In this regard, it has been discovered by the applicant that although a commercially available organic hardenable resin, such as epoxy, polyvinyl, polyphenol, acrylic, silicone or polyester resins will provide sufficiently good results in the composite panel of the invention, the applicant particularly prefers a thermosetting resin compound which is an epoxy resin available under the tradename EPIKOTE 828 LVEL from the company Resolution Europe BV, which is a medium viscosity epoxy resin, produced from bisphenol A and epichlorohydrin, and containing no diluent. This resin has a CAS number as follows : 25068-38-6. This resin is used in conjunction with a hardening agent, for example, EPIKURE 197, also available from Resolution European BV. EPIKURE 197 is a low viscosity and very high reactivity mannich base type hardening agent, comprising 4-tert-butylphenol, m-xylene-a,a'-diamine, a Mannich base, and 2-methyl-1,5-pentane diamine. In another preferred alternative embodiment, the resin is an inorganic polymer resin available from Cordi Geopolymer (France), and is a polysialate polymer. This polymer is obtained via geopolymerisation, involving natural and synthetic alumino-silicates. Such resins offer excellent flame resistance and can be bound to fibres, such as those used in the present invention.

[0015] This particular combination of compounds has been found to confer even better shear resistance to the envelope against the core when compared to other commercially available thermosetting resin compounds.

[0016] Usually, the basalt fibre will be impregnated substantially throughout the thickness of its layer when positioned around the core. However, it has been found particularly advantageous to impregnate the basalt fibre layer at between about 50% to about 80% of its thickness, since this provides an envelope to the core that leaves a part of the fibres still free. While not wishing to be bound by theory, it appears that the presence of free fibres on an outer surface of the panel provides for more intimate binding with inorganic hydraulic binders, such as are to be found in decorative coatings or claddings, thereby affording even greater shock resistance to such coatings if they are applied to the panel.

[0017] Other resins, for example the range of phenolic resins available under the trade name Cellobond from Borden Chemical UK Ltd, have also been found to be useful in the panels of the present invention.

[0018] The panels of the present invention may therefore also preferably comprise an exterior decorative coating or cladding. Such exterior decorative coatings are preferably hydraulic binders, such as cement, plaster, mortar, alabaster, stuc, and the like, but may also be cladding compositions that have a hydraulic binder base, and further comprise colorants, fillers, additives, texturizers and the like. Most preferred claddings or decorative coatings for the panels of the present invention are plaster, mortar, alabaster and stuc. As noted above, the cladding or decorative coating can be applied directly to an outer surface of the envelope, that is substantially fully impregnated throughout the thickness of the fibre layer, but it is preferred that the cladding or decorative coating be applied onto an envelope that has been impregnated with thermosetting resin at between about 50% to about 80% of its thickness.

[0019] The expanded polymer resin core of the composite panels of the present invention can be any of those that are already well known to the skilled person, such as expanded polystyrene, expanded polyurethane, and high impact expanded polymers such as ABS. However, it is preferred that the expanded polymer core be made of expanded polystyrene that has also been compressed during expansion to obtain compressed expanded polystyrene. Such compressed expanded polystyrenes are highly resistant to impacts, and generally denser than the uncompressed expanded polystyrene resin cores that are often used in such composite panels. In a preferred embodiment, the compressed expanded polystyrene core of the panel has a density comprised between about 40 kg/m3 to about 80 kg/m3, since this enables such a core to withstand dynamic loads of about 1900 kg without rupturing.

[0020] In still yet another preferred embodiment of the present invention, the fibres of the envelope may also be mixed with electrically conducting fibres or threads, such as carbon fibres or metallic fibres or threads to create an electrically conducting circuit within the surface of the panel. Such an electrically conducting circuit can be connected to an alarm system that will set off an alarm if electrical contact is broken, or there is a drop in voltage across the circuit, say for instance, in the case of a fire or with an attempt to destroy the panel, for example during a burglary.

[0021] The panel can be shaped to any desirable length, and also to any desirable form, for example by compression moulding. In most cases, rounded forms of the composite panels can be obtained by positioning the expanded polymer core on a rounded preform, such as a movable curvature support table operated by hydraulic pistons, whereby the hydraulic pistons are linked to the support table in such a way that relative movement of the pistons cause the table curvature to change. The panel will then, if left say overnight, bend under its own weight to conform itself to the shape of the preform, after which the envelope can be molded and the impregnating resin set.

[0022] The composite panels of the present invention also preferably have at least one groove along an edge of the panel, and even more preferably have a groove running centrally along each edge of the panel. When a groove is provided in the panel, the panel can also preferably include a separate basalt fibre reinforced and pre-impregnated (prepeg), pre-hardened resin element that has a shape and size that corresponds to the shape of the groove. It is also possible, and specially preferred to have a pre-hardened resin element that has a shape and size corresponding to a bevelled edged of the panel, for example, when the top of the panel is intended to receive a roofing panel, or for example, in corners of the construction. It will be thus understood that the panels of the invention can have at least one sloping edge, such that panels can be used to form corners when the corresponding sloping edge of one panel is placed against another.

[0023] Some of the advantages of the composite panel of the present invention are as follows :

- lightweight, yet highly resistant to dynamic loads ;
- fire resistant envelope ;
- substantially recyclable, that is, nearly 100% of the product is recyclable. The basalt fibres can simply be rewound off ready to be used again as the polymer resin and core are separated out through heating ;
- sufficiently mechanically strong to be able to be used in the building industry for walls, flooring, and roofing ;
- low maintenance : if ever a panel should get damaged for whatever reason, it can simply be replaced ;

- claddable : the panels, as mentioned, can be easliy cladded with a decorative coating ; the cladding can occur either during manufacture to provide a pre-cladded panel, or afterwards at the point of use.
- anchor point tear resistant : it has been found that when anchor points or fixation devices are placed into a panel according to the present invention, the envelope does not split, as with aramide or Kevlar ® based envelopes. On the contrary, when threaded anchoring devices, such as screws or bolts are inserted into the panel, the basalt fibres have a tendency to seize the threads and prevent their slip or withdrawal under load, and the panel does not split. The consequence of this is greatly increased tear resistance to loads applied to the anchor point ;
- reduced phonic transmission : the composite panels according to the invention have been found to reduce sound propagation when they are cladded and yet receive an impact, such as from a hammer stroke. In most cases on traditional cladded composite panels, the sound generated by the impact is transmitted through or away from the panel and can thus be heard at a level far greater than that of the panel of the present invention ;
- no need to coat moulds with a protective demoulding gel coat.

[0024] The composite panels according to the present invention are self-supporting, weight bearing and very versatile and can be used in all kinds of circumstances for construction of buildings and habitations, including for exterior and interior walls, flooring, roofing, and partitions.

[0025] In another preferred aspect of the invention, there is provided a method and apparatus for manufacturing the composite panels of the present invention. This method is particularly suited to the production of large lengths of panel, preferably from about 2 m to about 80 m in length, and even more preferably from about 12 m to about 30 m in length. The method according to the present invention comprises the steps of :

- drawing out in a first direction a length of basalt roving or woven roving onto a preform ;
- applying an impregnating resin to the length of basalt roving or woven roving ;
- placing a synthetic resin expanded polymer core onto the length of basalt ;
- applying an impregnating resin to the expanded polymer core ;
- drawing back, in a direction oppposite to the first direction, a second length of basalt roving or woven roving over the expanded polymer core ;
- applying heat to set the impregnating resin and form the composite panel.

[0026] In a particularly preferred embodiment, the application of an impregnating resin to the basalt occurs at the same time as the basalt is drawn. This can be achieved, for example, by drawing the basalt roving or woven roving through a bath of impregnating resin provided with nip rollers to remove excess resin as the fibres are being drawn out. Alternative methods for applying the impregnating resin can also be used, such as hand painting, or spraying via a nozzle or a jet placed above the fibre layer as it is drawn or applied to the layer once it is drawn out.

[0027] The apparatus of the present invention comprises :

- a preform support table adapted for receiving a layer of fibres and an expanded polymer core ;
- a movable fibre distributor, that is capable of translational movement along and above the preform support table ;
- an impregnating station for applying impregnating resin.

[0028] Preferably, the movable fibre distributor is a reel attached to a rail-guided rolling support, and even more preferably, the rail-guided rolling support extends across the width of the preform support table. The rail guided support is basically comprised of a support frame for a reel that will hold the basalt fibre to be distributed. At the bottom of the support, wheels or rollers are provided that match with the rails into which the wheels or rollers slot. The rails thus guide the translational movement of the distributor over the preform support table. It will be understood that the rails preferably extend over and beyond the length of the preform support table, so that room can be left to maneuver around the table, should that be deemed necessary. The fibre distributor can be manually driven, although this is not the most preferred option, and most preferably, the distributor is fitted with a drive motor so that it can be driven along the guide rails.

[0029] As mentioned above, the preform support table need not necessarily be flat, and accordingly, the apparatus of the invention also provides for a preform support table that is a movable curvature support table, operated by a relative movement of hydraulic pistons that are connected to the table, thereby modifying the curvature of the table. It is therefore possible with such a table to obtain virtually any curved shape that is desirable for the composite panels of the invention. The pistons can be moved individually to fine tailor the curve applied to the preform table, which in this case is made of a sufficiently rigid, but sufficiently flexible support material. Instead of hydraulic pistons, it would also be possible to use manually driven extension arms that work on the principle of the crick.

[0030] Even more preferably, and as mentioned above, the impregnating station comprises a well containing impregnating resin and at least one pair of nip rollers placed above the well to draw off excess impregnating resin.

[0031] In yet another aspect of the invention, a method of construction of a building is provided, that makes use of the composite panels according to the invention. This method of construction comprises :

- laying a support foundation made of concrete ;
- positioning one or more composite panels according to the invention on the support foundation to form outer and inner walls ;
- positioning one or more composite panels according to the invention obliquely onto the outer walls to form a roof structure ;
- attaching the panels to the support foundation and to each other.

[0032] The girder is similar to those used in the building industry, for example, of steel reinforced concrete, and is generally set on a foundation block that will support the mechanical constraints of the building once finished. The reinforcing steel struts in the concrete are interleaved with steel struts that can project from the foundation block, and another girder. In the method of construction according to the invention, a support girder preferably comprises a ridge, that mates with a corresponding groove on the composite panel of the invention. The panel and girder are more preferably attached to each other via bolts or pitons, that can be applied via a bolt gun or hammered or nailed in. The bolts used in the present invention require no application of torque to stay in place, since the compression exerted by the concrete and the composite panel together are sufficient to prevent accidental withdrawal of the bolt.

[0033] Where it is required to build more than one storey to the building, such can be accomplished quite easily with the composite panels and the method of construction of the present invention. In such a case, the panels will also be provided with a groove running along the top and side edges of the panel. In this way, it is possible to use generally cross-shaped beams, preferably steel reinforced concrete beams, wherein the each projection of the cross shape of the beam is a ridge that fits snugly into the corresponding groove of the panel. The cross-beams are can thus be positioned in the upper and side grooves of the panel to define uprights and horizontals, upon which a further layer, or storey, or even a roof of composite panels can be placed.

[0034] Additionally, the panels can have at least one sloping edge, such that panels can be used to form corners of the building, or for creating the roof apex, when the corresponding sloping edge of one panel is placed against another having the same angle of slope.

[0035] The present invention will now be further described in detail with reference to the Figures, which are given only as an illustration of examples of the invention.

Brief Description of the Figures

[0036]

Figure 1 depicts a schematic sectional representation of a composite panel according to the invention ;

Figure 2 is a schematic sectional representation of another preferred embodiment of the composite panel of the invention;

Figure 3 is a schematic representation of an example of the interleaving of a foundation block with a girder according to the method of construction of the invention ;

Figure 4 is a schematic sectional representation of the manner in which the composite panels of the invention can be assembled with a girder ;

Figure 5 is a schematic representation of a preferred apparatus for the manufacture of the composite panels according to the invention.

Detailed Description of Preferred Embodiments

[0037] Turning now to Figures 1 and 2, a composite panel, indicated generally by the numerical reference 1, is shown. The panel 1 has an envelope 2 and an expanded polymer core 3. The envelope 2 completely surrounds the core and is intimately bonded thereto. The envelope 2 comprises a layer of basalt fibres 4, as roving or a woven roving mat, that is surrounded at least partially, and preferably from about 50% to 80% of its thickness, by an impregnating resin 5. The panel additionally and optionally comprises an exterior cladding 6, such as a layer of plaster, stuc, alabaster or weatherproof resin. At least one side of the panel has a groove 7, and in the example given, a groove is present along two opposing sides of the panel, where both grooves 7, 8, extend substantially along the length thereof. A W- or M-shaped prepeg reinforcing element 9 mates with the groove 7, made up of basalt fibres, and adheres to the groove and other sides of the panel via a layer 5 of impregnating resin. The envelope 2 and prepeg reinforcing element 9 form a single structure with the alveolar core once the impregnating resin 5 in the envelope has hardened. It will be understood that it is also possible to have a prepeg reinforcing element 9 that is formed into a different shape, for example a generally U- or C-shape, for composite panels that have a bevelled edge, in particular a bevelled edge that can be used for example, to meet up against a corresponding roofing composite panel, or to meet up against another correspondingly bezelled composite panel.

[0038] Figure 3 schematically represents the base of a construction that can be used in the method of construction of the present invention. In this embodiment, a concrete foundation block 10, comprises at least one reinforcing upright 11, and preferably multiple reinforcing uprights, in this case four uprights 11, 12, 13, 14. The uprights can be made of steel rods of the type that are usually used in reinforced concrete. In the method of construction, the foundation blocks are set into the ground at positions located around the perimeter of the construction and in the necessary architectural positions that define where the construction is going erected. A reinforced girder 15 comprising reinforcing steel struts 17, 18 or rods projecting from each extremity is interleaved or positioned on the foundation block 10 in between the uprights 11, 12, 13, 14. The other end of the girder 15 would be positioned on another foundation block 10 in a similar fashion. The vertical volume between the girder 15 and the foundation block are usually made up of concrete formed in the usual way, that is, by shuttering and pouring in of wet concrete that is then left to harden around the reinforcing struts 17, 18. The girder 15 comprises a raised rail or longitudinal projection 16 that extends substantially along the entire length of the girder 15. The raised rail or projection 16 has a shape that complements or fits the groove 7 of the composite panel. The composite panels of the invention are placed onto the girder 15, whereby the projection 16 slots into the groove 7 or 8 and thus locates the panel.

[0039] In Figure 4, a more detailed representation of the mounting of the panel onto the girder 15 is given. In this representation, the projection 16 of the girder mates with the groove 8 . Optionally, a sealing layer 19 is placed between the girder 15 and the composite panel to prevent or reduce humidity or ground water from seeping up into the construction. The panel is held in place on the girder 15 via at least one fixation means such as a bolt, nail, pin or screw 20 that passes through an optional washer 21, the envelope 2, through the core 3, and then into the projection 16 of the girder 15. The bolt is held particularly tightly in place by the basalt fibres of the envelope that tend to grip the bolt as it is inserted, thereby providing increased friction against accidental and even voluntary withdrawal. The bolts can be introduced using a bolt gun such as are commercially available.

[0040] In Figure 5, an apparatus for manufacturing the composite panels of the present invention is illustrated. This apparatus comprises a mobile chassis 22, comprising for example a set of wheels 23. The chassis 22 can be motor driven or manually displaced. The wheels 23 are set on a pair of rails 30 that are positioned either side of a preform support table 29. The chassis 22 carries a reel 24 of basalt roving 26 that unwinds from the reel 24 as the chassis 22 is displaced. In Figure 5, an extremity of the basalt roving 24 is attached to the preform support table 29 by a pin, or clamp means 28, such as a bar. The clamp means 28 enables tension to be applied to the roving placed on the preform support table 29, via the displacement of the chassis whereby the tension applied may be upwards of about 10 kg. The chassis 22 is displaced at a speed that enables the roving to be kept taut. An alveolar core, such as compressed expanded polystyrene, is positioned on the preform support table 29 and on top of the basalt roving. It will be understood by the skilled person that the preform support table can have dimensions appropriate to the size of panel to be manufactured. The remainder of the apparatus will be dimensioned accordingly. It is thus easily possible to work with panels that are 3 metres wides and over 20 metres long. As the roving unwinds from the reel 24, it passes through an enduction or impregnation tray 25, containing the synthetic hardenable resin that is used to impregnate the fibers and in adhere to the core. Any excess impregnating resin is removed from the roving 24 on leaving the impregnation tray 25 via a pinch or nip roller 31. Once the alveolar core 3 has been positioned on the roving 24, the chassis 22 is displaced in the opposite direction, back towards the clamp means 28, thereby covering the upper side of the core with impregnated roving. Any bubbles formed are rolled out using conventional techniques, but the rolling is effected such that only approximately 1 in every 2 knit points actually remains impregnated by the resin. This leads to a product with increased fire resistance, and also enables any cladding coat to adhere more easily to the envelope, since such cladding material can also impregnated the remaining available fibres.

[0041] The envelope thus completely surrounds the alveolar core, and can be left to cure or harden for a short period of time before the composite panel is removed from the support table in a finished state. Where panels comprising grooves are manufactured, the W- or M-shaped elements 9 can be inserted along the edge corresponding to the groove and the roving applied as described for the rest of the panel. In this way, the preformed and hardened W- or M-shaped elements 9 will adhere to the resin that has been applied to the roving 24. The general conditions for hardening are as follows : the synthetic hardenable resin and curing agent are mixed together at approximately 70°C, or, where the resin is preheated prior to contact with the curing agent, at 55°C, in which case hardening is almost instantaneous. Alternatively, the hardening of the resin can be carried out at room temperature for a period of approximately 10 minutes.

Claims

1. A composite construction panel, comprising a synthetic resin expanded polymer core and a resin impregnated fibre-reinforced envelope in intimate contact with an outer surface of the expanded polymer core, wherein the fibres of the envelope are basalt.

2. A composite construction panel according to claim 1, wherein the basalt fibres are present as roving or a woven roving mat.

3. A composite construction panel according to claim 2, wherein the woven roving mat has a weight comprised between about 200 g/m2 and about 800 g/m2.

4. A composite construction panel according to claim 1, wherein the expanded polymer core is compressed expanded polystyrene, having a density comprised between about 40 kg/m3 to about 80 kg/m3.

5. A composite construction panel according to claim 1, wherein the panel also comprises a decorative coating or cladding.

6. A composite construction panel according to claim 1, wherein a layer of basalt fibres of the envelope are impregnated to between about 50% to about 80% of its thickness.

7. A composite construction panel according to claim 1, wherein the impregnating resin is an epoxy resin obtainable from epichlorohydrin and bisphenol A, or an inorganic resin comprised of geopolymerized natural and synthetic alumino-silicates.

8. A composite construction panel according to claim 1, wherein the envelope also contains electrically conducting fibres that form an electrically conducting circuit within the panel.

9. A composite construction panel according to claim 1, wherein the panel comprises at least one groove along an edge of the panel, and preferably a groove running centrally along each edge of the panel.

10. A composite construction panel according to claim 1, also comprising a separate basalt fibre-reinforced and pre-impregnated, pre-hardened resin element that has a shape and size that corresponds to the shape of the groove.

11. Method for the production of a composite panel according to any one of the preceding claims, comprising the steps of :

(a)drawing out in a first direction a length of basalt roving or woven roving onto a preform ;
(b)applying an impregnating resin to the length of basalt roving or woven roving ;
(c)placing a synthetic resin expanded polymer core onto the length of basalt ;
(d)applying an impregnating resin onto the expanded polymer core ;
(e)drawing back, in a direction oppposite to the first direction, a second length of basalt roving or woven roving over the expanded polymer core ;
(f)applying heat to set the impregnating resin and form the composite panel.

12. Method according to claim 11, wherein the application of an impregnating resin to the basalt occurs at the same time as the basalt is drawn.

13. Apparatus for the production of a composite panel according to any one of claims 1 to 10, comprising :

(a)a preform support table adapted for receiving a layer of fibres and an expanded polymer core;
(b)a movable fibre distributor, that is capable of translational movement along and above the preform support table ;
(c)an impregnating station for applying impregnating resin.

14. Apparatus according to claim 13, wherein the movable fibre distributor is a reel attached to a rail-guided rolling support.

15. Apparatus according to claim 14, wherein the rail-guided rolling support extends across the width of the preform support table.

16. Apparatus according to claim 13, wherein the movable fibre distributor is motor driven.

17. Apparatus according to claim 13, wherein the preform support table is a movable curvature support table, operated by a relative movement of hydraulic pistons that are connected to the table, thereby modifying the curvature of the table.

18. Apparatus according to claim 13, wherein the impregnating station comprises a well containing impregnating resin and at least one pair of nip rollers placed above the well to draw off excess impregnating resin.

19. Method of construction of a building, comprising :

(a)laying a support girder;
(b)positioning one or more composite panels according to the invention on the support girder to form outer and inner walls ;
(c)positioning one or more composite panels according to the invention onto the outer walls to form a roof structure ;
(d)attaching the panels to the support girder and to each other.

20. Method according to claim 20, wherein the support girder comprises a ridge or projection, that mates with a corresponding groove on the composite panel according to claim 9 or 10.

21. Method according to claim 20, wherein the composite panels and support girder are attached to each other via bolts or pitons.

22. Method according to claim 19 or claim 20, further comprising :

(a)providing composite panels having a groove along each edge of the panel ;
(b)mating at least one groove of a panel with a corresponding ridge of a cross-shaped beam ;

(c)attaching the panel to the cross-beam.

23. Construction obtainable according to the method of any one of claims 19 to 22.

24. Construction comprising at least one composite panel according to any one of claims 1 to 10.

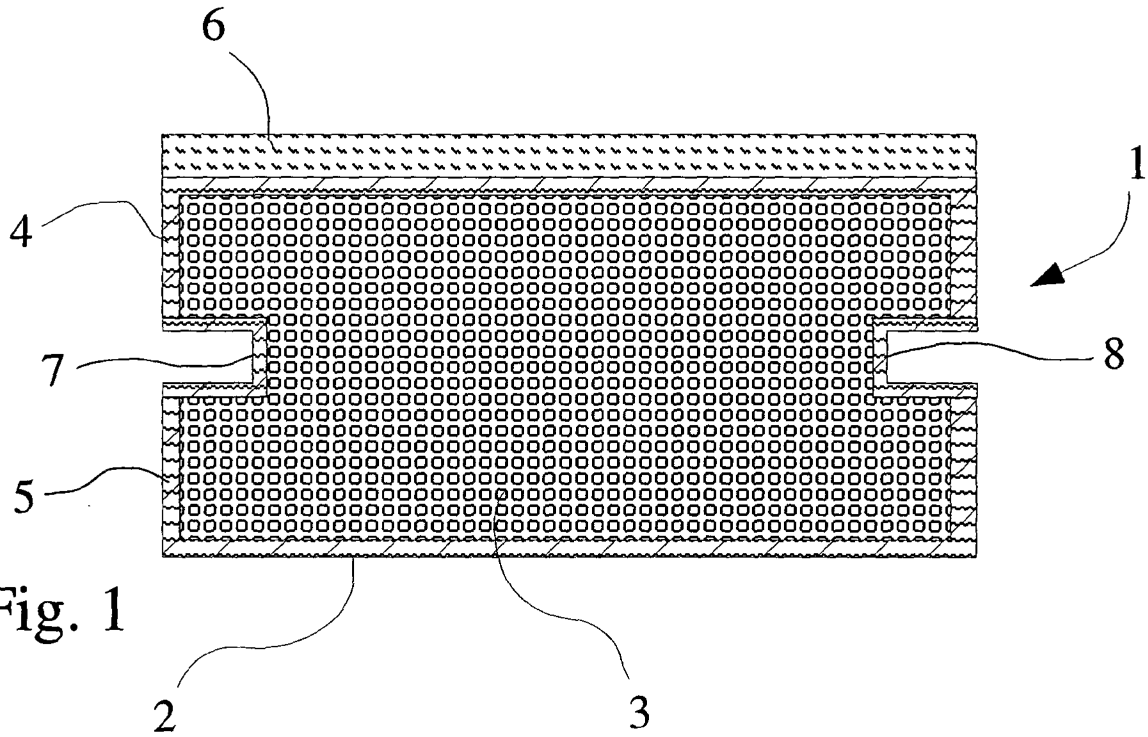


Fig. 1

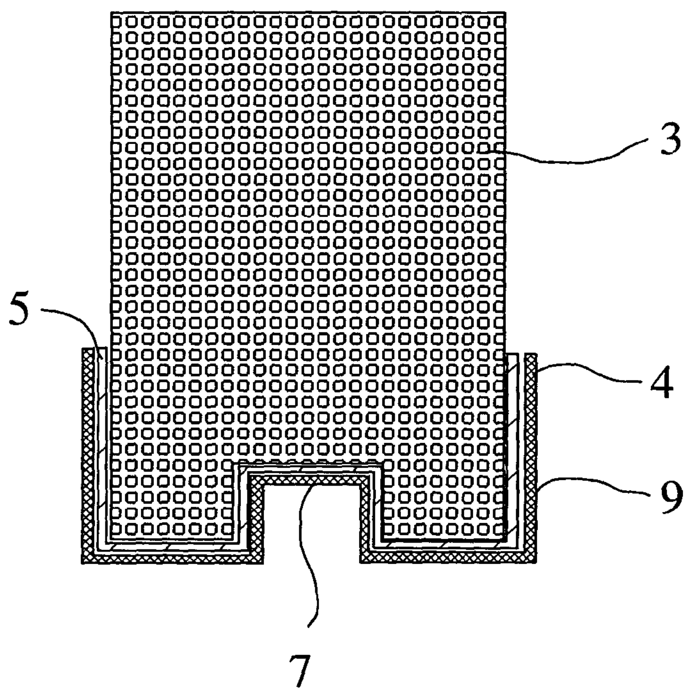


Fig. 2

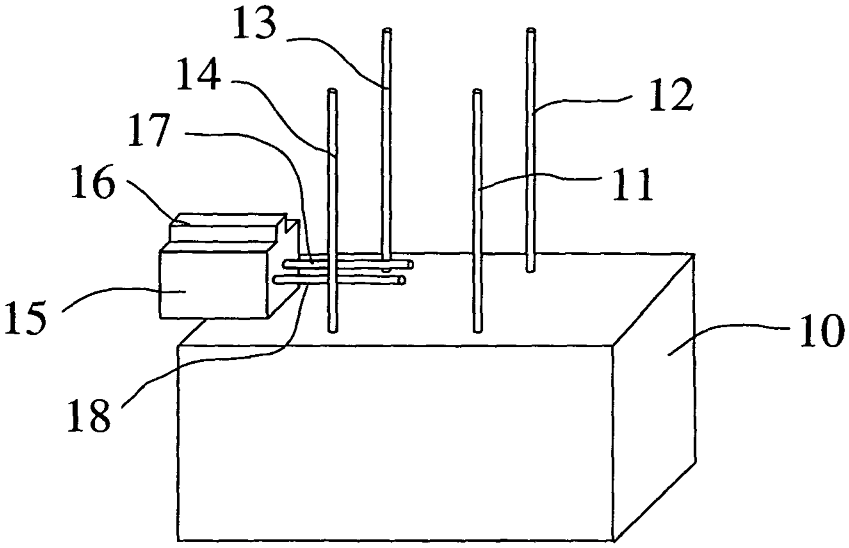


Fig. 3

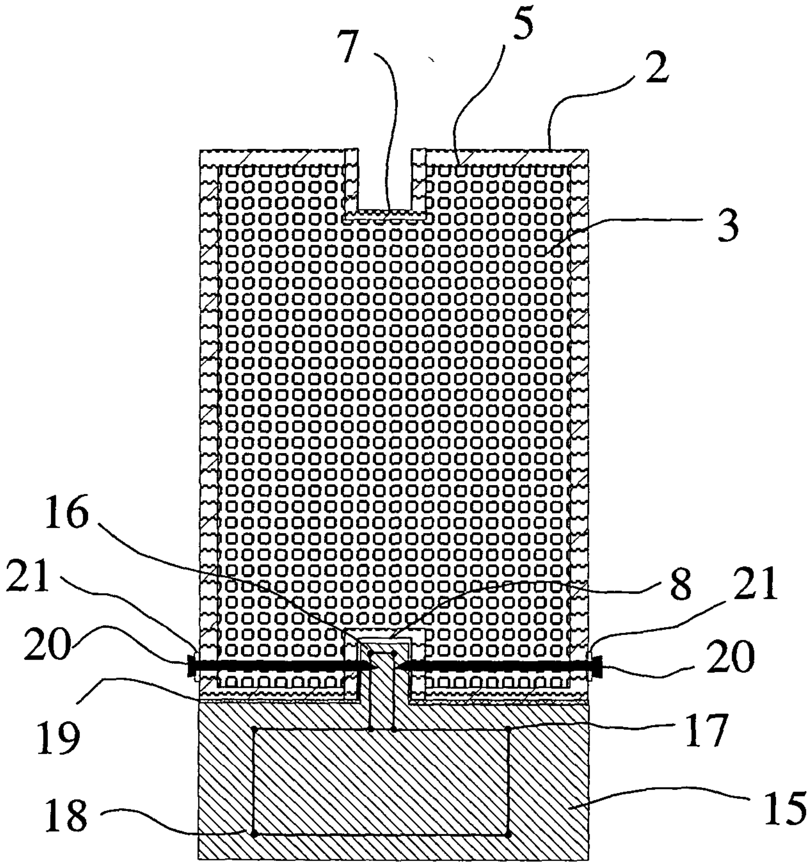
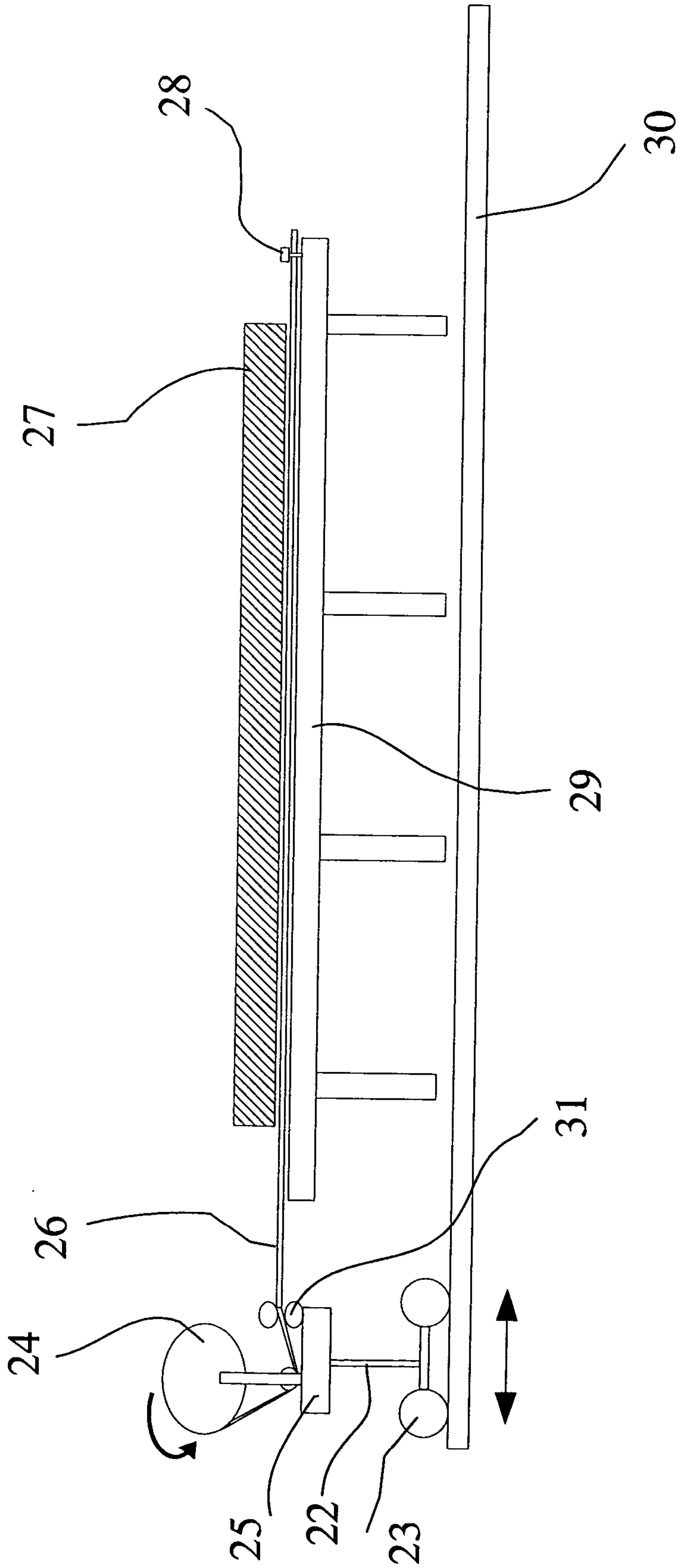


Fig. 4

Fig. 5



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The present search report has been drawn up for all claims

Place of search	Date of completion of the search	Examiner
The Hague	23 February 2005	Mysliwetz, W

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