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<tr>
<td>9701092.0</td>
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| (54) Title:                             | COMPOSITE ROOF SYSTEM |

| (57) Abstract:                          | The present invention relates to a flat roof composite comprising a resin-impregnated mineral fibre layer (1), a fabric layer (2) with impregnated adhesive throughout the layer, the adhesive penetrating also into the surface of the mineral fibre layer, and a moisture impermeable sheet (4) adhered to the fabric layer by the adhesive (5). The fabric is preferably formed of woven strands (3) of glass fibre filaments. The fabric is united with the mineral wool insulating core prior to passage through the curing oven which cures the resin applied to the mineral wool in the spinning chamber. The size of the apertures between strands of glass fibre filaments is selected so as to allow penetration of liquid adhesive into the wool and reduces delamination of the water impermeable sheet. |
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TM Turkmenistan
TR Turkey
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COMPOSITE ROOF SYSTEM

The present invention relates to a flat roof composite comprising a resin-impregnated mineral fibre layer, a fabric layer with impregnated adhesive throughout the layer, the adhesive penetrating also into the surface of the mineral fibre layer, and a moisture (i.e. liquid water) impermeable sheet adhered to the scrim layer by the adhesive.

Background of the Invention

Flat roofs are primarily formed by one of two systems. The main system was molten bitumen applied over roofing felt, with mineral chippings applied on top to provide some protection from the effect of the sun's radiation. This well tested system is successful and has a long life but does require maintenance. The other system uses a sheet of moisture/water impermeable material extending across the roof. The material may be mechanically secured to the underlying substrate by appropriate fixings, or alternatively may be adhered over its whole area to the underlying substrate. This is known as a fully adhered system.

This is carried out on site by applying adhesive to the underside of the impermeable sheet and/or the top surface of the substrate in situ on the roof to form a composite. The use of rigid mineral fibre boards, formed by impregnating a board shaped slab of mineral fibre with a resin containing impregnant liquid in a bath, for the roof is known and provides excellent mechanical, thermal and sound insulating properties.

It is also known to apply a layer of mineral fibre, for instance glass fibre, tissue across the mineral fibre boards whereby it is sandwiched between the board and the impermeable sheet. A panel formed of several boards arranged side-by-side may have a layer of tissue extending across its entire area. The tissue is adhered to the board(s) by adhesive applied between the contacting
surfaces. The tissue holds the boards in position in the panel and may improve the mechanical strength by enabling forces exerted on one board to be transferred to the adjacent board. The tissue has small pores, for instance having average pore size, or distance between adjacent fibres of less than 0.5 mm, for instance as little as 0.1 mm.

When the tissue-mineral fibre board panel is used as a substrate for a fully adhered system the adhesion to the moisture/water impermeable sheet may be unsatisfactory. This problem can be qualified by measurement of the peel strength of the moisture/water impermeable sheet from the composite. The present inventors believe that this is due to an inadequate transfer of forces from the impermeable sheet to the mineral fibre board. The present invention solves that problem.

**Relevant Prior Art**

US 4707961 describes the adhesion of an impermeable sheet to a mineral board (plasterboard/dry wall).

GB-A-1587270 a mineral fibre board used as a roof substrate has a glass fibre fabric which extends across its surface, the two layers being united by passing the glass fabric through a bath of resin-containing liquid and curing resin. The laminated board is used as a substrate for the application of bitumen, and the incorporation of this fabric is said to provide reinforcement for the mineral fibre board and to reduce the amount of bitumen used. The intention therefore appears to be to reduce the extent to which molten bitumen penetrates into the mineral fibre layer.

**Summary of the Invention**

A new roofing system according to the present invention comprises a mineral fibre core, a fabric overlying the core and united to the core by a resin to form a panel and a moisture/water impermeable (i.e. impermeable to water as a liquid, preferably also as vapour) sheet overlying the fabric, which is joined to the
panel by adhesive which penetrates into the mineral fibre core.

The fabric preferably is characterised by being woven of strands, each of the strands being formed of filaments. The filaments may be of polymeric material, but are preferably wholly inorganic, for instance formed of glass. This optimises fire resistance.

The fabric is porous, allowing penetration throughout its thickness of liquid adhesive. The present inventors have found that an excellent combination of performance and materials usage can be achieved where the size of the openings between strands of a woven fabric is greater than 0.5 mm, preferably in the range 0.75 to 2.0 mm, more preferably in the range 1.0 to 1.5 mm. It may be desirable for one or both surfaces of the fabric to be fleecy as this can mask joins between edges of two slabs of mineral fibre in a panel.

The density of the mineral fibre core should preferably be at least 80 kg/m³. It could also be a dual density product, where the surface could have a higher density than the lower part of the core. For instance, a higher density surface layer may have a density greater than 200 kg/m³ and a lower density core may have a density less than 180 kg/m³, for instance less than 150 kg/m³.

The fabric and mineral fibre core may be joined together by resin which penetrates both the fabric and the surface region at least of the mineral fibre core. Although it is possible for this fabric to be adhered to a resin-impregnated board formed of mineral fibre, it is preferred for the fabric and the mineral fibre core to be optimally united by laying the fabric over a slab of mineral wool before or during its passage through a bath of resin-containing liquid whereby resin impregnates both the fabric and the whole volume of the mineral wool slab, and then curing the resin to form a panel. The uniting of the fabric and the core is thus preferably part of the manufacturing process carried out prior to building site
work. The panel may comprise several slabs of mineral wool joined by a single sheet of fabric.

The impermeable sheet is usually adhered to the panel on site. Thus the roof is first built in the normal way using panels having a mineral fibre core. Adhesive liquid is then applied to either or both of the impermeable sheet and the fabric surface and the impermeable sheet is laid over the fabric so that the two become adhered. In the invention it is essential that the adhesive penetrate right through the fabric and it is therefore essential that the adhesive is in liquid form when it first contacts the fabric side. Where the adhesive is a curable resin, for instance which cures on contact with air, or moisture or moisture vapour or after activator or on being heated, the liquid adhesive may be applied to only one of the fabric or impermeable layer, usually the fabric. Where the adhesive develops its adhesion by evaporation of a solvent/liquid vehicle, whereby the adhesive solidifies (or gels), the liquid adhesive composite must be applied at least to the fabric, so that it can penetrate to the mineral fibre core whilst in liquid form. For one class of such adhesives, contact adhesives, the adhesive liquid should preferably be applied to both fabric and impermeable sheet and solvent allowed to evaporate at least partially, before the coated surfaces are contacted with one another.

The viscosity of the liquid adhesive is adjusted/selected so as to allow penetration to the mineral fibre core. It has been found that liquids having viscosities in the range 500 to 10,000 cps, preferably in the range 1000 to 5000 cps, measured at 20°C, have good penetration. The application rate (of liquid adhesive) is preferably in the range 100 to 700 g/m², preferably 200 to 300 g/m².

Penetration of the liquid adhesive may be increased and material usage may be minimised by the use of a foamable adhesive, for instance which foams on contact with water during or after application to the fabric.
Suitable adhesives are, for example, those typically used for fully adhered impermeable sheet attachment, for instance polyurethanes or polyacrylic or rubber contact adhesives.

The present invention gives excellent, mechanical characteristics, especially improved peel strength as compared to a comparable panel having a layer of tissue across its surface.

The invention is illustrated in the accompanying drawing, which is a perspective view of a portion of a roofing system showing the layers in cross section. In the figure mineral fibre core 1, for instance formed of rock wool, having a density in the range 150 to 250 kg/m$^3$, preferably in the range 175 to 200 kg/m$^3$, is covered by a fabric 2 formed of woven strands 3 each of many filaments of glass fibre. The spacing $d$ between the strands is in the range 1 to 1.5 mm. Impregnated throughout the volume of the core 1 and the fabric 2 is a resin, in this case a thermoset resin which unites the core and fabric to form a panel. The fabric and core may be assembled prior to the application of resin Apparatus may be similar to that currently used to impregnate high density rock wool boards. The impregnated material is passed through an oven to cure the resin.

The fabric may be covered with a polymeric roofing material (sheet 4), for instance formed of polyethylene or poly vinyl chloride and being about 0.8 to 4 mm thick. It is adhered thereto by adhesive 5 which penetrates between the strands 3 of the fabric and into the surface layer 6 of the mineral wool core.

The improved properties of the roofing system of the invention can be seen from the following experiments. The adhesive indicated in the table below was applied by brush to the fabric of the panel described above (rock wool density 200 kg/m$^3$) at the spreading rate recommended (200 to 300 g/m$^2$). A polymeric roofing membrane was fitted and the adhesive allowed to cure for 7 days. Test samples of
200 by 50 mm were cut, clamped at an angle to the horizontal of about 30°. The clamp of a tensile testing machine was applied over a width of 50 mm by attachment of the moving head to the lower edge of the PVC sheet. The load was applied at a predetermined rate to test the peel strength. The results are reported in the table below.

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<th>Adhesive Type</th>
<th>Test Speed mm/min</th>
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<tr>
<td>Polyurethane</td>
<td>500</td>
<td>150</td>
</tr>
<tr>
<td>Polyurethane</td>
<td>100</td>
<td>90 to 95</td>
</tr>
<tr>
<td>Rubber contact</td>
<td>500</td>
<td>&gt;100</td>
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CLAIMS
1. A roofing system comprising a mineral fibre core, a fabric overlying the core and united to the core by a resin to form a panel and a moisture/water impermeable sheet overlying the fabric, which is joined to the panel by adhesive which penetrates into the mineral fibre core.
2. A roofing system according to claim 1 in which the fabric is formed of woven strands, each of which is formed of filaments.
3. A roofing system according to claim 2 in which the filaments are formed of inorganic fibres.
4. A roofing system according to claim 3 in which the inorganic fibres are glass fibres.
5. A roofing system according to any of claims 2 to 4 in which the size of the openings between the strands is greater than 0.5 mm.
6. A roofing system according to any of claims 2 to 5 in which the openings between the strands is in the range 1.0 to 1.5 mm.
7. A roofing system according to any of claims 1 to 6 in which one side of the fabric is fleecy.
8. A roofing system according to any preceding claim in which the fabric and mineral fibre core are joined together by resin which penetrates both the fabric and the surface region at least of the mineral fibre core.
9. A roofing system according to claim 8 in which the fabric and mineral fibre core have been united by contacting the fabric and a slab of mineral fibre containing uncured resin applied in the spinning chamber prior to curing of the resin in the curing oven.
10. A method of producing a roofing system according to any preceding claim in which a panel is laid on the roof supports with the fabric side upper most, a adhesive liquid is then applied to either or both of the impermeable sheet and the fabric surface and the impermeable sheet is laid over the fabric so that the two become adhered, whereby the
adhesive penetrates the fabric, and the adhesive is allowed to solidify.

11. A method according to claim 10 in which the adhesive comprises a curable resin.

12. A method according to claim 11 in which the curable resin is applied to one surface only.

13. A method according to claim 10 in which the adhesive develops its adhesion by evaporation of a solvent/liquid vehicle, whereby the adhesive solidifies (or gels), and in which liquid adhesive is applied at least to the fabric.

14. A method according to claim 13 in which the adhesive is a contact adhesive and is applied to both surfaces, solvent is allowed to evaporate and then the adhesive coated surfaces are contacted with one another.

15. A method according to any of claims 10 to 14 in which the liquid adhesive has a viscosity in the range 500 to 10,000 cps measured at 20°C.

16. A method according to claim 15 in which the viscosity is in the range 1000 to 5000 cps.

17. A method according to any of claims 10 to 16 in which the rate of application of the adhesive in the range 100-700 g/m².
**INTERNATIONAL SEARCH REPORT**

**A. CLASSIFICATION OF SUBJECT MATTER**

| IPC 6 | E04D11/02 | E04D5/10 |

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

**B. FIELDS SEARCHED**

Minimum documentation searched (classification system followed by classification symbols)

| IPC 6 | E04D |

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

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<th>Category</th>
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<td>GB 2 161 749 A (COOLA) 22 January 1986 see the whole document</td>
<td>1-17</td>
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<td>GB 2 289 436 A (GARRARD) 22 November 1995 see page 4, paragraph 2 - page 5, paragraph 1; figures</td>
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<td>A</td>
<td>GB 2 155 854 A (RUTGERSWERKE) 2 October 1985 see abstract; figures</td>
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<td>A</td>
<td>DE 29 25 511 A (DEITERMANN) 8 January 1981 see claims 1,2,6,7,9; figures</td>
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<td>A</td>
<td>DE 32 46 573 A (MÜLLER) 20 June 1984 see page 18, last paragraph - page 19, line 27; figures</td>
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**Date of the actual completion of the international search**

28 April 1998

**Date of mailing of the international search report**

08/05/1998

**Name and mailing address of the ISA**

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Righetti, R
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