Title: STONE BASED SANDWICH PANEL AND ITS MANUFACTURING PROCESS

Abstract: Sandwich panel consists of face stone layer (1) of 5 to 20 mm thickness and bottom layer (2) of cured polyurethane foam of 5 to 100 mm thickness and 45 to 500 kg/m³ density that are bonded together. Polyol component which polyurethane material is made of contains minimum 20% of polyol mass made on the base of plant oils. In bottom layer (2) of cured polyurethane foam material grid (3) of mineral or organic fibres is advantageously situated in the depth of 0.2 to 10 mm under the external surface of sandwich panel bottom layer (2). The manufacturing process of the sandwich panel consists in the procedure when bottom layer of cured polyurethane foam is formed by mould injection where grid (3) is advantageously stretched in. Foamed polyurethane material is allowed to cure in the mould the size of which corresponds with bottom layer of cured foam of polyurethane mass.
Stone based sandwich panel and its manufacturing process

Technical field

The invention applies to sandwich panel based on artificial or natural stones and its manufacturing process.

Background art

Large-area construction elements made from artificial or natural stones such as e.g. working table panels for fitted kitchens, bathrooms and laboratory furniture, coffee tables, tiling, paving, aesthetic accessories are used in domestic interior decorating architecture.

Panels based on artificial or natural stones have a disadvantageous feature consisting in their great volume weight. Products made of them are heavy, difficult to handle both for purposes of logistics and for further processing as well as for their proper assembling. They require corresponding strengthened supporting system due to their weight.

Rigid and hard materials require demanding workability and considerable consumption of expensive, mostly diamond tools.

Summary of the invention

Above mentioned disadvantages joined with the application of panels based on artificial or natural stones of high weight are solved by sandwich panels according to this invention which consists in the fact that it is consisting of stone face layer selected from a group formed by artificial or natural stones of 5 to 20 mm thickness and of bottom layer of foam cured from polyurethane mass of 5 to 100 mm thickness and of 34 to 500 kg/m³ density which are bonded together.

Polyol component out of which polyurethane mass is made contains minimum 20% wt. polyol produced on the base of plant oils. Ecologically favourable polyols are produced on the base of plant oil, e.g. rape, sunflower, soya been or palm oils which represent recoverable sources of raw material.
Inside the bottom layer of foam cured from polyurethane mass there is a suitably situated grid of mineral or synthetic fibres which is cast in bottom layer of foam cured from polyurethane mass in the depth of 0.2 to 10 mm under the external surface of foam cured from polyurethane mass of the sandwich panel.

The grid is formed by woven or knitted fabric preferably by warp knitted fabric of synthetic fibres selected from the group containing polyester or polyacrylonitrile or polyamide synthetic fibres or their mixtures. Polyester fibre of excellent adhesion with polyurethane mass is the best one.

In no direction knitted or woven fabric dimensional change (contractility) exceeds 5%. Grid may be also formed by woven reinforcing grid of mineral fibres selected from a group of glass, basalt or carbon fibres. Production procedure of the sandwich panel consists in making bottom layer of cured foam from polyurethane mass by mixing the components of polyurethane system consisting of polyl component A which contains minimum 20% wt of polyl made on the base of plant oil and of component B on the base of isocyanate (MDI). This mixture is injected into a mould with advantageously stretched grid inside. In the mould the size of which corresponds to bottom layer of cured foam from polyurethane mass, foamed polyurethane mass is allowed to cure. After withdrawing it from the mould, cured polyurethane mass is ground to the required thickness on the side which is bonded to the reverse side of the stone face layer, then it is coated with adhesive and is pressed with the reverse side of the stone face layer forming thus a compact multilayer.

Reinforcing grid in the mould is stretched so that it can be situated in foam cured from polyurethane mass in the distance of 0.2 to 10 mm under outer surface of bottom layer of cured foam from polyurethane mass of the sandwich panel.

Sandwich panel provides necessary level of mechanical properties, e.g. panel carrying capacity with theoretical span of supporting joists of 560 mm is 3.4 kN minimum, carrying capacity of wood screw connection anchored into polyurethane mass is 0.7 kN minimum. At the same time its weight in comparison with rigid panel decreases markedly, e.g. sandwich panel of 35 mm thickness is 2.8 times lighter than panel of the same size made solely from artificial stone thus making handling during production, distribution and further processing easier.
especially in connection with observing the limit of maximum weight of the load per one worker's manual handling. This enables to reduce the requirements put upon supporting structure of the furniture and to reduce the production costs of the sandwich panel proper as well as of the supporting structure. Thinner layer of hard material (stone) is workable more easily with lower cutting tool consumption. When using it as facing material it significantly contributes to increase thermal resistance of the multilayer of the faced element since thermal conductivity coefficient of the applied sandwich polyurethane layer, e.g. of 120 kg/m³ volume weight is lower than 0.032 W/mK.

Polyurethane layer makes easy application of wood screw joints when using dowel pins applied for gypsum plasterboards and easy workability with common woodworking tools possible. The applied manufacturing process enables to make smooth and glossy bottom surface of the polyurethane foam sandwich panel which can be easily cleaned and is free from any separating agents and can be easily and firmly bonded to the carrying corpus e.g. with polyurethane adhesives and cements. Sandwich panel according to this invention imitates thick wall board but its weight is lower in multiples than weight of panel of the same thickness and area made only of artificial stone.

For example, large area panel from artificial stone of 300 x 132 x 3 cm size (standard size) of 2300 kg/m³ density has the weight of 273 kg approximately. For example, sandwich panel of 300 x 132 cm size and 3 cm total thickness made from the same kind of artificial stone of 10 mm thickness, polyurethane layer of 2.0 cm thickness and 220 kg/m³ density with glass fibre fabric has the weight of 109 kg only, i.e. it is 2.5 times lighter than a panel of 30 mm thickness made only from artificial stone.

For example, sandwich panel of 300 x 132 size and 3.5 cm thickness made from the same kind of artificial stone of 10 mm thickness, polyurethane layer of 25 mm thickness and 220 kg/m³ density with knitted fabric of textile fibres weights about 113 kg and is about 2.8 times lighter than a panel of 3.5 cm thickness made from artificial stone only.

The sandwich panel layer made from artificial stone may be substituted with natural stone.
Survey of figures

Figure 1 illustrates cross-section of sandwich panel.

Execution example No. 1

Figure 1 illustrates sandwich panel the face layer 1 of which is made from polished artificial stone of 300 x 130 x 1 cm size and of 2 300 kg/m³ density. Bottom layer 2 of foam cured from polyurethane mass is of 25 mm thickness and comprises inside grid 3 about 1 mm under the surface made of polyester textile knitted fibre fabric. Both layers are joined by means of adhesive 4. Grid 3 was situated in mould the size of which coincides with dimensions required for bottom layer 2 of foam cured from polyurethane mass. Mixture of polyurethane system containing 25% wt. polyol based on rape oil was injected into the mould. Thus a panel of foam cured from polyurethane mass of 220 kg/m³ density and of 25 to 26 mm polyurethane layer thickness which had, in the depth of about 1 mm under the surface, cast grid 3 formed by polyester textile knitted fabric situated so that the knitted fabric was parallel with longitudinal axis of bottom layer 2 of foam cured from polyurethane mass was made. Panel was ground down on the plane grinding machine on the surface more distant from inserted fabric to thickness of 25 mm and it was bonded in a press with adhesive 4 to face layer 1 of artificial stone so that artificial stone formed face side of sandwich panel and surface with adjacent cast grid of polyester fibres formed the reverse side of the sandwich panel. In this way sandwich panel of 35 mm thickness was made where face and reverse sides are glossy and smooth thus enabling easy maintenance (impurities do not adhere, they are washable and easy to clean). A dowel used for wood screw joints of gypsum plasterboards by means of wood screws was screwed for the purpose of testing strength of wood screw joints. Weight of this panel is 113 kg approximately. Square weight is 32.3 kg/m². Sandwich panel coefficient of thermal conductivity is better than 0.038 W/mK. Carrying capacity without any marks of destruction with span of supporting beams of 560 mm min. is 3.4 kN, carrying capacity till the moment of panel destruction is 5.5 kN minimum. Strength of wood screw joint is at least 0.7 kN.
Execution example No. 2

Face layer 1 is made from artificial polished stone of 300 x 130 x 1 cm size and 2,300 kg/m³ density. Bottom layer 2 of foam cured from polyurethane mass is of 21 mm thickness and contains grid 3 about 2 mm under its surface which is formed by glass woven fibre reinforcing grid. Both layers are bonded with adhesive 4.

Bottom layer 2 of foam cured from polyurethane mass of about 220 kg/m³ density and about 21 mm thickness was formed in the mould from polyurethane system containing 25% wt. of polyol on the base of rape oil into which reinforcing grid formed by glass woven fibre fabric was cast into the depth of about 2 mm under its surface. By applying the plane grinding machine it was ground down on the more distant surface from inserted fabric to 20 mm thickness and was bonded in the press onto the face layer 1 of artificial stone so that polished surface of artificial stone could make face side of sandwich panel and glossy surface with adjacent cast grid 3 of glass fibres could make sandwich panel reverse side. Thus a sandwich panel with smooth and glossy surfaces enabling easy maintenance was made. Weight of this panel is about 108 kg. Square weight is 30.8 kg/m³ approximately. Coefficient of thermal conductivity of the sandwich panel is better than 0.038 W/mK.

Industrial utilization

Sandwich panels according to this invention can be used in stoneworks, kitchen and bathroom studios, for manufacturing furniture, for laying tiling and medium loaded pavings as well as for other interior elements utilizing artificial or natural stones. They can be preferably used as facing or pavement for simultaneous increase of thermal resistance of the wall or floor in air-conditioned buildings especially.
Claims

1. Stone based sandwich panel characterized by its composition of face layer (1) of stone selected from group consisting of artificial or natural stones of 5 to 20 mm thickness and of bottom layer (2) of foam cured from polyurethane mass of 5 to 100 mm thickness and of 45 to 500 kg/m³ density which are bonded together by means of adhesive (4) whereby polyol component which polyurethane mass is made of contains minimum 20% of polyl made on the base of plant oils.

2. Sandwich panel according to Claim 1 characterized by its bottom layer (2) of foam cured from polyurethane mass where grid (3) of mineral or synthetic fibres is situated in the depth of 0.2 to 10 mm under outer surface of bottom layer (2) of foam cured from sandwich panel polyurethane mass.

3. Sandwich panel according to Claims 1 and 2 characterized by its bottom layer (2) of foam cured from polyurethane mass in which there is an inserted grid (3) formed by woven textile or knitted fabric of synthetic fibres or by their mixtures.

4. Sandwich panel according to Claim 3 characterized by grid (3) which is formed by warp textile knitted fabric.

5. Sandwich panel according to Claims 3 and 4 being characterized by synthetic fibres which are of polyester or polyacrylonitrile or polyamide or where their mixture is used.

6. Sandwich panel according to Claims 3 to 5 characterized by the fact that dimensional change (contractility) of woven textile or knitted fabric is as a maximum 5% in all directions.

7. Sandwich panel according to Claim 2 characterized by its bottom layer (2) in which grid (3) formed by reinforcing grid of woven fabric of mineral fibres selected from group of glass, basalt or carbon fibres is inserted in.

8. Sandwich panel manufacturing process characterized by bottom layer (2) of foam cured from polyurethane mass which is made of polyurethane system consisting of polyl component A containing minimum 20% wt. polyl made on base of plant oil and of component B based on isocyanate (MDI), their mixture is injected into mould where foamed polyurethane mass is
allowed to cure, after its removal from mould cured polyurethane mass is
ground to the required thickness on its side that is bonded to the reverse
side of stone face layer (1), then it is coated with adhesive (4) and pressed
together with reverse side of stone face layer (1) thus forming a rigid
multilayer.

9. Sandwich panel manufacturing process according to Claim 8 characterized
by stretching grid (3) in the mould before injecting mixture of polyurethane
system.
AMENDED CLAIMS

received by the International Bureau on 03 October 2005: claims 1-9 have been replaced by amended claims 1-7.

1. Stone based sandwich panel characterized by its composition consisting of face layer (1) of stone, selected from group consisting of artificial or natural stones, 5 to 20 mm thick, and of bottom layer (2) of foam cured from polyurethane mass 5 to 100 mm thick and of 45 to 500 kg/m³ density, which are bonded together by means of adhesive (4), whereby polyl component used for production of the polyurethane mass contains minimum 20% wt. of polyl made on the base of plant oils, and in the bottom layer (2) of foam cured from polyurethane mass a grid (3) of mineral or synthetic fibers is situated in the depth of 0.2 to 10 mm below outer surface of bottom layer (2) of foam cured from polyurethane mass of the sandwich panel.

2. Sandwich panel according to Claim 1 characterized by the fact that into its bottom layer (2) of foam cured from polyurethane mass a grid (3) is inserted, which is formed by woven textile or knitted fabric of synthetic fibers or their mixtures.

3. Sandwich panel according to Claim 2 characterized by the fact that the grid (3) is formed by warp textile knitted fabric.

4. Sandwich panel according to Claims 2 and 3 characterized by the fact that the synthetic fibers are made of polyester or polyacrylonitrile or polyamide, or their mixture is used.

5. Sandwich panel according to Claims 2 to 4 characterized by the fact that dimensional change (shrinkage) of woven textile or knitted fabric does not exceed 5% in any direction.

6. Sandwich panel according to Claim 2 characterized by the fact that into its bottom layer (2) of foam cured from polyurethane mass, a grid (3) is inserted, which is formed by reinforcing grid of woven fabric of mineral fibers selected from group of glass, basalt or carbon fibers.

7. Sandwich panel manufacturing process characterized by the fact that the bottom layer (2) of foam cured from polyurethane mass is made of polyurethane system consisting of polyl component A containing minimum 20% wt. polyl made on base of plant oil and of component B based on isocyanate (MDI), their mixture is injected into mould where the grid (3) is stretched, the foamed
polyurethane mass is allowed to cure, after its removal from mould the cured polyurethane mass is ground to the required thickness on its side that is to be bonded to the reverse side of stone face layer (1), then it is coated with adhesive (4) and pressed together with reverse side of stone face layer (1) thus forming a rigid multilayer body.
**INTERNATIONAL SEARCH REPORT**

**A. CLASSIFICATION OF SUBJECT MATTER**

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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)

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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)

**EPO-Internal, WPI Data**

**C. DOCUMENTS CONSIDERED TO BE RELEVANT**

<table>
<thead>
<tr>
<th>Category</th>
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<td>X</td>
<td>WO 02/46262 A (HENKEL KOMMANDITGESELLSCHAFT AUF AKTIEN; THIELE, LOTHAR; HERZOG, JOERG) 13 June 2002 (2002-06-13) Stone/PU foam laminate and method. One of many similar applications from Henkel. page 3, paragraph 2 - page 4, paragraph 1 page 7, paragraph 2 page 11, paragraph 2 page 16, paragraph 3 - page 17, paragraph 2 page 21, paragraph 2 examples 1,2</td>
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Further documents are listed in the continuation of box C. Patent family members are listed in annex.

**Date of the actual completion of the international search**

5 August 2005

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

17/08/2005

**Name and mailing address of the ISA**

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