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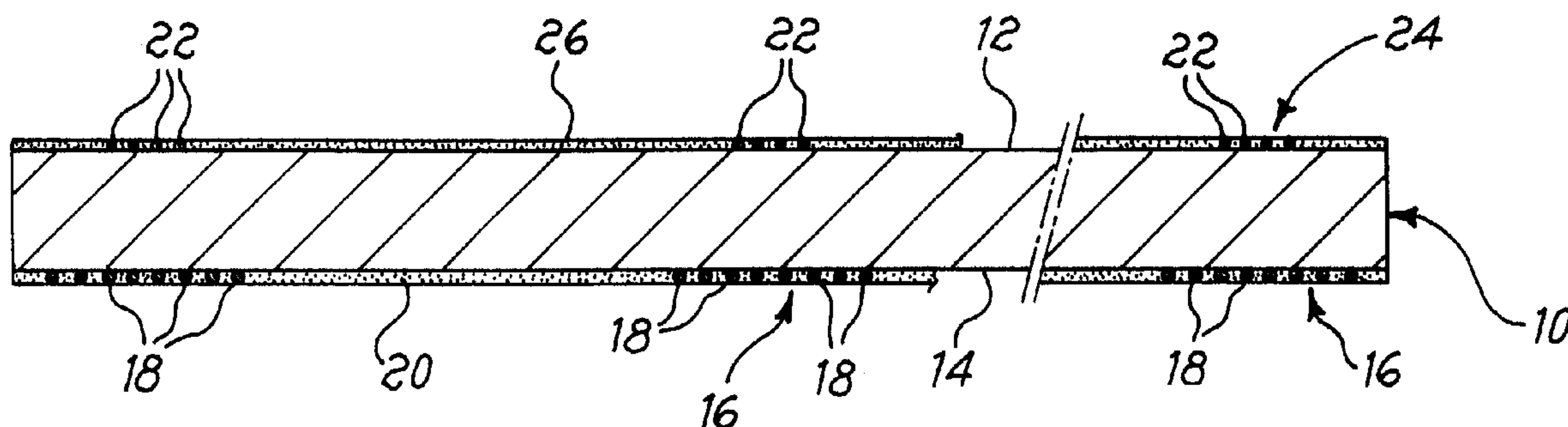
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(54) Titre : ROCEDE POUR LA PRODUCTION DE DALLES DE MATERIAU PIERREUX RENFORCEES ET DALLES
RENFORCEES OBTENUES

(54) Title: PROCESS FOR THE PRODUCTION OF REINFORCED SLABS OF STONE MATERIAL AND REINFORCED
SLABS OBTAINED



(57) Abrégé/Abstract:

By applying to the visible face of slabs of stone material (such as marble and granite), especially thin slabs, a reinforcing layer constituted by non-twisted glass threads, preferably in the form of a mat, and by a transparent resin resistant to the action of atmospheric and chemical agents, a reinforced slab is obtained which has a small thickness and in which the resistance to negative flexing is greatly increased, concomitantly with the resistance to positive flexing if the rear, or invisible, face of the slab is also reinforced.



Abstract

By applying to the visible face of slabs of stone material (such as marble and granite), especially thin slabs, a reinforcing layer constituted by non-twisted glass threads, preferably in the form of a mat, and by a transparent resin resistant to the action of atmospheric and chemical agents, a reinforced slab is obtained which has a small thickness and in which the resistance to negative flexing is greatly increased, concomitantly with the resistance to positive flexing if the rear, or invisible, face of the slab is also reinforced.

"Process for the production of reinforced slabs of stone material and reinforced slabs obtained"

The present invention relates to a process for the production of reinforced slabs of stone material and also to the reinforced slabs so obtained. More specifically, the present invention relates to a process for the production of slabs of stone material which have a small thickness and which exhibit a high level of resistance to both positive and negative flexing. These slabs are usually used as coverings for masonry structures, for example for pavings, for facing walls of buildings and, more generally, for applications in which the mechanical characteristics must be accompanied by special aesthetic effects. It is well known that, in the case of natural stone materials in the form of slabs, the main objective has always been, and still is, to produce slabs that are as thin as possible (for obvious reasons) without the mechanical properties being diminished to an unacceptable extent. With regard to thin slabs, a problem of not inconsiderable importance from the point of view of use is that of the manipulation of the slabs which have to be handled with great care to avoid breakages or cracks: therefore, both during transport and in the course of their manipulation, for example during the moving operations which precede final installation, it is necessary to avoid any situation in which the slab is supported in cantilevered manner, because any oscillation, however slight, of the free edge of the slab will inevitably lead to breakage.

European Patent Application No. 95201590.7, filed June 15, 1995 in the name of Marcello Toncelli, describes a process for the production of thin slabs of stone material, such as marble and granite, which are reinforced at their rear face, or in other words the face that is not visible, which process basically consists in applying to the above-mentioned rear, or invisible, face of the slab a layer of hardenable resin, for example an epoxy resin, while incorporating in the resin layer a reinforcing material comprising non-twisted linear elements of glass threads, preferably in the form of a mat, and maintaining a specific percentage ratio by weight between the resin and the mat of glass threads. According to one variant, it is possible to form, in the rear face of the slab, cavities or grooves which accommodate additional linear reinforcing elements, preferably in the form of glass fibre strands, which are thus also embedded in the resin layer.

For further details on the method of implementing this process, the technical problem which this process solves and the properties of the resulting reinforced slabs, reference should be made to the text of the above-mentioned patent application.

In particular, it is noteworthy that the flexural resistance of the slabs of stone material thus reinforced is greatly increased: for example, in the case of a granite slab from 10 to 12 mm thick, of which the flexural resistance is normally of the order of 150 kg/cm^2 by producing the reinforcement using two mats of glass threads and epoxy resin, it is found that the resulting composite slab (always for a total thickness of 10

mm) exhibits a flexural resistance of approximately 1350 kg/cm^2 . In the case of facings for the external walls of buildings, it is, however, necessary also to bear in mind another resistance problem which is associated specifically with the action of atmospheric agents and, in particular, winds.

The flexural resistance is increased by the process of the above-mentioned patent application in respect of the reinforced face, while, for the face which is in view, this resistance remains at the usual values of from 120 to 180 kg/cm^2 (depending upon whether the material concerned is marble, granite or another natural stone material).

When the building is subjected to winds of substantial force and speed, a partial vacuum, which
 10 can also cause the breakage of some of the slabs, with the obvious disadvantages, acts on the slabs covering the face of the building that is not directly subjected to the wind current, especially in the region of the vertical edges of the building.

On the other hand, no means have hitherto been known for increasing the flexural resistance of these slabs in respect of the face that is to form the visible face, for which there are absolutely essential requirements of a formal and aesthetic nature.

Therefore, the only solution for facing buildings situated in regions subjected to strong winds has hitherto been to adopt slabs of stone material of substantial thickness in order to compensate for the lesser flexural resistance.

An object of the present invention is therefore to produce slabs of stone material which

- 20 (a) have a small thickness;
 (b) are reinforced on both faces in such a manner as to increase resistance to both positive and negative flexing; and
 (c) maintain unchanged over time the aesthetic properties of the stone material from which they are formed.

Accordingly, the present invention relates to a process for the production of reinforced slabs of stone material having an exposed front face and an unexposed rear reinforced face, comprising the steps of: providing a transparent hardenable resin having transparent, non-twisted glass threads embedded therein, the resin being resistant to atmospheric agents; and applying the resin to the exposed front face of the slabs, whereby the front face of the slab, which is visible through
 30 the resin, is protected against the atmospheric agents and is reinforced against flexural damage.

The expression "small thickness" means that the thickness is preferably not greater than 10 mm , although this is naturally not to be understood in a limiting sense.

In the preferred embodiment of the present invention, the layer of reinforcing material comprises a mat of non-twisted glass threads similar to that used for reinforcing the rear face except that the

glass mat is used in an amount such that there are approximately from 100 to 800 g of mat per square metre of slab surface area, preferably 500 g of mat per square metre of slab surface area. With regard to the transparent hardenable resin, the best results are obtained by using epoxy resins, preferably aliphatic epoxy resins, to which UV ray absorbers and UV ray scavengers are added. Alternatively, it is possible to use resins of the acrylic and/or polyurethane acrylate type. The percentage ratios by weight between the mat and the resin are of the same order as those used for reinforcing the rear face of the slab.

Practical tests carried out using the process of the present invention have shown that the flexural resistance of the slab, which is always from 10 to 12 mm thick, in respect of its front, or visible, face, increases from values of from 120 to 180 kg/cm² (naturally depending on the stone material constituting the slab) to values of from 400 to 800 kg/cm².

After the resin-hardening stage, the visible surface of the resultant slab can be subjected to polishing and/or varnishing operations, while the mechanical smoothing and/or polishing of the slab surface underneath the reinforcing layer of mat and transparent resin is no longer necessary. In terms of industrial working, the advantages which are thus obtained are clear.

According to a variant which is especially useful when it is also desired to increase the resistance of the visible front face of the slab to scratching or abrasion, the resin is supplemented with a suitable anti-scratch agent and/or is charged with extremely fine glass or quartz powder in an amount such as not to compromise the transparency of the resin. One of the major advantages of the process according to the present invention resides in the fact that, in the case of slabs of marble or other calcareous stones, the reinforcing layer obtained by the process of the present invention also provides lasting protection against yellowing and/or discolouration which is one of the disadvantages of using such material as an external covering. In addition, because both marble and calcareous stone are

sensitive to the action of acids and thus also to the action of so-called acid rain, the present invention substantially solves this specific problem and disadvantage also.

Such stone materials are generally considered to be non-porous, but even in the case of porous stone material, such as, for example, travertines, the external reinforcing layer, or the layer applied to the front face of the slabs, increases the slabs' resistance to breakage or damage resulting from the alternation of hot and cold seasons because the possibility of water being absorbed in the open pores of the front face is drastically reduced.

Therefore, the present invention provides a process for the production of a reinforced slab of non-porous stone material, the slab having an unexposed invisible reinforced rear face
10 and an exposed front face having a visible surface area, the process comprising the steps of providing a layer of reinforcing material comprising transparent non-twisted glass threads embedded in a transparent, hardenable resin, which is resistant to atmospheric agents, applying the layer of reinforcing material to the visible surface area of the exposed front face of the slab, and carrying out the hardening of the resin, such that the flexural resistance of the front visible face of the slab varies between 400 and 800 kg/cm².

The present invention also provides a reinforced slab of non-porous stone material having a visible front face, the front face having a reinforcing layer overlying the front face and including transparent non-twisted glass threads within a transparent hardenable resin resistant to atmospheric agents whereby the reinforced slab has a flexural resistance of
20 between 400 and 800 kg/cm².

The term "non-porous" is generally understood, in relation to stone materials, as indicating the stone material is not disposed to impregnation by a liquid, or a liquefied material.

The appended Figures show, in diagrammatic form, a slab reinforced on both faces; wherein Fig. 1 is a cross-sectional view; and Fig. 2 is a plan view.

Referring to the drawings and in particular to Figure 1, the reference 10 indicates a slab of stone material having a thickness not greater than 10 mm (although this must of course not constitute a limitation of the present invention) and having a front face, or visible face, 12 and a rear face 14.

The rear face 14 is reinforced by the process forming the subject-matter of the patent application singled out above, by means of a mat 16 of glass threads 18 and a layer of epoxy resin 20.

As already mentioned above, the rear face 14 may have grooves or cavities which accommodate linear elements, for example glass fibre strands, which are also embedded in the epoxy resin in cases where a firmer and more substantial reinforcement of the rear face is required.

The front face 12 is provided with a reinforcing layer which comprises a plurality of non-twisted glass threads 22, preferably in the form of a mat 24, in an amount corresponding to approximately from 100 to 800, preferably approximately 500, grams of mat per square metre of slab surface area.

Figure 2 shows a portion of the mat 24 in a form which is diagrammatic and exaggerated, since the mat 24, being composed of transparent glass threads distributed more thinly than the glass threads of the mat reinforcing the rear face, is in fact practically invisible.

The reference 26 indicates a protective and reinforcing resin layer which, by definition, must be transparent and hardenable and, in addition, must be resistant to the action of atmospheric agents (in particular the yellowing which UV rays often cause in plastics materials).

Epoxy resins, preferably aliphatic epoxy resins, supplemented with UV ray absorbers and/or so-called UV ray scavengers, have been found to be especially advantageous.

Alternatively, it is possible to use acrylic resins (which definition is intended to cover both acrylic resins proper and methacrylic resins) and also copolymers of acrylic and methacrylic resins with other monomers, for example of the urethane type, provided of course the above-mentioned requirements are satisfied. When the mat and the resin have been applied, the resin is hardened, after which it is possible to proceed with the above-mentioned finishing works.

As already mentioned above, when it is desired to obtain a reinforcement which confers on the face 12 resistance to scratching and abrasion, the resin 26 may be charged with silica or quartz powder in an amount such as not to compromise the perfect transparency of the reinforcing layer. Alternatively and/or in addition to the resin, it is possible to add an anti-scratch agent known per se.

Furthermore, the reinforcing process according to the present invention also increases the resistance of the visible face of the slab to the action of aggressive chemical agents, such as, for example, acids.

The invention has been described in relation to preferred embodiments, it being understood that modifications and variations which are equivalent in terms of design and structure are possible and can be provided for without departing from the scope of the invention. For example, the rear, or invisible, face of

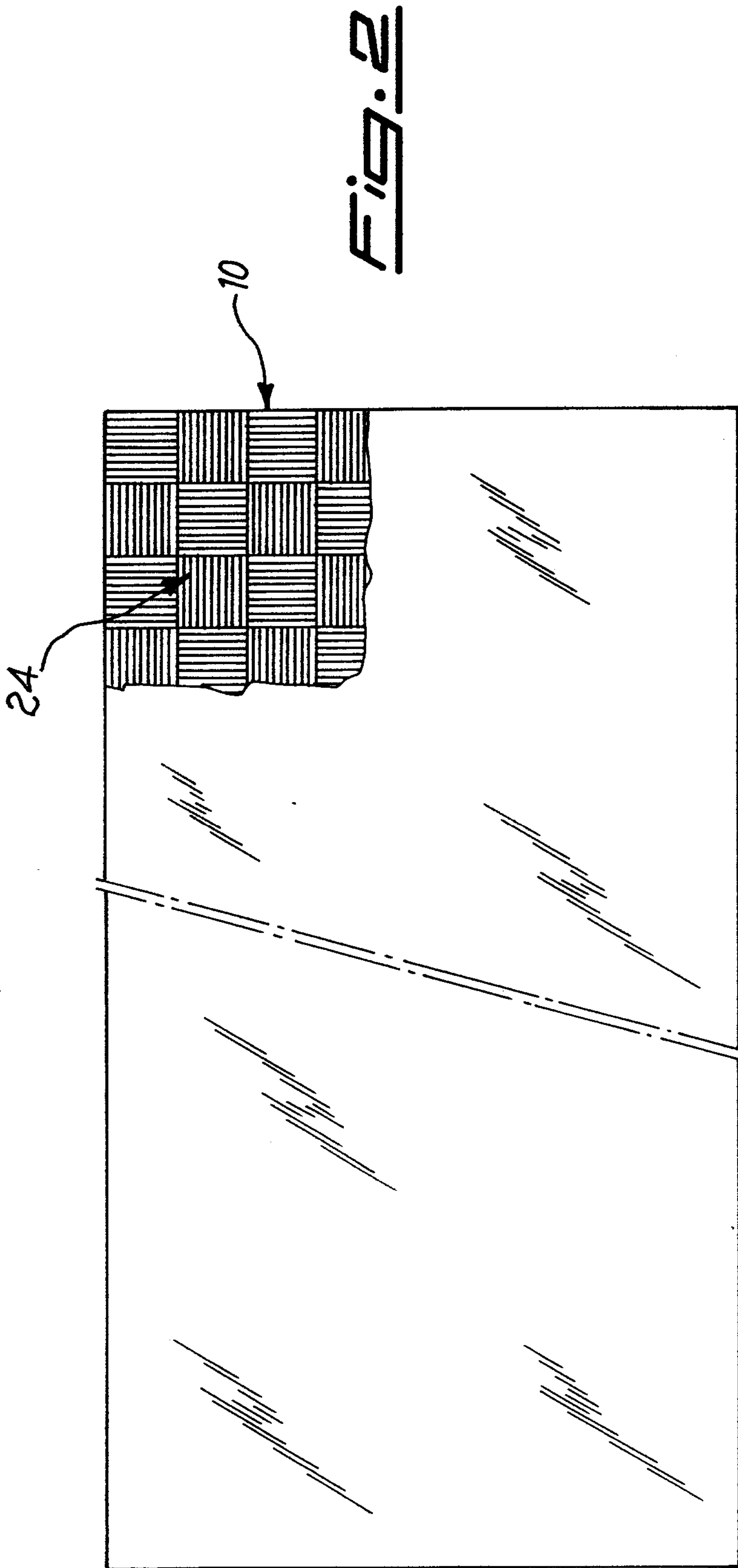
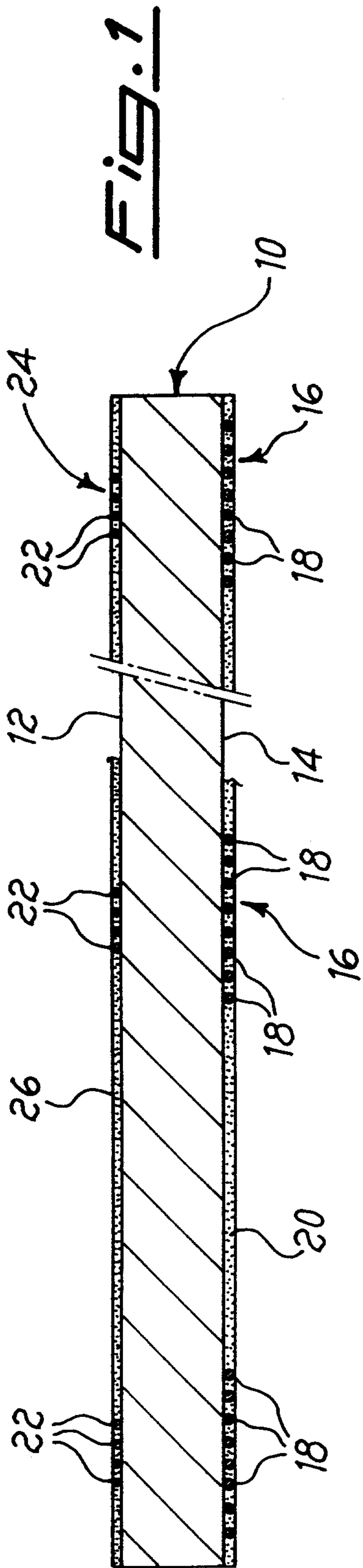
the slab could be reinforced in a manner different from that provided for above, or it could be combined with other materials, such as in the case of composite slabs of glass and/or stone materials having fire-retardant and/or sound-absorbing properties

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A process for the production of a reinforced slab of non-porous stone material, said slab having an unexposed invisible reinforced rear face and an exposed front face having a visible surface area, the process comprising the steps of:
providing a layer of reinforcing material comprising transparent non-twisted glass threads embedded in a transparent, hardenable resin, which is resistant to atmospheric agents;
applying said layer of reinforcing material to said visible surface area of the exposed front face of said slab; and
carrying out the hardening of said resin, such that the flexural resistance of the front visible face of the slab varies between 400 and 800 kg/cm².
2. The process according to claim 1, wherein said slab has a thickness of less than 12 mm.
3. The process according to claim 1, wherein said slab has a thickness of less than 10 mm.
4. The process according to claim 1, 2 or 3, wherein said resin is resistant to chemical agents.
5. The process according to any one of claims 1 to 4, wherein said non-twisted glass threads are in the form of a mat.
6. The process according to claim 5, wherein said mat is applied to provide from 100 to 800 grams per square meter of slab surface area.

7. The process according to claim 5, wherein said mat is applied to provide about 500 grams per square meter of slab surface area.
8. The process according to any one of claims 1 to 7, wherein said resin is selected from epoxy, acrylic and methacrylic resins, and copolymers thereof.
9. The process according to any one of claims 1 to 7, wherein said resin is an aliphatic epoxy resin.
10. The process according to any one of claims 1 to 9, wherein said resin includes anti-scratch and anti-abrasion agents.
11. The process according to any one of claims 1 to 10, wherein said resin includes material capable of increasing the resistance of said front face of a finished slab to abrasion and scratching.
12. The process according to claim 11, wherein said material is selected from quartz and silica in a fine powdered form.
13. A reinforced slab of non-porous stone material having a visible front face, said front face having a reinforcing layer overlying said front face and including transparent non-twisted glass threads within a transparent hardenable resin resistant to atmospheric agents whereby said reinforced slab has a flexural resistance of between 400 and 800 kg/cm².
14. The reinforced slab of non-porous stone material according to claim 13, wherein said slab has a thickness of less than 12 mm.

15. The reinforced slab of non-porous stone material according to claim 14, wherein said slab has a thickness of less than 10 mm.
16. The reinforced slab of non-porous stone material according to claim 13, 14 or 15, wherein said resin is resistant to chemical agents.
17. The reinforced slab of non-porous stone material according to any one of claims 13 to 16, wherein said non-twisted glass threads are in the form of a mat.
18. The reinforced slab of non-porous stone material according to claim 17, wherein said mat is in an amount of from 100 to 800 grams per square meter of slab.
19. The reinforced slab of non-porous stone material according to any one of claims 13 to 18, wherein said slab is selected from marbles, granites, porphyries and similar materials.
20. The reinforced slab of non-porous stone material according to any one of claims 13 to 19, wherein said resin is selected from epoxy, acrylic and methacrylic resins, and copolymers thereof.
21. The reinforced slab of non-porous stone material according to any one of claims 13 to 19, wherein said resin is an aliphatic epoxy resin.
22. The reinforced slab of non-porous stone material according to any one of claims 13 to 21, wherein said slab includes a rear reinforced face.



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