

A METHOD OF PRODUCING COMPOSITE BOARDS

The present invention relates to composite boards or panels comprising a layer of a cementitious material (hereinafter referred to as a cement layer or board) and a layer of a foamed material bonded thereto, and more particularly to a method of producing composite boards having patterns on a surface of the cement layer and composite boards produced therefrom.

Composite boards which are utilised for the exterior of buildings, e.g., for roofs and walls, for the purpose of insulation and the design of the building, are known in the art.

In conventional methods of producing composite boards, a relatively fluid uncured cementitious material or mortar is poured into a mold having a cavity, the bottom surface of which may be provided with a desired pattern to be impressed into the mortar. The uncured mortar is then tamped down in the mold cavity and allowed to cure to form a mortar board having patterns on the surface thereof. The back surface of the mortar

board is joined with a foamed synthetic resin board having a thickness of from 25 to 50 mm, by an adhesive. The foamed synthetic resin board is also utilized as a back-up material.

5 According to this conventional method, the productivity in making such composite boards is very low because adhesion of the foamed synthetic resin board is carried out after the uncured mortar is fully cured. For this reason, methods for the production of
10 composite boards have been investigated whereby adhesion of the foamed synthetic resin board can be carried out before the uncured mortar is fully cured, i.e., where adhesion can be carried out when the mortar is still in a plastic condition.

15 In one of such production methods, an uncured cement is placed on the upper surface of the ready-made foamed synthetic resin board. A cavity-type metal mold having patterns on an inner surface thereof is then placed on the uncured cement, with the cavity of the
20 mold facing downwardly so that a composite board is produced.

 In another production method, uncured cement is poured into the cavity of a mold with the cavity facing upwardly. The ready-made foamed synthetic resin
25 board is then placed on the uncured cement, so that a composite board is produced.

 In the former method, if the surface of the foamed synthetic resin board is porous in order to obtain good bonding between the uncured mortar and the
30 board, some of the mortar flows into the board in view

- 3 -

of its high flow property, resulting in a poor finish of the patterns on the surface of the cured mortar. Another disadvantage is that the metal mold must be kept under pressure until the mortar is fully cured.

- 05 Keeping the metal mold under pressure is also extremely difficult.

In the latter method, even if the metal mold is vibrated, bubbles and moisture within the uncured mortar are likely to rise toward the undersurface of the foamed synthetic resin board and will be collected within a boundary layer between the board and the uncured mortar. This results in a lowering of the bonding property between the board and the mortar.

15

- On the other hand, the thickness of the mortar layer is generally quite small, e.g., from 10 to 25 mm, so as to maintain the light weight of the finished composite board. Therefore, in order to reduce cracking in such a thin mortar layer, together with adding to the elasticity thereof, such a mortar layer usually contains about 10 percent by weight of a latex, in a latex-cement ratio measured by dry weight. This addition of a latex also improves the durability, water-tight property, and strength of the mortar layer. However, the stripping or demolding property of the latex-containing mortar from the mold is extremely difficult, in comparison with plain mortar, and cannot be overcome by merely using slipping agents.

30

- It is an object of the present invention to provide an improved method of producing composite panels or boards by placing a cover sheet of sufficient thickness to maintain rigidity on an inner

35

15

- 4 -

surface of a high-rigidity mold having a cavity, the cover sheet having a pattern which generally corresponds to the pattern that is to be impressed on a surface of a layer of cementitious material or
05 mortar, the uncured mortar is then packed into the cover sheet in the mold and a layer of a foamed synthetic resin material is subsequently bonded to the layer of cementitious material.

10 More particularly, the present invention resides in a method of producing composite boards comprising a layer of a cementitious material having a pattern on a surface thereof and a layer of a foamed material that is bonded thereto, the method comprising
15 the steps of

placing a cover sheet of synthetic resinous material on an inner surface of a high-rigidity mold having a cavity, said cover sheet having a thickness sufficient to maintain rigidity, a pattern generally
20 the same as the pattern that is to be impressed on the surface of the layer of cementitious material and a shape generally corresponding to the inner surface of the mold;

packing uncured cementitious material into
25 the cavity formed by said cover sheet;

pressing a generally planar board of a foamed synthetic resinous material on an upper surface of the uncured cementitious material layer;

vibrating the mold so that the uncured
30 cementitious material is densified and so that the

- 5 -

board of foamed material is bonded to said cementitious material;

removing the uncured cementitious material and the board of foamed material from the mold with
05 the cover sheet being attached to the uncured cementitious material; and

curing the uncured cementitious material in the cover sheet in a place other than the mold.

The present invention also resides in a
10 composite board comprising a layer of a cementitious material having a pattern on an upper surface thereof, a cover sheet having a pattern generally corresponding to the pattern of said layer of cementitious material and removably adhered to the patterned surface of said
15 layer of cementitious material, and a layer of a foamed material bonded to a lower surface of said layer of cementitious material.

According to one preferred embodiment of the
20 present invention, composite boards are produced by placing a synthetic resin cover sheet on an inner surface of a high-rigidity mold having a cavity, the cover sheet has a thickness sufficient to maintain rigidity and a pattern generally the same as the
25 pattern that is to be impressed on a surface of a layer of cementitious material or mortar. The cover sheet also has a shape that generally corresponds to the patterned inner surface of the mold. The uncured mortar is then packed into the cavity formed by the
30 cover sheet. A layer, e.g., a plank or board of a foamed synthetic resin material is then placed on the upper surface of

the uncured mortar under the application of pressure and the mold is vibrated so that the uncured mortar is densely tamped or densified, and so that the layer of foamed synthetic resin material is joined to the mortar. The uncured mortar and the layer of foamed material, which are bonded together, are then removed from the mold with the cover sheet being attached to the uncured mortar, and the uncured mortar is cured in the cover sheet in a place other than the mold.

05
10

According to a second preferred embodiment of the present invention, composite boards are produced by placing a cover sheet of a synthetic resinous material on an inner surface of a high rigidity mold having a cavity, the cover sheet has a thickness sufficient to maintain rigidity, a pattern which is generally the same as the pattern that is to be impressed on the surface of a layer of cementitious material or mortar and a shape that is adapted to the inner surface of the mold. Uncured mortar is packed into the cavity formed by the cover sheet. A layer, e.g., a plank or board of a foamed synthetic resinous material to which a mortar-type adhesive has been applied is then placed under the application of pressure on the upper surface of the uncured mortar in such a manner that the surface to which the mortar-type adhesive has been applied is opposite, i.e., facing the upper surface of the uncured mortar. The metal mold is vibrated so that the uncured mortar is densified, i.e., densely tamped-down, whereby the layer of foamed material is bonded to the mortar by the mortar-type adhesive. The uncured mortar and the

15
20
25
30

- 7 -

layer of foamed material which are joined or bonded together are then stripped from the mold with the cover sheet being attached to the uncured mortar. The uncured mortar is then cured in the cover sheet in a place other than the mold.

Hereinafter, preferred embodiments of the invention will be described in detail with reference to the accompanying drawings.

10

Figure 1 is a perspective view of a composite board according to the present invention, with the synthetic resin cover sheet removed from the composite board.

15

Figure 2 is a vertical cross-sectional view taken along the lines II-II in Figure 1.

Figures 3A to 3E are sequential views, in cross-section, showing the manufacturing process of a first embodiment composite board.

Figure 4 is a cross-sectional view showing a composite board manufactured by a second production method.

With particular reference to Figure 3A, reference numeral 1 denotes a mold 1 forming a cavity having a patten P on a bottom surface thereof which is representative of the pattern D that is to be impressed on the surface of a layer of mortar M (Figure 1). Unevenness of patterns in the mold is

inversed from that of patterns D in the layer of mortar M. A cover sheet 2 of a synthetic resinous material having a patterned shape that substantially corresponds to the inner surface of the mold 1 is placed on the inner surface of the mold 1. The cover
05 sheet is made of a rigid hydrophobic synthetic resinous sheet material such as polyvinyl chloride (PVC), polyethylene (PE), high impact polystyrene (HIPS), or the like. The thickness of the cover sheet is within the range of from 0.03 to 1 mm, and
10 sufficient to maintain its rigidity. It is desirable to use a mold having the same shape as that of the mold 1 and to manufacture the cover sheet 2 by vacuum forming in the mold. The uncured mortar 3, with a
15 cup by the slump test according to Japanese Industrial Standard A1101), is then poured into the cavity formed by the cover sheet (Figure 3C).

When uncured mortar with a low flow

property is poured, the time interval for curing the mortar can be shortened, however, the appearance of the surface of the mortar becomes poor.)

5 A ready-made layer 4 of a foamed synthetic
resinous material as a backing material made from,
e.g., foamed polystyrene, or the like, is placed on the
upper surface of the uncured mortar 3 (Figure 3D). The
mold 1 is vibrated, using a vibrating apparatus (not
shown), and the layer or board of foamed polystyrene is
10 placed under pressure from above so that the uncured
mortar is tamped down to form a densified mass. The
uncured mortar 3 thus conforms to and is bonded to the
styrofoam board 4. The uncured mortar 3 and the styrofoam
board 4, which are bonded together, are removed, by
15 using a vacuum cup or the like, from the mold 1 with
the cover sheet still attached to the uncured mortar.
The composite board is then placed on a support 5 made
from, e.g., veneer board, or the like, and is cured.
Since the uncured mortar 3 is covered by the cover
20 sheet 2 having a hydrophobic property, slipping the
composite board from the mold is quite easy. Thus, if
a plurality of patterned cover sheets 2 are provided,
composite boards can be mass-produced by using a single
mold. Since curing of the uncured mortar does not take
25 place in the metal mold itself, as in the prior art,
the utilization factor of the mold is greatly increased.
In the present invention, a high-rigidity metal mold is
preferably used that is capable of withstanding intense
vibration and high pressure used in the manufacturing
30 process.

The foregoing description is applicable to
the case where the surface of the layer of foamed

synthetic resinous material 4 is porous and has a hydrophilic property, so that it has a good bonding property with the uncured mortar 3. However, as described in the production method of the prior art, when the surface of a board of foamed synthetic resinous material 4 is smooth and has a hydrophilic property, bubbles and moisture will rise to the boundary layer between the uncured mortar 3 and the board 4, and thus substantially reduce the bonding property between them.

In order to overcome the above problem, the following production method is utilized. A mortar-type adhesive 6 is applied on one of the surfaces of the layer of foamed synthetic resinous material 4, and the layer 4 is placed on the upper surface of the uncured mortar 3 in such a manner that the surface to which the adhesive has been applied is opposed to the upper surface of the uncured mortar. Placing of the board 4 on the uncured mortar may be effected after the adhesive 6 has partially hardened or has fully hardened. The remaining manufacturing processes are substantially the same as that in the first example. In this case, bubbles and moisture rising through the uncured mortar layer engage the partially or fully hardened adhesive layer. However, since the adhesive layer is porous, such bubbles and moisture are absorbed within the adhesive layer and do not reach the undersurface of the board 4. Thus, when hardening of the uncured mortar 3 is completed, a composite board in which the cured mortar and the layer of foamed synthetic resinous material are firmly bonded with each other, is obtained.

The above describes the case when the mold and the synthetic resin cover sheet have the same patterns, respectively. However, if the uncured mortar has sufficient flow property, so that the desired pattern on the surface of the uncured mortar can be attained by applying a relatively gentle vibration and low pressure, or if the cover sheet is relatively thick and the pattern to be impressed are simple, so that deformation of the cover sheet during the application of vibration and pressure can be disregarded, the pattern on the surface of the mold can be negligible. In particular, the mold can be a flat mold having no pattern in its inner surface. Thus, the mold is used as the holding frame for the cover sheet.

15

After the composite board is completed, if the cover sheet 2 is not removed from the composite board until it reaches the installation site, soiling of the composite board can also be prevented during shipping. If the cover sheet is removed before shipping, the cover sheet can be reused in the manufacture of additional composite boards.

As can be readily understood from the foregoing description, in the manufacture of the composite board of this invention, the surface of the uncured mortar can be removed from the metal mold in an uncured condition and without spoiling the patterns impressed on the mortar surface. This results in enabling the mass-production of composite boards.

30

Since the layer of foamed synthetic resinous material is bonded to the uncured mortar before curing, the bonding property is outstanding. Furthermore, if the bonding property deteriorates by adverse conditions, such bonding property can be improved by using a
05 mortar-type adhesive between the uncured mortar and the foamed synthetic resin board.



24

- 13 -

CLAIMS

1. A method of producing composite boards
05 comprising a layer of a cementitious material having a
pattern on a surface thereof and a layer of a foamed
material that is bonded thereto, the method comprising
the steps of

placing a cover sheet of synthetic resinous
10 material on an inner surface of a high-rigidity mold
having a cavity, said cover sheet having a thickness
sufficient to maintain rigidity, a pattern generally
the same as the pattern that is to be impressed on the
surface of the layer of cementitious material and
15 a shape generally corresponding to the inner surface
of the mold;

packing uncured cementitious material into
the cavity formed by said cover sheet;

pressing a generally planar board of a
20 foamed synthetic resinous material onto an upper
surface of the uncured cementitious material layer;

vibrating the mold so that the uncured
cementitious material is densified and so that the
board of foamed material is bonded to said
25 cementitious material;

removing the uncured cementitious material
and the board of foamed material from the mold with
the cover sheet being attached to the uncured
cementitious material; and

30 curing the uncured cementitious material in



- 14 -

the cover sheet in a place other than the mold.

2. A method as claimed in Claim 1, wherein the cover sheet has a thickness of from 0.03 to 1 mm.

05 3. A method as claimed in either of the preceding claims including the step of applying a mortar-type adhesive to the board and placing the board on the upper surface of the uncured cementitious material in such a manner that the surface to which
10 the adhesive has been applied is facing the upper surface of the uncured cementitious material.

4. A method as claimed in Claim 3, wherein the adhesive has at least partially hardened before
15 placing the board on the uncured cementitious material.

5. A method as claimed in Claim 3 or Claim 4, wherein the foamed material is smooth and hydrophilic.

20 6. A method as claimed in any one of Claims 1 to 4, wherein the foamed material is porous and hydrophilic.

25 7. A method as claimed in any one of the preceding claims, wherein the cover sheet is of a hydrophobic resinous material.

8. A method as claimed in Claim 7, wherein
30 the resinous material is selected from polyvinyl



(26)

- 15 -

chloride, polyethylene or high impact polystyrene.

9. A method as claimed in any one of the preceding claims, wherein the mold and cover sheet
05 have the same pattern.

10. A method as claimed in any one of Claims 1 to 8, wherein the mold is a flat mold which does not have a design pattern in its inner surface.
10

11. A method as claimed in Claim 10, wherein the cover sheet has a thickness from 0.3 to 0.6 mm.

12. A method as claimed in any one of the preceding claims, wherein the mold is a high-rigidity metal mold.
15

13. A method as claimed in any one of the preceding claims, wherein the cover sheet has been
20 formed by vacuum forming in the mold.

14. A method as claimed in Claim 1 and substantially as hereinbefore described with reference to Figures 1,2 and 3A to 3E.
25

15. A method as claimed in Claim 3 and substantially as hereinbefore described with reference to Figure 4.

16. A composite board whenever prepared by a
30 method as claimed in any one of the preceding Claims.
