

METHOD OF MANUFACTURING A SANDWICH BOARD AND A BOARD AND STRUCTURE MANUFACTURED BY THE METHOD

The present invention relates to a method of manufacturing a sandwich board. The invention further relates to a panel for application as a wall panel, a ceiling panel or a floor panel and to a sound insulating structure for use as a wall, a ceiling or a floor.

The invention particularly, although not exclusively, pertains to environments where space is scarce, such as in accommodations on board ships.

DE patent 34 44 992 C2 discloses a floor structure for accommodations on board ships and designed for sound insulation. According to this teaching a tile is manufactured by making a shallow box of 1 mm steel plate with open top and pouring into this box a mixture comprising a PU based adhesive together with fillers. Once the compound has set, the tile is turned upside down and placed on and adhered to a steel deck. Tiles made in this way are placed close together to build a floor-covering layer. Where particular requirements to gas-sealing prevail this floor-covering may be covered by a 0.5 mm steel plate adhered on top of the tiles and this structure may be topped by a carpet.

DE published application 27 06 969 B2 discloses a sound damping floor structure for use on ships and comprising a layer of mineral fiber material covered with a steel plating. The butt joints between sections of the steel plating are secured by fish plates arranged below the steel plating and on top of the mineral fiber material. The publication suggests adhering the fish plates to the steel platings by two-component polyurethane adhesive.

It is considered known in the art of ship building to build a sound attenuating floor structure by placing on top of a steel deck a mineral fiber wool layer, a first structural layer of steel plates, a layer of viscoelastic polyurethane, a second structural layer of steel plates and a carpet. Steel plates in the first structural layer are interconnected along the butt joints by spaced weldings for structural reasons. As part of the process of building this floor, the viscoelastic polyurethane is poured while in a viscous or fluent state on top of the first structural layer and screeded. Steel plates for the second structural layer are placed on top of the viscous layer and ballasted until the viscoelastic mass has set.

The inventor has discovered that the efficiency in terms of sound and vibration reduction capability of this floor is critically dependent on the accurate controlling of the thickness of the viscoelastic layer and on achieving full face contact between the viscoelastic layer and the steel plates of the two structural layers. However, lack of planity of the top surface of the viscous layer, unavoidable distortions of the steel plates, trapped air and the difficulty of inspecting the viscous layer while in the process of setting may give rise to difficulties during construction and imperfections in the result.

These difficulties are according to the state of the art encountered by using for the second structural layer steel plates of comparatively small formats, e.g. no more than 60 x 60 cm, by using heavy ballasting and by careful work. This complicates the procedure and the small formats of the steel plates of the second structural layer limits the structural rigidity provided by this floor. Furthermore, level offsets between adjacent plates require extensive filling, which has to be done using the

same viscous compound as used below the second structural layer, which compound is costly and difficult to apply.

- The invention provides a method as recited in claim 1.
- 5 According to this method at least one through opening is provided in the sheet of the second layer. A greater number of openings may be provided as appropriate. The openings permit the inspection of the space between the sheets and thus of the thickness of the viscous layer.
- 10 The openings permit the escape of any trapped air. The openings further permit the injection of additional viscous mass if required. Should the inspection reveal that the space between the sheets was too wide, e.g. due to local distortions of the plates, it is easy to adjust the
- 15 compressive force applied on the top sheet to correct the situation. Once the viscous mass has set it adheres together the plates and the compressive force may be relieved.
- 20 The method according to the invention applies to sandwich boards used for floor coverings as well as for wall structures or ceiling structures. The sheets may comprise any kind of structural plate material, in particular plates of steel, aluminium or other metals. The sandwich
- 25 board may or may not be backed by other materials also selected for sound attenuating properties, e.g. mineral fiber wool. In case no backing is used, a steel deck, a bulkhead or a ceiling plate may provide the first sheet.
- 30 The spacer means may be provided by installing a set of structural spacers, e.g. pads of wood, steel, mineral wool or other material, or the spacer means may be provided by applying a filling of viscoelastic mass and allowing it to set to form a coating on one of or both of
- 35 said sheets. Pre-treatment of at least one of the sheets by applying a filling of viscoelastic mass and allowing

it to set at least until assuming a viscous state prior to the step of bringing together the sheets is of particular advantage when installing the sandwich boards for wall panels or ceiling panels where a pouring in situ of a fluent mass might be difficult.

According to a preferred embodiment, the surface of the coating may be textured, e.g. by pouring the viscous mass in a fluent state on to a textured foil material and placing the sheet on top. Texturing the surface of the coating provides a simple manner of controlling effectively the thickness of the coating.

According to a preferred embodiment, the filling of the viscoelastic mass may be topped up subsequent to the step of bringing together the sheets by injecting additional mass in a viscous or fluent state and allowing it to set. This ensures the complete filling of the space between the sheets.

According to a preferred embodiment, injection of mass is continued until it has been observed that excess mass is being driven out past the sheet edge along the whole sheet contour.

According to a preferred embodiment, the sheets are interconnected at least until the mass has set by a structural component, such as a bolt, serving to secure the relative positions of the sheets. This structural component is easily introduced through an opening in the second sheet. This precaution secures the relative positions of the sheets, thus facilitating subsequent operations, such as bringing in additional ballast or adjusting the compressive force since there is no danger that these operations will offset the sheet from the intended position. The additional structural component may also be

utilized to apply all of or part of the compressive force. E.g. a bolt could be welded to the first sheet and a nut and washer engaging the bolt could be tightened to force the second sheet closer to the first sheet. If the
5 opening is provided in the center of the second sheet, one bolt with a washer and optionally a plate or similar for distributing the force could be used to hold down the second sheet.

10 The invention also provides a panel as recited in claim 11. This panel could comprise any number of sandwich boards or composite sandwich boards made by the inventive methods.

15 According to a preferred embodiment, the first and second sheets comprise steel plates or aluminium plates, and the gauge of the second sheet is equal to or less than the gauge of the first sheet. Using a small gauge of steel or aluminium plating for the second sheet reduces sound re-
20 flection and sound radiation from the panel and to the adjacent side.

According to a preferred embodiment the compound comprises a viscoelastic damping mass based on polymer. Par-
25 ticularly preferred polymers comprise polyerethane and acrylate.

The invention further provides a sound insulating structure as recited in claim 15. This structure may provide a
30 wall, a ceiling or a floor, which combines the advantages of a superior performance in terms of sound and vibration insulation with ease of manufacturing and comparatively low cost of materials. This structure may be combined with other structures, such as soft layers for added
35 sound attenuation or it may be used as the sole structural component relied upon for sound and vibration at-

tenuation. The inventive structure is easily combined with other structural components as may be installed for various purposes, e.g. for enhancing esthetic value, etc.

5 Further objects and features of the invention will appear from the following detailed description of preferred embodiments, which is given with reference to the appended drawings on which

10 Fig. 1 shows a section through a part of a panel according to a first embodiment of the invention,

Fig. 2 illustrates a panel according to a second embodiment of the invention in a view similar to
15 that of Fig. 1,

Fig. 3 illustrates a panel according to a third embodiment of the invention in a view similar to that
20 of Fig. 1,

Fig. 4 illustrates a portion of a wall structure according to the invention in plan view,

Fig. 5 is a section by the line B-B in Fig. 4,
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Fig. 6 is a section by the line C-C in Fig. 4,

Fig. 7 illustrates a floor structure according to the invention in plan view, with portions of the upper layers removed for the purpose of illustration, and
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Fig. 8 illustrates a vertical section through part of the floor structure of Fig. 7.
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All the drawings are schematic, not necessarily to scale and illustrate only parts essential to enable those skilled in the art to practise the invention whereas other parts are omitted from the drawings to preserve clarity. Throughout the drawings identical or similar parts are designated by the same references.

Fig. 1 illustrates a section through part of a sandwich board 1 according to the first embodiment of the invention. This sandwich board comprises a first sheet 4, a core 6 and a second sheet 5 in a sandwiched relationship. The core 6 effectively fills the space 10 between the sheets. The second sheet 5 is provided with openings 7 which extend also through the body of the core.

Fig. 1 illustrates how bolts 16 have been inserted through two of these holes to engage tapped holes in the first sheet 4. These bolts, which may be provided with washers or plates for force distribution, may be operated to apply and control a compressive force compressing the first and second sheets together.

One of the openings 7 illustrated between the two bolts in Fig. 1 has not been used for the insertion of a bolt, but has been left open so as to permit the insertion of a probe 29 by which the depth of the hole and hence the thickness of the core or the sheet interspace may be gauged accurately.

Preferred materials for the sheets are steel plates and according to a preferred embodiment the gauge of the second sheet is equal to or less than the gauge of the first sheet. An embodiment in which the first sheet has a thickness of 3 mm, the second sheet a thickness of 1.5 mm and the core a thickness of about 1 mm has been tested and found to perform well.

Spacers 8 illustrated in Fig. 1 and serving to control the spacing 10 between the sheets may comprise pads of steel, wood, or mineral wool or any other solid matter.

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The sandwich board illustrated in Fig. 1 may be manufactured in customized formats or lengths or it may be manufactured in standardized formats referred to as panels to provide a prefabricated structural component which may be installed as a unit. The sandwich board may also be manufactured in situ using e.g. a deck or a bulkhead as the first sheet.

Reference is now made to Fig. 2 illustrating a sandwich board 2 according to a second embodiment of the invention. In the embodiment of Fig. 2 the second sheet has been pre-treated by the application of a coating of a compound. A preferred method of applying this coating comprises pouring the compound in a fluent state on to a sheet of textured foil, placing the plate to form the second sheet on top and allowing the compound to set at least partially to assume a viscous state.

This procedure facilitates controlling the thickness of the layer of compound, which might otherwise be difficult, as the compound is generally poured in a rather fluent state and as the sheet might be distorted. Subsequent to the partial setting, the textured foil is removed and the second sheet 5 with the partly set compound, which provides the coating 11, placed on to the first sheet 4 and secured by a bolt 16. In the second embodiment the textured coating 11 effectively provides a means for spacing the sheets.

35 An embodiment in which a coating was applied to a thickness of 0.7 mm and an extra layer to a thickness of ap-

proximately 0.3 mm was injected, has been tested and found to perform well.

Once the second sheet has been secured, an additional
5 compound in a viscous or fluent state may be injected through one or more of the openings 7 by placing a gun 28 in registry with the opening. Sufficient injection pressure is applied to drive the fluent compound 9 into the interspace between the surface of the coating 11 and the
10 first sheet 4 to fill this volume and provide full surface contact between the coating and the first sheet. Injection may be continued until egress of surplus compound has been observed along the full contour of the second sheet.

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Reference is now made to Fig. 3 for an explanation of a sandwich board 3 according to a third embodiment of the invention.

20 In the third embodiment, a compound in a viscous or fluent state is initially applied on to the surface of the first sheet 4 and allowed to set at least partially to a viscous state. The surface of the compound is leveled or screeded. However, by the method according to the invention
25 a certain amount of departures from a level surface may be tolerated. In Fig. 3, the departures from the flat state are grossly exaggerated for the sake of illustration. The semi-set compound provides a coating 11.

30 Subsequently, the plate forming the second sheet 5 is placed into contact with the surface of the coating 11 and secured by bolts 16 similarly as explained above. The semi-set coating 11 serves as spacer means to control the spacing between the sheets.

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The gun 28 is placed in registry with one of the openings 7 and a compound 9 in a fluent or viscous state is injected at a pressure sufficient to drive it into the interspace between the coating 11 and the second sheet 5 to effectively fill this volume and ensure a full surface contact with the second sheet.

The compound 9 and the coating 11 are allowed to set completely and the bolts may be removed or ground away or they may be left in place as appropriate.

According to other preferred embodiments (not shown), stay bolts are secured to the first sheet by welding instead of by threaded engagement in tapped holes, and the second sheet is secured by nuts in threaded engagement with respective stay bolts.

Reference is now made to Figs. 4, 5 and 6 for an explanation of a wall structure according to the invention. The wall structure 12 effectively comprises a first plate 30, a core 6 and a second plate 13. The first plate 30 in this case effectively comprises a bulkhead 27. The bulkhead is provided with protruding and flanged ribs 19. Onto this bulkhead compound and second plates 13 are applied, basically using any of the methods explained above. The second plates 13 are laterally spaced in order to leave gaps 15 between the contours 14 of adjacent plates.

The flanged ribs 19 (refer in particular to Fig. 5) are utilized to attach laths 20 extending across the second plates in spaced relationship. Wedges 21 are driven down between the laths and the outside of the second plates 13 in order to apply a compressive force holding the second plates tightly against the first sheet 4. Each of the second plates 13 has been provided with a central opening

similarly as explained above and a bolt has been inserted through this opening to secure each of the plates 13.

5 The central bolt in each of the plates 13 provides the possibility of quickly placing the plates and securing them after which ample time may be taken to attach the laths and drive in the wedges. The bulkhead and the plates may have been pre-treated with the compound, and additional compound may be injected after the plates have
10 been placed in the positions illustrated in the figures using openings in the plates (not illustrated in the figures).

In cases where there are no protruding ribs, additional
15 bolts may be inserted through openings in the plates and tightened to provide compressive force as required. A ceiling structure or a floor structure may be built by similar methods.

20 Reference is now made to Figs. 7 and 8 for an explanation of a floor structure provided by the invention. Referring more particularly to Fig. 8 this floor structure 22 basically is installed on top of a deck 23 and essentially comprises a layer of mineral fiber wool 25, a first
25 structural layer 17, a core 6 of elastic vibration deadening compound, a second structural layer 18 and a carpet 26 on top. The edges of the first structural layer and the second structural layer are spaced laterally from the bulkhead 27 in order to decouple any transmission of vi-
30 brations.

Referring more particularly to Fig.7 the method of the installing this floor structure essentially is carried out as follows.

Initially, mats of mineral fiber wool 25 are placed to cover all of the deck 23. First plates 30 to provide the first structural layer 17 are placed in abutting relationship and are secured by spaced butt-welds 24 for structural reasons.

On top of these plates, compound 9 is poured and leveled or screeded. On top of the layer of compound, second plates 13 adapted for providing the second structural layer 18 are placed in juxtaposition with lateral gaps or spaces 15 between their contours 14. These plates 13 are provided with regularly spaced openings 7 as illustrated in the figure. The plates of the first structural layer are secured to those of the second structural layer by welding through at least some of the openings as appropriate. Additional compound may be injected through any openings available as appropriate. Once the compound has set the structure is finished by removing protruding bolts as appropriate and by placing a carpet 26 on top.

Alternative methods of securing together the plates of the two structural layers comprise the insertion of screws or rivets.

An exemplary structure has been manufactured by this method. The exemplary structure comprised 40 mm of rock wool, 3 mm plates for the first structural layer in formats of 100 x 200 cm, a 1 mm layer of compound and 1.5 mm plates for the second structural layer also in formats of 100 x 200 cm. The second plates were provided with openings in a regular grid with 10 cm intervals. The structural rigidity provided by this floor is superior to that provided by a comparable floor of the prior art due to the larger format of plates used in the second structural layer and due to the better control over the surface bonding of the second structural layer.

Although specific embodiments of the invention have been explained above, this explanation has been presented for illustrative purposes only and it is intended that the scope of the invention should be limited only by the terms of the appended claims.



PATENT CLAIMS

1. A method of manufacturing a sandwich board, said sandwich board comprising a first sheet, a second sheet in
5 spaced parallel relation with said first sheet, and a core, which core effectively bridges the space between and adheres together said sheets, and which core comprises an elastic, vibration deadening compound, c h a r a c t e r i z e d by comprising the steps of pro-
10 viding at least one through opening in said second sheet, applying compound on one of or both of said sheets to provide at least part of said core, bringing together said sheets and applying a compressive force onto said sheets in order to urge them together, using said opening
15 to inspect the space between the sheets and to inspect said core, adjusting the compressive force depending on an evaluation of the result of the inspection, and allowing said compound to set to an elastic, vibration deadening state.
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2. The method according to claim 1, c h a r a c t e r - i z e d by comprising the step of attaching spacer means onto one of or both of said sheets, prior to the step of bringing together said sheets, said spacer means being
25 adapted for controlling the spacing between the sheets.
3. The method according to claim 2, c h a r a c t e r - i z e d by comprising the step of providing said spacer means by applying a filling of said compound in a viscous
30 or fluent state to form a coating on one of or both of said sheets, and allowing the filling to set at least until assuming a viscous state, prior to the step of bringing together said sheets.
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4. The method according to claim 3, c h a r a c t e r - i z e d by comprising the step of allowing said coating



to set completely, prior to the step of bringing together said sheets.

5 5. The method according to claim 4, c h a r a c t e r -
i z e d by comprising the step of texturing the surface
of said coating.

6. The method according to any of the preceding claims,
c h a r a c t e r i z e d by comprising the step of util-
10 izing said opening to introduce into said space a supple-
mentary filling of said compound, while in a viscous or
fluent state.

7. The method according to claim 6, c h a r a c t e r -
15 i z e d by comprising the step of continuing the intro-
duction of said supplementary filling until outflow of
excess compound around substantially the entire contour
of the sheets is observed.

20 8. The method according to any of the preceding claims,
c h a r a c t e r i z e d by comprising the step of in-
terconnecting said sheets, at least until said compound
has set, by a structural component, such as a screw, a
bolt, a rivet or a piece of welding, serving to secure
25 their relative positions.

9. The method according to claim 8, c h a r a c t e r -
i z e d by comprising the step of utilizing said struc-
tural component to apply all of or part of said compres-
30 sive force.

10. The method according to any of the preceding claims,
c h a r a c t e r i z e d by comprising the step of pro-
viding said opening in the center of said second sheet.



11. The method according to any of the preceding claims, characterized by comprising the step of providing said second sheet with a number of openings with regular spacings.

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12. A panel for the application as a wall panel, a ceiling panel or a floor panel and manufactured by the method according to any of the preceding claims.

10 13. A panel according to claim 12, characterized in that said first and second sheets comprise steel plates or aluminium plates, and in that the gauge of said second sheet is equal to or less than the gauge of said first panel.

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14. The panel according to claim 12 or 13, characterized in that said compound comprises a viscoelastic damping mass based on polymer.

20 15. A sound insulating structure for use as a wall, a ceiling or a floor, comprising first plates, arranged in coplanar and contiguous relationship in order to form a first structural layer, second plates arranged in coplanar relationship in order to form a second structural
25 layer in spaced parallel relation with said first structural layer, and a core, which core effectively bridges the space between and adheres together plates of the respective layers, and which core comprises an elastic, vibration deadening mass, characterized in that
30 said structure is manufactured by providing at least one through opening in each of said second plates, applying compound onto at least one of said first or said second plates to provide at least part of said core, bringing together plates of said second structural layer with
35 plates of said first structural layer, applying a compressive force in order to urge said structural layers



together, using said openings to inspect the space between the structural layers, adjusting the compressive force depending on an evaluation of the result of the inspection, and allowing said mass in said core to set to
5 an elastic state.

16. The structure according to claim 15, c h a r a c -
t e r i z e d in that spacer means is attached onto at
least one of said first or second plates, said spacer
10 means serving to control the spacing between the plates
of the respective structural layers.

17. The structure according to claim 15 or 16, c h a r -
a c t e r i z e d in that said first plates are structur-
15 ally interconnected at their edges by welding, prior to
the step of bringing together plates of the respective
layers.

18. The structure according to claim 15, 16 or 17,
20 c h a r a c t e r i z e d in that it comprises a backing
layer of soft, sound deadening material, such as mineral
fiber wool, backing one of said structural layers.