

COMPOSITE PANEL

[0001] The present application claims a filing date of an earlier Singapore patent application number 10201708009R as a priority date, which was submitted to
5 Intellectual Property Office of Singapore (IPOS) on 28 September 2017. All contents or relevant subject matter of the priority application is hereby incorporated entirely or wherever appropriate by reference.

[0002] The present application relates to a composite panel for masonry construction.
10 The application also relates one or more methods for making, assembling, disassembling, installing, configuring, maintaining, repairing and using the one or more composite panels.

[0003] Composite panels are also known as sandwich panels, as a composite panel
15 commonly includes a plurality of different layers arranged on top of each other. In many cases, a composite panel exhibits three or more layers, in particular an internal core layer as well as two outer layers attached to either side of the internal core layer. However, different layers of a sandwich panel are easily peeled off or separated because the different layers are typically made of distinctively different materials that
20 may not have sufficient inherent adhesion in-between the different layers.

[0004] The present application aims to provide one or more new and useful composite panel for masonry construction. The present application further aims to provide one or more new and useful methods for making, assembling, disassembling, installing,
25 configuring, maintaining, repairing and using one or more said composite panels. Essential features of the application are provided by one or more independent claims, whilst advantageous features are presented by their dependent claims respectively.

[0005] The present application also aims to provide a composite panel that has
30 advantages of improved weather proofing, improved noise absorbing, improved fireproofing, lightweight, impact resistance and easy to maintain thereof.

[0006] According to a first aspect, the present application provides a composite panel for masonry construction. The composite panel comprises a first skin layer; a

composite layer including composite materials and a reinforcing structure such as a wireframe (i.e. wire mesh); and a second skin layer. The composite layer is also known as a connecting layer because the connecting layer optionally include a composite material (e.g. concrete) (e.g. wireframe or rebars) or structural material.

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[0007] The first and second skin layers can comprise a coarse particulate and a cement. The composite material in the composite layer can comprise a cement 0.65-0.80 part; a hydrogenated carbon 0.05-0.15 part; a quartz sand 0.05-0.15 part; a pearlite powder 0.02-0.05 part; a cellulose ether 0.001-0.004 part; a mortar additive
10 0.008-0.03 part; an air entraining agent 0.0001-0.0005 part; a zinc stearate 0.001-0.004 part; a calcium formate 0.008-0.013 part, an extruded polystyrene foam 6-72 part; and water 100-130 part. The strength class of the cement is at least 52.5.

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[0008] According to a second aspect, the present application provides a method of forming a hollow wireframe, which is also known as wire mesh. The method comprises the steps of forming a high tensile strength metal cylindrical rod with the two ends bent orthogonally (pointing upwards); tying or welding two of the formed metal cylindrical rods to form a cross; and the above two steps to get the desired size. The method may further comprise the steps of pouring a liquefied concrete into the polygonal mold;
20 placing the wireframe onto the liquefied concrete; pouring a liquefied composite material into the polygonal mold; concealing the wireframe; revealing a partial top portion of the wireframe; pouring the liquefied concrete to the brim of the polygonal mold; curing; and disassembling the polygonal mold.

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[0009] According to a third aspect, the present application provides a composite panel for building construction. The composite panel comprises a first skin layer; a composite layer attached to the first skin layer; a wireframe embedded through the composite layer; and a second skin layer further attached to the composite layer. The first skin layer and the second skin layer are attached to opposite sides of the
30 composite layer. The composite layer is also known as a connecting layer because the connecting layer optionally include a composite material (e.g. concrete) (e.g. wireframe or rebars) or structural material.

[0010] The wireframe can be embedded in first skin layer, the second skin layer or both. The wireframe can be bent at opposite sides or ends of the composite layer. The wireframe can surround the composite layer. The wireframe can fully or substantially enclose the composite layer. The wireframe can include metal rods or wires that have a diameter from about 01 millimetres to about 05 millimetres each substantially. Neighbouring metal wires of the wire mesh can have a distance of from 20 millimetres to 100 millimetres substantially. One or more connectors are provided at a lateral side of the composite panel. One or more of connectors can comprise a rib and a groove at opposite sides or end of the composite panel. The rib and the groove can have complimentary shapes or sides for joining another composite panel according to any of the preceding claims.

[0011] According to a fourth aspect, the present application provides a method of making a composite panel. The method comprises steps of providing a mould having a bottom part, a front part and a back part, the front part and the back part being at opposite sides of the mould; offering a first skin layer on the bottom part; putting a wireframe onto the first skin layer; filling on top of the wireframe with a composite material; covering the composite material with a second skin layer; and removing the mould.

[0012] The step of putting a wireframe onto the first skin layer can comprise enclosing a room between the front part and the back part. The step of enclosing a room between the front part and the back part can comprise joining two baskets at their edges. The method can further comprise a step of embedding a portion of the wire mesh into the first skin layer, the second layer or both the first skin layer and the second skin layer. The method can additionally comprise a step of adding at least one connector to a side of the composite panel for joining other composite panels.

[0013] The accompanying figures (Figs.) illustrate embodiments and serve to explain principles of the disclosed embodiments. It is to be understood, however, that these figures are presented for purposes of illustration only, and not for defining limits of relevant inventions.

Fig. 1 illustrates an exploded view of a first polygonal mould for making a composite panel;

- Fig. 2 illustrates a first side view of a second polygonal mould having a liquefied concrete at bottom;
- Fig. 3 illustrates a second side view of the second polygonal mould having the liquefied concrete and a second wireframe;
- 5 Fig. 4 illustrates a third side view of the second polygonal mould having the liquefied concrete, the second wireframe and a liquefied composite material;
- Fig. 5 illustrates a fourth side view of the second polygonal mould having the liquefied concrete, the second wireframe, the liquefied composite material and a second liquefied concrete;
- 10 Fig. 6 illustrates a first wireframe of the composite panel;
- Fig. 7 illustrates a second wireframe of the composite panel;
- Fig. 8 illustrates the second wireframe with a plurality of cylindrical metal rod;
- Fig. 9 illustrates a section of the second wireframe;
- Fig. 10 illustrates a top wireframe of the second wireframe; and
- 15 Fig. 11 illustrates a side view of an assembled alternative second wireframe.

[0014] Exemplary, non-limiting embodiments of the present application will now be described with references to the above-mentioned figures. Particularly, Fig. 1 illustrates a three-dimensional construction of a prefabricated composite body 90 which is formed by a first polygonal mold 104. The prefabricated composite body is also known as a composite panel. The first polygonal mold 104 is water-tight with an open top. The first polygonal mold 104 is made of cast iron and formed by a plurality of vertical wall 100 and a base 102. The thicknesses of the wall 100 and the base 102 are both twenty millimetres (20 mm). The base 102 has a length of five hundred millimetres (500 mm) and a width of four hundred millimetres (400 mm). The wall 100 has a height of a hundred and fifty millimetres (150 mm). The walls 100 of the first polygonal mold 104 are erected on the base 102 with a margin of thirty millimetres (30 mm) measured from the periphery of the base 102. A valley-like recess 120 is along a first length vertical side 116. A knoll-like protrusion 122 is along a second length vertical side 118. The first length vertical side 116 and the second length vertical side 118 are parallel with the two lengths of the base 102.

[0015] A first layer of liquefied concrete 110 is poured into the first polygonal mold 104 from the open top as shown by the liquefied concrete in arrow 112. The pouring speed

is controlled by a fluid meter or any device of the similar function. For the best performance, the speed is preferred to be controlled in the range of 0.8~18 liter per minute second in order mold a slag of about one cubic meter (i.e. 1m³). The liquefied concrete 110 is a composite material composing coarse aggregates bonded together with a fluid cement that hardens over time. The coarse aggregates comprise sand, natural gravel and crushed stone. The liquefied concrete 110 is filled to a height of about thirty-seven millimetres (37 mm). The hardening time varies according to specific working parameters, such as specific coarse aggregates, the surrounding temperature and humidity and the pastes used in the cement.

[0016] Fig. 6 illustrates a first wireframe 106 which comprises a lower (bottom) wireframe unit 124 and an upper (top) wireframe unit 126. The first wireframe 106 takes a shape of a hollow cuboid with an exposed side. The hollow cuboid has five rectangular sides orthogonal to each other as viewed from a levelled plane from each side. The first wireframe 106 is constructed by either welding 128 or tying 130 a plurality of metal-alloy wire to each other (metal-alloy wire to metal-alloy wire) or a combination of both welding 128 and tying 130. A plurality of thin metal wire is used to tie the plurality of metal-alloy wire. The thin metal wire is pliable by a pair of human hands.

[0017] Two identical wireframe units 124 and 126 make up the first wireframes 106. The lower wireframe unit 124 is at the bottom and the inverted identical upper wireframe unit 126 is above the lower wireframe unit 124. The lower wireframe unit 124 has a trough as seen from a plan view as shown in Fig. 1 and 6 (not labelled in the figures). The upper wireframe unit 126 is identical but inverted. Welding 128 is performed to join the two wireframes units 124,126 together to form a six-sided rectangular first wireframe 106.

[0018] There are four vertical cylindrical metal rods 123 that has a length of a hundred and fifty millimetres (150 mm) and a diameter in the range of 01 millimetres (01 mm) to 05 millimetres (05 mm). Each cylindrical metal rod 123 is placed on one of the four corners of the first wireframe 106.

[0019] A distance between two metal-alloy wires can be in the range of 20 millimeters to 100 millimeters, such as fifty millimetres (50 mm) in this embodiment with a diameter of one metal-alloy wire at five millimetres (5 mm). A diameter of the one thin metal wire is 2 millimetres (2 mm). The height of the one first wireframe 106 is sixty millimetres (60 mm). The joining of two identical wireframes units of 106 (i.e. the lower unit 124 and the upper wireframe unit 126) on top of each other has a total height of a hundred and twenty millimetres (120 mm). The lengths and the widths of the first wireframe 106 are slightly smaller relative to the first polygonal mold 104. A gap of twenty millimetres (20 mm) from the interior wall 100 of the first polygonal mold 104 is provided to allow an insertion and placement of the first wireframe 106 into the first mold 104.

[0020] Referring back to Fig. 1, the constructed (welded or tied) six-sided rectangular first wireframe 106 is then inserted into the first polygonal mold 104 after the liquefied concrete 110 was introduced thereof. The first wireframe 106 is pushed downward towards the base 102 of the first polygonal mold 104 until a portion of the bottom part of the first wireframe 106 is submerged in the liquefied concrete 110 and invisible to the human eyes. The first wireframe 106 is erected and levelled without contacting the interior walls 100 of the first polygonal mold 104.

[0021] As shown by the liquefied composite material in arrow 115, a liquefied composite material 114 is then poured into the first polygonal mold 104 and onto the first layer of liquefied concrete 110 with the first wireframe 106 within. The liquefied composite material 114 comprises cement, hydrogenated carbon, quartz sand, pearlite powder, cellulose ether, mortar additives, air entraining agent, zinc stearate, calcium formate and Styrofoam. The liquefied composite material 114 is filled to a height of a hundred and thirteen millimetres (113 mm) or seventy-six millimetres (76 mm) above the first layer of liquefied concrete 110.

[0022] After the above process, a second layer of the liquefied concrete 110 is poured into the first polygonal mold 104. The liquefied concrete 110 and the liquefied composite material 114 are then left to cure over time in the first polygonal mold 104. The length of the curing time is dependent on the ambient conditions like temperature and humidity.

[0023] Figs. 2 to 5 illustrate a side view as viewed from a width of a second polygonal mould 150. Fig. 2 illustrates the liquefied concrete 110 poured into the polygonal mold 150. The second polygonal mold 150 comprises a base plate 154 and four polygonal sidewalls 156. The base plate 154 is rectangular in shape having a length of five hundred millimetres (500 mm) and the width of four hundred millimetres (400 mm), and it has a plurality of hollow cavity 158 at regular intervals of fifty millimetres (50 mm) between each hollow cavity 158. The polygonal sidewall 156 comprises two long sides and two short sides with flat interior surface (not shown). A first interior side 160 has with a knoll protrusion 164 for making a groove of the composite panel 90 and a second interior side 162 has a valley recess 166 for making a rib of the composite panel 90. Profiles of the rib and groove are complementary or match each other such that multiple pieces of the composite panel 90 can align and join together by linking ribs with grooves respectively. The bottom side of the polygonal sidewall 156 has a plurality of protrusions (not shown). The plurality of protrusions is inserted into the plurality of hollow cavities 158 at the base plate 154. The thickness of the polygonal sidewall 156 is twenty millimetres (20 mm). The height of the polygonal sidewall 156 is a hundred and fifty millimetres (150 mm).

[0024] The first interior side 160 is inserted into the hollow cavity 158 along one length of the base plate 154. The second interior side 162 is inserted into the hollow cavity 158 along an opposite length of the base plate 154. The one short side and the second short side are inserted into the hollow cavity 158 along the two opposite widths of the base plate 154. The polygonal sidewalls 156 are placed with at least a fifteen millimetres (15 mm) margin measured from the periphery of the base plate 154 thereof.

[0025] Fig. 3 illustrates a side view of the second polygonal mould 150 having the liquefied concrete 110, the base plate 154 and a second wireframe 152 thereon.

[0026] Fig. 7 illustrates a second wireframe 152 which is formed by having two identical wireframe units with one on top of the other. Specifically, a top wireframe unit 170 is welded 128 or tied 130 to a bottom wireframe unit 168 to form a six-sided hollow cuboid. The four arrows pointing towards the bottom wireframe unit 168 denote that the top wireframe unit 170 is joined with the bottom wireframe unit 168. The second wireframe 152 has a dimension of 410 mm (length) by 310 mm (width) by 130 mm

(height). The second wireframe 152 is pushed into the liquefied concrete 110 whereby the bottom of the second wireframe 152 is partially submerged in the liquefied concrete 110. The liquefied concrete 110 is poured to a height of 37 mm. The four cylindrical metal rods 123 are inserted near the four corners of the second wireframe

5 152.

[0027] The four cylindrical metal rods 123 in the first wireframe 106 and the second wireframe 152 are inserted through the wireframes 106,152 revealing both of the two ends of the cylindrical metal rods 123. The four cylindrical metal rods 123 are either

10 welded or tied to the wireframes 106,152.

[0028] The first wireframe 106 is characterised by eight vertical sides and two horizontal sides. Five vertical sides out of the eight vertical sides are along a first length. The first length takes the shape of the recess 120 of the first polygonal mold 104.

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[0029] The second wireframe 152 is characterised by four vertical sides two horizontal sides which takes the shape of the second polygonal mold 150.

[0030] Fig. 4 illustrates a side view of the second polygonal mould 150 having the liquefied concrete 110, the second wireframe 152 thereon and a liquefied composite material 114 poured into the second polygonal mold 150. The composite material 114 is poured to a height of 113 mm as measured from the top surface of the base plate 154.

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[0031] Fig. 5 illustrates a side view of the second polygonal mould 150 having the liquefied concrete 110 poured therein, the second wireframe 152 placed thereon, the liquefied composite material 114 poured therein and a second liquefied concrete 110 poured therein.

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[0032] Fig. 8 illustrates the second wireframe 152 with a plurality of cylindrical metal rods 123. The cylindrical metal rods 123 are distributed in a six by three grid at the bottom wireframe unit 168 and are either tied 130 or welded 128 to the bottom wireframe unit 168.

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[0033] Fig. 9 illustrates a section of the second wireframe 152 specifically the bottom wireframe unit 168 in an isometric view. Four cylindrical metal rods 123 are arranged in a straight line along the width of the second wireframe 152

- 5 [0034] Fig. 10 illustrates a top wireframe unit 170 of the second wireframe 152. The top wireframe unit 170 is to be covered over the bottom wireframe 152.

[0035] Fig. 11 illustrates a side view of an assembled alternative second wireframe 152. The top wireframe unit 170 of the alternative second wireframe 152 circumscribes the bottom wireframe unit 168. The width of the top wireframe unit 170 is wider than the bottom wireframe unit 168. The height of the alternative wireframe 152 is approximately 130 mm. The two cylindrical metal rods 123 are welded 128 or tied 130 to the top wireframe unit 170 and the bottom wireframe unit 168 with the two ends protruding from the top wireframe unit 170 and the bottom wireframe unit 168 of the wireframe 152.

[0036] Unlike the second wireframe 152 as shown in Fig. 7 where the top wireframe unit 170 is on top the bottom wireframe unit 168. In Fig. 7, the height of the one top wireframe unit 170 and the one bottom wireframe unit 168 is 65 mm each. (not understanding the meanings here)

[0037] The prefabricated composite body 90 (i.e. the composite panel) provides a building material which can be used to make walls, pavements and other elements in masonry construction.

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[0038] The first polygonal mold 104 which is made of steel provides a cast for the containment of the liquefied concrete 110, the liquefied composite material 114 and the first wireframe 106. The 20mm thickness provides a strong upright support for holding the materials 106,110,114 within the first polygonal mold 104. The wall 100 is detachable and attachable to the base 102 of the first polygonal mold 104 which provides an easy access to the cured prefabricated composite body 90.

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[0039] The first layer of liquefied concrete 110 is poured into the first polygonal mold 104 to a height of 37 mm. The figure is in fact around 25% of the total height of the

wall 100 (150 mm). The liquefied composite material 114 is poured into the first polygonal mold 104 for the next around 50% which is 76 mm. The second layer of liquefied concrete 110 is poured into the first polygonal mold 104 to the open top. The pouring speeds in all of the pouring processes are controlled by a fluid meter or any device of the similar function. For the best performance, the speed is preferred to be controlled in the range of 0.8 to 18 liter per second or otherwise, assuming the mold configured to cast a slab or composite panel of less than 01 cubic meter (i.e. 1m³). The ratio of liquefied concrete 110 to the liquefied composite material 114 to the liquefied concrete 110 is 1:5:1 for exterior walls. For interior walls, the ratio is 3:14:3 whereby the middle liquefied composite material 114 is slightly thinner.

[0040] The first layer and the second skin layers of the liquefied concrete 110 provide the external surfaces of the prefabricated composite body 90 protecting the liquefied composite material within 114 and the first wireframe 106. The liquefied composite material 114 provides a heat retardation, an improved air flow therein and an insulation. The improved air flow provides a quicker drying process of the liquefied concrete 110 from the interior.

[0041] The first wireframe 106 and the second wireframe 152 provide a reinforcing material to improve the physical properties namely the tensile strength to the cured prefabricated composite body 90.

[0042] The cylindrical metal rods 123 in the wireframe 106,152 provide a support thereof. The support is to elevate the wireframe 106,152 from the bottom of the polygonal mold 104,150. The elevated wireframe 106,152 provides a gap in between so that the wireframe 106,152 does not touch the polygonal mold 104,150 at the bottom. Four cylindrical metal rods 123 are used to support the wireframe 106,152 so as to bear the weight of the liquefied concrete 110 and the liquefied composite material 114 after being poured into. Alternatively, three cylindrical metal rods 123 can be used to form a three-legged stand supporting the wireframe 106,152.

[0043] The method of forming the hollow wireframe 106,152 comprises the steps of forming a high tensile strength metal cylindrical rod with the two ends bent orthogonally (pointing upwards); tying 130 or welding 128 two of the formed metal

cylindrical rods together to form a cross; and repeating the above two steps to get the desired size. Eventually, a metal basket is obtained with a flat bottom and four vertical walls forming a five-sided cuboid with an exposed top. A second metal basket is done in the same way. The first and second metal baskets with the exposed tops are welded 5 128 together to form a six-sided cuboid. The six-sided cuboid is essentially the formed wireframe 106,152. Four cylindrical metal rods 123 are then inserted through the wireframe 106,152. The wireframe 106,152 has the height of a hundred and thirty millimetres (130 mm). The four cylindrical metal rods 123 has the length of a hundred and fifty millimetres (150 mm) each. Ten millimetres (10 mm) of the cylindrical metal 10 rod 123 is exposed or protrudes at the both ends thereof from the wireframe 106,152. The four cylindrical metal rods 123 are welded 128 or tied 130 to the top and bottom of the wireframe 106,152 individually. The four cylindrical metal rods 123 are positioned near the four corners of the wireframe 106,152.

15 [0044] The method of forming the prefabricated composite body 90 comprises the steps of pouring a liquefied concrete 110 into the polygonal mold 104,150; placing the wireframe 106,152 onto the first liquefied concrete 110; pouring a liquefied composite material 114 into the polygonal mold 104,150; concealing the wireframe 106,152; revealing the top part partially of the wireframe 106,152; and pouring the liquefied 20 concrete 110 to the brim of the polygonal mold 104,150. Alternatively, the wireframe 106,152 is placed into the polygonal mold 104,150 first before the process of pouring in the liquefied concrete 110.

[0045] In the application, unless specified otherwise, the terms "comprising", 25 "comprise", and grammatical variants thereof, intended to represent "open" or "inclusive" language such that they include recited elements but also permit inclusion of additional, non-explicitly recited elements.

[0046] As used herein, the term "about", in the context of concentrations of 30 components of the formulations, typically means +/- 5% of the stated value, more typically +/- 4% of the stated value, more typically +/- 3% of the stated value, more typically, +/- 2% of the stated value, even more typically +/- 1% of the stated value, and even more typically +/- 0.5% of the stated value.

[0047] Throughout this disclosure, certain embodiments may be disclosed in a range format. The description in range format is merely for convenience and brevity and should not be construed as an inflexible limitation on the scope of the disclosed ranges. Accordingly, the description of a range should be considered to have specifically disclosed all the possible sub-ranges as well as individual numerical values within that range. For example, description of a range such as from 1 to 6 should be considered to have specifically disclosed sub-ranges such as from 1 to 3, from 1 to 4, from 1 to 5, from 2 to 4, from 2 to 6, from 3 to 6 etc., as well as individual numbers within that range, for example, 1, 2, 3, 4, 5, and 6. This applies regardless of the breadth of the range.

[0048] It will be apparent that various other modifications and adaptations of the application will be apparent to the person skilled in the art after reading the foregoing disclosure without departing from the spirit and scope of the application and it is intended that all such modifications and adaptations come within the scope of the appended claims.

Reference Numerals

	90	prefabricated composite body
	100	wall
5	102	base
	104	first polygonal mold
	106	first wireframe or first wire mesh
	110	liquefied concrete
	112	liquefied concrete in arrow
10	114	liquefied composite material
	115	liquefied composite material in arrow
	116	first length vertical side
	118	second length vertical side
	120	recess
15	122	protrusion
	123	cylindrical metal rod
	124	lower (bottom) wireframe unit
	126	upper (top) wireframe unit
	128	weld, welding
20	130	tie, tying
	148	second prefabricated composite body
	150	second polygonal mold
	152	second wireframe or second wire mesh
	154	base plate
25	156	polygonal sidewall
	158	hollow cavity
	160	first interior side
	162	second interior side
	164	knoll protrusion or groove of the composite panel
30	166	valley recess or rib of the composite panel
	168	bottom wireframe unit or bottom wire mesh unit
	170	top wireframe unit or top wire mesh unit

Claims

1. A composite panel for building construction, the composite panel comprising
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- a first skin layer;
 - a second skin layer;
 - a connecting layer that joins the first skin layer and the second skin layer at opposite sides of the connecting layer.
- wherein the connecting layer comprises reinforce elements for providing structural integrity structure of the composite panel.
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2. The composite panel of claim 1 further comprising at least one connector at a lateral side of the composite panel.
3. The composite panel of claim 1 or 2, wherein
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- the at least one connector comprises a rib and a groove at opposite sides of the composite panel.
4. The composite panel of claim 3, wherein
- the rib and the groove has complimentary shapes or sides for joining another composite panel according to any of the preceding claims.
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5. A method of making a composite panel, the method comprising
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- providing a mold having a bottom part, a front part and a back part, the front part and the back part being at opposite sides of the mold;
 - offering a first skin layer on the bottom part;
 - putting a connecting layer onto the first skin layer;
 - covering the connecting layer with a second skin layer; and
 - curing the first skin layer, the connecting layer, the second skin layer or a combination of any of these layers.
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6. The method of claim 5 further comprising adding at least one connector to a side of the composite panel for joining other composite panels.

7. The method of claim 5 or 6 further comprising removing the mold after curing.