

## Wall Cladding, Panel and Assembly

### TECHNICAL FIELD

[0001] THIS INVENTION relates to wall cladding and in particular to various methods concerning wall cladding and an associated cladding panel and in particular but not limited to a folded edge cladding panel with improved edge integrity. More particularly, the invention concerns a cladding panel with unexpected characteristics in use.

### BACKGROUND

[0002] Metal wall cladding has been around for many years, as early as corrugated iron sheeting. More specialised cladding has developed over the years, primarily as a facade over masonry including concrete.

[0003] Aluminium composite panels have been used in wall cladding for over 30 years. Some of these panels have proved combustible. In recent times these have been exposed to catastrophic failure during fire events. The most notable is the Grenfell Tower fire in London. If the cladding is combustible fire can spread rapidly on the exterior of the building.

[0004] Composite panels have a wide variety of applications, such as architecture. In architecture, for instance, composite panels are used for external walls, shop awnings, signage and ceilings. Depending on their composition, composite panels can exhibit many advantageous features such as being weatherproof, noise-absorbing, fireproof, light and easy to cut, impact-resistant and easy to maintain. Composite panels are also known as sandwich elements, as they commonly consist of a plurality of different layers arranged on top of each other. In many cases, composite panels exhibit at least three layers, in particular a core layer as well as two outer layers attached to either side of the core.

[0005] Rather than being directed to general uses, as are typical in the example in the previous paragraph, the present invention has its primary application to exterior cladding.

[0006] It is an object of the present invention for provision, primarily to and for exterior cladding, to a method of exterior cladding, and to a cladding panel and associated parts and fittings.

[0007] A further object is to provide a relatively light cladding but substantially eliminate any fire risk including minimising any drop risk during a fire event and quite unexpectedly, a panel with virtually no fire risk to the underlying structure should the cladding be subjected to a fire event.

[0008] Furthermore, a still further object is to provide a mechanical panel fabrication and assembly process, from raw blank laminated material, so that the resulting panel assembly has reduced cracking of the external finish and reduced likelihood of a delamination.

[0009] Frequently, composite panels have tried to incorporate a fire-retardant layer into the panel based on the inclusion of a wet mix of fillers along with Magnesium Oxide or Magnesium Hydroxide in one form or another during manufacture to produce a core panel and then apply outer layers to the core panel. The outer layers may be aluminium or steel and aluminium (See for example US2013216796; US2017328063).

[0010] Generally speaking exterior cladding may be described as a crowded or mature art. US7866107; AU678668; US10190320; US9926707; US7621084; EP1306495; WO2019096882; WO2014108927; EP3511481; represent a non-exhaustive exemplification of cladding. In addition there are many arrangements for anchoring exterior cladding panels to buildings, for example US2012198788; WO9213153; US3266209; GB2470373; CH663813; GB2227262; GB1427234; DE19653672; DE19621624.

[0011] The Applicant's invention should be viewed through the lens of a crowded art in order to demonstrate that in all the circumstances the notional skilled person would be presented with many similar solutions to the present invention. Since the present invention arises in a crowded art it would be *prima facie* wrong to suggest that there was, or is, apart from the very general problem of fire, a particular problem or motivation extant at the filing date of the present application that would give rise to the non-inventive notional person coming up with the present invention either in idea, concept or practical form. Thus the recognition and the present conception may be considered as whole or part of the Applicant's inventive step.

[0012] With this and the other background factors, including as set out above, in mind, it should be clearly appreciated to the reader, that it is elementary that exercise of the inventive faculty in all the circumstances, in such a crowded art, is likely to be present in small variations. This is a background observation in hindsight only and is not to say that any of Applicant's new features whether individually or in combination are in any way slight or small. All that is required is a "scintilla" of invention.

[0013] Even though the art has become crowded, according to Applicant's understanding of the marketplace, there have been many offerings in the field of cladding, the use of cladding as a facade has been widely accepted. Consequently, there is a requirement for a fresh look "outside the box" through new eyes in an effort to provide an alternative to the efforts made over the last many years. It would be desirable to have something that is simple and easy to assemble, yet effective, but employing common techniques and methods to arrive at a new and useful combination and result. Simplicity is not considered a bar to invention but in a crowded art may indeed be an indicator of invention.

[0014] It will be appreciated from the following description that simplicity in a crowded art is a characteristic of the Applicant's invention.

[0015] This means that the present invention does not arise through any deterministic relationship to the prior art but rather is the inventor's own inspiration in an individualistic way applying the inventor's mind to the general state of the art and to the inventor's knowledge and recognition of defects arising during his prototyping and development that might be remedied, this being as an alternative to what is currently available, rather than an effort to deal with any specific generally recognised real extant problem common at the time or any notional problem derived *ex post facto* from any single item of the prior art, selected by hindsight, from a clearly crowded art, since any selection in a crowded art must necessarily be based on the Applicant's disclosure as the starting point. Selection of features from what are otherwise workable solutions must necessarily involve a rejection of other features from the combinations disclosed in those solutions. In the absence of a novelty destroying publication, it will be clear that over the many years the present invention escaped the skilled person.

## OUTLINE

[0016] In one broad aspect there is provided a fire resistant lightweight cladding comprising thin sheet material having an outer layer which is predominantly steel and a thicker inner layer which is predominantly aluminium, the inner layer being a supporting layer and the sheet material being formed into a panel of predetermined outline, panel attachment means being provided for the purpose of anchoring the panel to a substrate. The relative dimensions of the layers and the overall sheet thickness being so made and arranged that under a fire test of a specimen of said panels in a wall panel assembly according to British Standard BS 8414-2 2015 (amdt 1) as modified by Australian 5113-2016 (amdt 1). Preferably, the steel layer is about .4mm thick and the aluminium layer is about 2mm thick. Preferably, the cladding sheet density ranges from  $6\text{kg/m}^2$  to  $9\text{kg/m}^2$ . Typically each panel includes a molten metal collector behind the sheet. More preferably, each cladding sheet has a folded edge formation with a terminal edge of the sheet concealed inside the folded edge formation. While it is preferred that there only be two layers, the invention concerns at least those two layers so the addition of other non-combustible layers will not affect the working of the inventions although these may add to the weight and cost of the panels.

[0017] In another aspect there is provided a cladding panel having a relatively thick inner layer of aluminium or equivalent and a relatively thin outer layer of steel or equivalent, the relative dimensions of the layers and the overall panel thickness being so made and arranged that under a fire test of a specimen of said panels according to British Standard BS 8414-2 2015 (amdt 1) as modified by Australian 5113-2016 (amdt 1) the specimen passes the classification criteria 5.4.5(g). Under the test condition set out hereto, the preferred panel provides, quite unexpectedly, under classification criteria 5.4.5(g), a result of less than .1kg of debris falling from the test specimen.

[0018] In a still further aspect there is provided a cladding panel having a relatively thin outer steel layer and an aluminium layer, the panel being made from a flat sheet having a terminal edge exposing the aluminium, the completed panel having a folded edge formation with the terminal edge concealed inside the folded edge formation. The edge formation is typically a rolled over marginal edge section of the flat sheet. The rolled over marginal edge section typically comprises an upright flange of double thickness using an inward return flange. Edge formation is typically formed around the completed panel so that the panel forms an open box-like structure. Panels may be fitted to an underlying wall using a grid of rails or they may be fitted directly. The panel fittings may employ spaced brackets. The brackets may be fastenerless to the panels. The relationship between the panels and brackets may be such that the panels are effectively clamped by the brackets.

[0019] In a further preferred aspect there is provided a panel and fitting assembly, in a first form, the panel has a flange, typically a rolled over double thickness flange with a concealed edge, the flange having spaced bracket attachments, typically slots, and there being securing brackets inserted into the slots. The slots are optional and the panels may be fitted with brackets fastened directly or indirectly to the panel. The brackets may fit inside the panel. Ordinarily, there will be a gap between panels filled with a suitable filler.

[0020] The edge formation is typically a surrounding flange employing folds so that the original edge of the starting panel is concealed inside the flange. The flange typically has spaced slots, the slots being preformed slot sections formed before folding so that upon folding they overlay to form the slot.

[0021] Each panel preferably uses a panel connecting bracket and each bracket typically includes a slot fitting section and an offset wall connector section so that the panel may be secured to an underlying structure using fasteners passing through the bracket. The bracket is typically S-shaped in profile.

[0022] Preferably, in a preferred form according to the invention, the sheet material used is about 2.5mm thick and is about 6kg/m<sup>2</sup> to about 9kg/m<sup>2</sup> density when formed into panels. These panels may be box-like. Where the panel is box-like, an insulation material may

optionally be fitted into the box form. In another form, insulation may be fitted as a sheet under the cladding. Depending on the building height the insulation may typically vary from 25mm thick (low rise) to 50mm thick (high rise). Preferably, a lightweight insulating material may be employed. The lightweight insulation material may be solid polystyrene coated with carbon (EPC). In this form, the panels may be directly fitted to the building. Alternatively, a frame structure may be used but at added time and costs. The insulation may be applied first as a full sheet and then the panels fitted using brackets. The panel may be formed having spaced openings or cutouts of the like used to anchor the panel to a substrate.

[0023] In a preferred form a partially completed panel, has a partially formed edge formation along edges prior to folding from a sheet of composite material, the sheet having a thin front layer or outer layer of mild steel with a second thicker layer of aluminium, the flat sheet having corner cutouts, spaced side cutouts and slots matched to the side cutouts. Fold grooves are cut in the aluminium outboard and inboard of the slots to a depth just above the steel layer. The edges are then folded in turn about the respective fold grooves to give a panel with a double fold upright side of an open box form with a return flange inside the box and the steel layer on the outside of the box. Thus the terminal edge of the sheet is folded into a concealed position. The slots may be used to secure the panel to a wall using brackets fitted into the slots. The brackets are typically panel clamps slightly narrower than the distance from the clamp slot to the back edge of the panel so that the panel clamp performs its clamping function using suitable fasteners to an underlying structure while being a fastenerless connection to the panel.

[0024] The bracket slots are preferably greater than double the bracket length so that panels may fit side-by-side with respective brackets being offset relative to the adjacent bracket so the brackets of adjacent panels fit side-by-side. Other forms of cutouts or the like may be made in the panel and used to anchor the panel either directly or indirectly to a substrate.

[0025] In one form a stiffener may be used across panels to both stiffen and also capture molten material in a fire event. The stiffener has an upper opening so in a high-temperature fire event the stiffener will serve to capture melted aluminium to thereby reduce the drop of molten material from the wall.

## BRIEF DESCRIPTION OF THE DRAWINGS

[0026] In order that the present improvements may be more readily understood and put into practical effect reference will now be made to the accompanying drawings which illustrate preferred embodiments of the invention and wherein:-

Figures 1A to 1D are drawings showing the stages of construction of a panel according to the invention from an initial blank sheet;

Figure 2 is a perspective drawing of a panel;

Figure 3 is a perspective drawing of a panel of Figure 2 with a stiffening rail;

Figure 4 is a panelling clamp, two of which are used of each side of the panel in a typical fitting;

Figure 5 shows a typical panel with 8 panel clamps fitted;

Figure 6 is a section through B-B5 of Figure 5;

Figure 7 is a section through A-A of Figure 5;

Figure 8 is a detail "D" of Figure 6;

Figure 9 is a detail "C" of Figure 7;

Figure 10 is a typical stiffening rail;

Figure 11 is a corner bracket used at each corner of the panel of Figure 5 and at corners of each stiffening rail;

Figures 12 and 13 are drawings showing fitting of a group with panels directly to a wall (the wall is shown in phantom);

Figures 14 through 18 are respective, front, back, side, top and details "A" of the top view corresponding to the fitted panels of Figures 12 and 13;

Figures 19 and 20 are drawings showing fitting of a group of panels indirectly to a wall using "top hat" battens;

Figure 21 is an exploded view of the assembly applicable to Figures 19 and 20;

Figure 23 through 26 are respective front, back, side, top and detail "A" of the top view corresponding to the fitted panels with an intermediate panel 30 on the top hat battens;

Figure 27 is a exploded view of the fitting arrangement of Figures 23 through 26;

Figures 28-29C is of a test rig and measurement locations for thermocouples in a fire test carried out by CSIRO in accordance with British Standard BS 8414-2 2015 (amdt 1) as modified by Australian Standard AS 5113-2016 (amdt 1); and

Figures 30-35 are graphical representations of the measured temperatures over time.

## METHOD OF PERFORMANCE

[0027] Referring to the drawings and initially to Figures 1A through 1D there is illustrated in Figure 1A a partially completed panel 10 having a partially formed edge formation along edge 11 and a further stage of the formation along edge 12. The final formed panel is in Figure 1C and an anchor bracket fitted to the panel is shown in Figure 1D as part of an anchoring arrangement. The arrangement is optional as many proprietary anchoring arrangements for panels are known and the panels may be configured to suit known anchoring arrangements.

[0028] The panel, in this example, is made from a square or rectangular blank of composite material being a thin front layer or outer layer of mild steel with a second thicker layer of aluminium. The sheet overall thickness is 2.5mm. The front layer is sold under the Bluescope Steel trade name Zinccanneal and is mild steel with a protective zinc coating. The composite is formed using .4 mm Zinccanneal and 2mm Aluminium with a .1mm bonding membrane between the two for a total thickness of 2.5 mm. The Aluminium side is shown upward in Figures 1A-1C. A PVDF coating may be applied to the outside of the zinccanneal. Three coats are preferred. The raw panel sheet material may be obtained from VANCO® having website [vancopanel.com](http://vancopanel.com). It will be appreciated therefore that in referring to a steel layer, the layer envisage predominant steel layer but it may be protected by various treatments known in the art as in for example the zinc hot dipping and annealing process used in the production of Zinccanneal. Any equivalent known to the skilled person will be suitable. Likewise the Aluminium is employed in the design process to enable a lightweight fire panel in a form which quite unexpectedly has the benefits herein described. Thus the Aluminium is effectively a carrier for the steel layer. The composite may be formed as in pressing, rolling or cutting. Thus the relative dimensions is a balance of the practical use of the panel which dictates the relative dimensions in terms of thickness and area selected for the application, while still retaining the desirable outcome as set out in the test example which follows later in this description.

[0029] Edge 11 shows the result of earlier cutting, namely, three cutouts 13, 14 and 15 aligned with cutout slots 16, 17 and 18. These cutouts fold over the slots in the finished panel. Each

corner is cut as at 19. A fold groove 20 is also milled out along this edge between the slots and cutouts. In this case it is about 2mm wide and just to a depth above the steel layer. The next step is shown along the edge 12. A second fold groove 21 is cut inboard of the slots as shown along edge 12. The arrangement of edge 12 is reproduced along each edge. The edges are then folded.

[0030] Using the groove 20 there is made an upward fold (arrow 22) so that the flange sections between the cutouts are folded over 180° with the flange sections 23, 24 and so on along the edge 12 so that the cutouts align with the slots and then this means that the terminal edge 25 is folded into a concealed position according to the further 90° fold about fold groove 21 indicated by the arrow 27 to form the folded position illustrated in Figure 1C. The slots, for example, 18, may be fitted with a panel clamp 29 (see Figure 1D) used to secure the panel to a wall. A corner bracket 28 is used and riveted in each corner so that the result is a box-like arrangement as depicted more clearly in Figures 2 and 3. The panel clamp 29 is slightly narrower than the distance from the clamp slot to the back edge of the panel so that the panel clamp performs its clamping function using suitable fasteners. It is essentially a fastenerless connection to the panel.

[0031] All the bracket slots, for example, 18, in Figures 1A to 1D are greater than double the bracket 29 lengths so that panels may fit side-by-side with respective brackets being offset relative to the adjacent bracket. Thus the brackets fit side-by-side.

[0032] Figures 2 and 3 are corner panels 30 where the slots 31 are shorter on adjacent sides with the longer slots 32 on opposite sides to cater for the bracket of the next panel. The shorter slots are where the panels terminate on the edge of a wall. In Figure 3 an open channel stiffener 33 is fitted also using corner brackets 28.

[0033] The stiffener 33 has its opening 34 uppermost when the panel is in its operative position. The stiffener 33 is hard against the aluminium so in a high-temperature fire event the stiffener will serve to capture melted aluminium to thereby reduce the drop of molten material from the wall.

[0034] Figures 8 and 9 show the fold at 35 and 36 where the terminal edges 37 and 38 of the original blank are folded and tucked up under the panel to a concealed position under the front face 39 so that edges are protected right around the panel.

[0035] Figures 12 through 18 show one form of direct fitting of four panels 36 to a mid-wall section shown in phantom at 37. This could, for example, be a concrete wall. In Figures 23 through 28 there is an intervening layer of wall panelling 38.

[0036] In Figure 18 a fastener 39 is simultaneously used to secure the battens 40, 41 and the panels directly to the wall 37. The battens are so-called top-hat profile 42, these may first be secured, then the panels. The panels may have the stiffener or may also be infilled with insulation. The panels fit inside the top hat as clearly seen in Figure 18. A fireproof sealant may be used between and around the panels.

[0037] In Figure 27 it may be seen that the panel 30 fits on top of the top hat profile and the panels 37 fit on top of the intermediate panel 38. The panel 38 may be an insulating panel. A fireproof sealant may be used between and around the panels.

[0038] The panels described herein were tested according to British Standard BS 8414-2 2015 (amdt 1) as modified by Australian 5113-2016 (amdt 1) and the specimen passes the classification criteria 5.4.4(b) which concerns the temperature differential from the outer fireside and inside and 5.4.5(g) which concerns debris. Under the test conditions set out in Figures 28 and 29A-29C hereto, the preferred panel, in this test case Zinc-steel and Aluminium backing with 25mm X 25mm aluminium angle brackets on each internal corner, the panels having a density of 8.5kg/m<sup>2</sup> total thickness 2.3 mm, steel .3mm Al 2.0mm, the panels being of various heights and width and depth being 27mm, provides, quite unexpectedly, a very low inside temperature of less than 100°C temperature under classification criteria 5.4.5(b), and also quite unexpectedly, under classification criteria 5.4.5(g), a result of less than .1kg of debris falling from the test rig. The test rig was about 9m high and 3m wide.

[0039] The panels were tested according to British Standard BS 8414-2 2015 (amdt 1) as modified by Australian 5113-2016 (amdt 1) and the specimen passes the classification criteria

5.4.4(b) which concerns the temperature differential from the outer fireside and inside and  
5.4.5(g) which concerns debris.

[0040] Whilst the above has been given by way of illustrative example many variations and modifications will be apparent to those skilled in the art without departing from the broad ambit and scope of the invention as set out in the appended claims.

### Claims

1. Fire resistant lightweight sheeting when used as vertical wall cladding panel applied to a substrate comprising thin sheet material having an outer layer which is predominantly steel and a thicker inner layer which is predominantly aluminium, the inner layer being a supporting layer, wherein the assembled cladding is fire resistant according British Standard BS8414-2 2015 (amdt 1) as modified by Australian 5113-2016 (amdt1).
2. The fire-resistant cladding panel according to claim 1, the panel having attachment means provided for the purpose of anchoring the panel to the substrate.
3. The fire-resistant cladding panel according to claim 1 or claim 2 wherein the steel layer is about .4mm thick and the aluminium layer is about 2mm thick.
4. The fire-resistant cladding panel according to claim 1 or claim 2 wherein cladding sheet density ranges from 6kg/m<sup>2</sup> to 9kg/m<sup>2</sup>.
5. The fire-resistant cladding panel assembly according to claim 1 wherein each panel has a lower edge formed behind the sheet and extending toward the substrate.
6. The fire-resistant cladding panel according to any one of claims 1 to 3 wherein the panel has a folded edge formation with a terminal edge of the sheet concealed inside the folded edge formation.
7. The fire-resistant cladding panel according to claim 6 wherein the panel has an open box form with the folded edge formation being an upstanding surrounding flange, the terminal edge being located inside the flange.
8. The fire-resistant cladding panel according to any one of claims 1-5 wherein the panel has an open box form with the folded edge formation being an upstanding surrounding flange, the flange having spaced openings used to anchor the panel to a substrate.
9. The fire-resistant cladding panel assembly according to any one of claims 7-9 wherein

the folded edge formation is a double fold.

10. In the fire-resistant cladding panel as claimed in use in claim 5, the composite sheet having a sheet density ranging from  $6\text{kg/m}^2$  to  $9\text{kg/m}^2$ , the thin steel layer, the thicker aluminium layer, being pre formed then folded to provide a folded edge formation with a terminal edge of the sheet concealed inside the folded edge formation to protect the terminal edge.

11. The fire-resistant cladding panel according to claim 10 wherein the steel layer is about .4mm thick, the aluminium layer is about 2mm thick.

12. The fire-resistant cladding panel according to claim 10 or 11 wherein the panel has an open box form with the folded edge formation being an upstanding surrounding flange, the terminal edge being located inside the flange.

13. The fire-resistant cladding panel according to claim 10 or 11 wherein the panel has an open box form with the folded edge formation being an upstanding surrounding flange, the flange having spaced panel attachment means used to anchor the panel to a substrate.

14. A method for forming a panel as set out in any one of claims 7 and 12-13, the method comprising:

- a. providing a rectangular sheet of predetermined external dimensions having respective marginal edge sections terminating in respective terminal edges of the sheet;
- b. cutting corners from the sheet;
- c. pressing fold lines in the marginal edge sections;
- d. folding the marginal edge sections about the fold lines to form a double fold folded edge formation, with the terminal edges concealed inside the flange.

15. The method according to claim 14 including a further step of cutting spaced slots between the fold lines before performing step d.

16. The method according to claim 14 including, in no particular order, but before step d. a further step of, cutting spaced slots at a position set to be between the fold lines and cutting the terminal edges with cutouts aligned with the position of said slots.

17. The method according to claim 14 including a further step of providing spaced slots in said flange.
18. The sheet material when used in any one of claims 1-17, said steel layer being Zincanneal or equivalent.