

WALL PANEL

Technical Field

- 5 The invention relates to modular, prefabricated wall panels adapted to be assembled edge to edge for the construction of building walls. More particularly, the invention relates to such wall panels which include two containment sheets which are spaced apart and which are designed for the receipt of a poured in filling of concrete or like settable material.

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Background Art

- Composite building walls which are formed on site by pouring a settable material (such as concrete) between two spaced containment sheets are
15 known. The filling is necessarily dense to give substance to the finished wall and is necessarily fluid when being put in place. Thus the containment sheets are required to resist considerable hydrostatic pressure until such time as the filling material sets. As a result, some bulging of the containment sheets is inevitable and in prior art panels various approaches
20 have been adopted in efforts to limit that bulging. These prior art approaches have met with limited success and have been objectionable for other reasons.

- A previous modular wall panel comprises three, equal spaced apart,
25 channel sectioned sheet-steel studs, with the channel webs lying in vertical planes extending transversely of the panel, and two fibre-cement sheets secured flatly against the channel flanges. Those fibre-cement sheets may function as wall cladding sheets and as the containment sheets for the concrete filling. Notwithstanding the additional support from the
30 intermediate stud, the fibre-cement containment sheets have had to be thick and heavy to function satisfactorily. This adds to the weight of the panel and thus increases the difficulty of site assembly of the panels and of course the additional intermediate stud increases the cost of the panel.

- 35 It is also known to provide a modular panel with only two studs, one at or near each vertical edge of the panel and two sheet-steel containment sheets. In this instance, the containment sheets have been provided with two dove tail shaped, vertically extending stiffening ribs, intermediate vertical edges

of the panel. The ribs in one containment sheet are in register with the ribs in the other, and tensile ties extend transversely of the panel from each rib in one sheet to the corresponding rib in the other. This reduces the weight of the unfilled panel by comparison with the panel mentioned above, but
5 permits objectionable bowing of the containment sheets in horizontal planes. Usually, an external cladding sheet, for example plaster board, is applied to the ribs of at least one of the containment sheets, and is itself undesirably bowed. Further, it is difficult to fix the plaster boards to the filled ribs.

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An aim of at least a preferred form of the invention is to provide a modular wall panel which is light weight when unfilled, relatively inexpensive to fabricate, is resistant to bowing of the containment sheets and may be handled and installed without having to be overly protected from minor
15 surface damage likely to occur during those operations.

Summary of the Invention

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A modular wall panel comprising two containment sheets formed from sheet metal, and spacer means disposed between the containment sheets and fixed thereto so as to prevent separation of the containment sheets, the wall panel being arranged to be filled with a settable material and wherein, to resist hydrostatic pressure induced on filling the panel with the settable material, the containment sheets are profiled to have linear stiffening
25 formations extending along the sheets in a first direction to resist outward bowing of the containment sheets in planes extending in the first direction, and the spacer means extend along the containment sheets in a direction transverse to the first direction so as to resist bowing of the containment sheets in planes extending in a second direction perpendicular to the first
30 direction.

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The linear stiffening formations may be corrugations, ribs or pleats or the like, such that a cross sectional profile of the containment sheet displays a regular wave form with crests and troughs displaced from the centre plane of the sheet. The wave form may be smoothly curved throughout or it may comprise straight portions meeting at relatively abrupt angles, or a combination of both these possibilities.

For descriptive convenience, further description of the panels according to the invention is made hereinafter as if the panels were in place in a conventional vertical wall extending upwardly from a horizontal floor, and the terms “horizontal” and “vertical” as applied to the panels and the panel
5 components are used accordingly.

The construction of the spacer means may take various forms. In one embodiment, the spacer means are in the form of sheet metal studs, the studs are channel shaped and include a web and a pair of flanges. In one
10 form, these flanges are generally linear. In that embodiment, fastener means fix the containment sheet to the flanges of the studs preferably adjacent the web so as to inhibit torsional strain at the junction of the flanges and the web.

15 In a second form, the studs include hollow flange elements which are integral with and spaced apart by the web. Preferably the flanges are positioned and shaped to reduce torsional strain at the junctions between the flange elements and the web.

20 In yet a further aspect, the invention provides a modular wall panel comprising two containment sheets formed from sheet metal and spacer means disposed between the containment sheets, the containment sheets being profiled to have linear stiffening formations extending in a first direction to resist outward bowing of the containment sheets in planes
25 extending in the first direction, and wherein the spacer means are in the form of sheet metal studs, the studs being channel shaped and including a web and a pair of flanges which extend laterally from the web, and fasteners fixing the sheets to respective flange elements.

30 There are two classes of embodiments of the invention which incorporate the hollow flange elements. In the first, each stud may be a generally channel sectioned member wherein the hollow flange elements project from one face of the web, in which the width of the junction renders it very resistant to torsional strain. In a second of those classes, each stud may be
35 in the nature of a hollow flanged I-beam of “dumbbell” cross section, wherein the hollow flange elements are preferably circular or triangular in cross section and are symmetrical about the centre plane of the web, in which class the line of action of fastening means may be in substantial

register with the centre plane of the web, so as to substantially eliminate torsional stress on the junction and therefore torsional strain of the junction.

5 Preferably the fastening means penetrates opposing walls of the respective hollow flange elements. This provides a firm affixture of the containment sheets to the studs and is one reason why studs of this particular cross sectional shape are preferred.

10 For preference, the hollow flange elements may be provided with openings along their length to enable, in use, filler material to enter and at least partially fill the hollow within the flange elements thereby to enhance soundproofing and fireproofing the wall panel.

15 In another form, the spacer means includes a plurality of spaced apart anchorage devices affixed to opposing faces of the containment sheets. Preferably each anchorage device on one sheet is in register with a corresponding anchorage device on the other sheet and a plurality of connector elements, wherein the anchorage device and the connector elements have cooperating coupling formations such that each connector
20 elements may be coupled to an anchorage device on one containment sheet and the corresponding anchorage device on the other containment sheet. Preferably this is achieved by the connector element being moved endwisely of itself and of those corresponding anchorage devices to effect mutual engagement of their respective coupling formations.

25 In yet a further aspect, the invention provides a modular wall panel comprising two containment sheets, and a plurality of spacer means disposed between the sheets, the spacer means including a plurality of anchorage devices fixed to opposing faces of the containment sheets and a
30 plurality of connector elements, each anchorage device on one sheet being in register with a corresponding anchorage device on the other sheet, and the anchorage devices and the connector elements having cooperating coupling formations such that each connector element may be coupled to an anchorage device on one containment sheet and the corresponding
35 anchorage device on the other containment sheet so as to interconnect the anchorage devices, the panel being operative to adopt an assembled form where a cavity is formed between the sheets arranged to be filled with a settable material and the spacer means prevent separation of the

containment sheets on filling of the cavity.

Preferably each anchorage device and each connector element is an elongated component extending substantially from one edge of a
5 containment sheet to an opposite edge of the sheet. However, each such elongated anchorage device may be replaced in less preferred embodiments, by a row of spaced apart, short lengths of the elongated device. Thus, the term "anchorage device" as herein is to be construed not
10 only a single elongated item but also a functionally equivalent row of spaced apart, shorter sections of such an item.

Preferably the linear stiffening formations extend horizontally in the finished panel, that is to say the first direction is horizontal. In that event, the second direction is vertical and the spacer means lie in vertical planes.
15 That orientation is preferred as it facilitates the placement of the filling, in that the spacer means than present a minimum of obstruction to the flowing of filling material from the top to the bottom of the cavity between the containment sheets.

20 Preferably the wall panel further includes at least one rigid batten which is secured to an outer surface of one or both of the containment sheets. Preferably each rigid batten extends in the second direction perpendicular to the first direction.

25 In yet another form, the panel includes at least one pair of rigid battens. Each batten in the pair is disposed opposite one another on respective containment sheets and is tied together by tensile means to prevent separation of the battens to thereby resist bowing of the containment sheets in planes extending in the second direction.

30 In a further aspect, the invention relates to a building wall formed using the modular panels and to a method of making a building wall.

Brief Description of the Drawings

35 It is convenient to hereinafter describe an embodiment of the present invention with reference to the accompanying drawings. It is to be appreciated that the particularity of the drawings is to be understood as not

superseding the generality of the preceding broad description of the invention.

In the drawings:

5 Figure 1 is a side elevation of a wall panel according to a first embodiment of the invention;

 Figure 2 is a plan view of the panel of Figure 1;

 Figure 3 is an inverted plan view of the panel of Figure 1;

 Figure 4 is a cross sectional view of a stud, being a component of the panel of Figure 1;

10 Figure 5 is a side elevation of the top portion of the panel of Figure 1 including detailed views of an associated concrete reinforcing component;

 Figure 6 is a view similar to Figure 5 showing a bottom portion of the panel of Figure 1 including a detailed view of a further concrete reinforcing component;

15 Figure 7 is a plan view of a wall panel according to a second embodiment of the invention;

 Figure 8 is a side elevation of the top portion of the panel of Figure 7;

20 Figure 9 is a plan view of a wall panel according to a third embodiment of the invention;

 Figure 10 is a detailed view of a spacer, being a component of the panel of Figure 9;

25 Figure 11 is a plan view of a modular wall panel according to a fourth embodiment of the invention;

 Figure 12 is a detailed view of the material within the enclosure marked (xii) within Figure 11, drawn to a larger scale and omitting the containment sheet appearing in the enclosure;

30 Figure 13 is a perspective sketch of a portion of the modular wall panel according to Figure 11;

 Figure 14 is a side elevation sketch of the subject matter of Figure 12, showing the containment sheet;

35 Figure 15 is a diagrammatic end elevation of the essential components of a continuous clinch forming apparatus showing a containment sheet and an anchorage device being clinched together;

 Figure 16 is a sectional elevation view of a wall system;

 Figure 17 is a plan view of the wall system according to claim 16;

and

Figure 18 is a diagrammatic perspective view of an acoustic barrier used in the wall system of Figure 16.

Detailed Description of the Preferred Embodiments

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The panel 1 illustrated in Figures 1 to 6 includes five upright, substantially parallel, equally spaced apart, sheet-steel studs, namely end studs 7 and 8 and intermediate studs 9.

- 10 Each of the studs is a length of a known structural channel member that may be roll-formed from a sheet-metal strip, for example a strip of steel coated with a protective coating of an alloy of aluminium and zinc. As may best be seen from Figure 3 each stud comprises a web 10 and hollow flanges 11 formed from edge margins of the original strip. The flanges 11
15 display outer walls 12 extending integrally from the web 10 and inner walls 13 terminating in edge margins 14 lying flatly against the web 10. The edge margins 14 may be secured to the web 10 by, for example, spot welds, clinches or other conventional localised fastening means spaced apart regularly along the length of the stud. Alternatively, conventional
20 continuous fastening means may be used, for example, seam welding, crimping or adhesives.

- The panel also includes two sheet-steel containment sheets 15 secured to the studs 7, 8 and 9 by, for example, closely spaced self-tapping screws, pop rivets, or other conventional fastening means. The presently preferred
25 option is self-drilling, self-tapping screws 16, positioned, as shown by their centre-lines in Figure 4, so as to penetrate both of the walls 12 and 13 of the flanges 11. That last mentioned feature provides for a firm affixture of the containment sheets to the studs and is one reason why studs of this particular cross-sectional shape are preferred. Also, as shown in Figure 1,
30 the spacing between the screws 16 may be closer at the lower end of the panel 1 as compared to its upper end so as to accommodate the larger hydrostatic forces that occur at the lower end on filling the panel with a settable material as described in more detail below.

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Each containment sheet 15 is corrugated with the corrugations extending horizontally from one vertical edge of the sheet to the other, as indicated diagrammatically by the horizontal parallel lines appearing in Figure 1.

Such a profile rigidifies the sheet in respect of bowing in horizontal planes. Other rigidifying profiles characterised by elongated zones of the sheet being displaced horizontally from its mid-plane may also be used if desired.

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It will be noted that the stud 7 projects outboard of the adjacent vertical edges of the sheets 15 by a distance approximating one half of the width of the flanges of that stud. It will also be noted that the stud is disposed inboard of the vertical edges of the sheets 15 adjacent to it to the same extent. This is a preferred, but not essential feature of the invention. It facilitates the location and alignment of adjacent panels during their assembly into a finished wall.

For preference battens, for example hat-sectioned, sheet-steel battens 17, are applied to the containment sheets 15 to facilitate the affixture of wall cladding sheets, for example, plaster board sheets, to the panels once they have been assembled into a wall.

Once two or more of the above-described panels have been assembled edge-to-edge in a building wall, concrete or the like may be poured into the cavity between the panels, to add substance to the wall, and render it more sound proof and more fire proof.

In some embodiments, to enhance the sound proofing and fire proofing of the panel, the hollow flange elements may be provided with openings along their length to enable concrete to enter and at least partially fill the hollow within the flange elements.

For preference the concrete filling is reinforced. To that end, a planar grid 18 of reinforcing rods may be provided, in the pre-fabricated panel. That grid may comprise horizontal rods 19 extending through clearance holes in the webs of the studs and held in place by down turned ends, as shown in Figures 5 and 6, and a plurality of horizontal rods 20 tied to the rods 19.

In those instances where the panel is to be incorporated in a multi-storey building and is called upon to support a concrete floor, and may be a superimposed similar panel, the reinforcement provided in the pre-fabricated panel may also comprise "starter" elements 21 intended to be

embedded in the concrete of two pours and bridge the gap between them. In this instance those starter elements may be tubes affixed to an appropriate number of studs by saddles 22 and a fastener extending through a fastened end 23 into and through the web of the relevant stud.

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Figures 7 and 8 illustrate a second embodiment of the panel. As the panel of the second embodiment includes many of the features of the first embodiment illustrated in Figures 1 to 6, like features have been given like reference numerals.

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The second embodiment differs in the construction of the sheet-steel stud, namely end studs 30 and 31 and intermediate studs 32.

The studs 30, 31 and 32 are formed as a simple channel section which
15 comprise a web 33 and sheet flanges 34 which extend from edge margins of the web 33. Typically the studs 30, 31 and 32 are pressed or roll formed from sheet metal strip, for example a strip of steel coated with a protective coating of an alloy of aluminium and zinc.

20 The purpose of the studs 30, 31 and 32 is the same as studs 7, 8 and 9 as disclosed in the first embodiment and as such they are disposed in a similar manner relative to the containment sheets 15. The containment sheets 15 are secured to the studs 30, 31 and 32 via, for example closely spaced self-tapping screws, pop rivets or other conventional fastening means. As in the
25 first embodiment, the preferred option is self-drilling, self-tapping screws 16. Preferably these screws are positioned to extend through the flanges 34 at a location which is immediately adjacent the web 33 of the respective stud. The advantage of this position is that the line of action of the fasteners 16 is close to the centre plane of the web 33 so as to substantially
30 reduce torsional stress induced in the studs.

Similar to the first embodiment, the studs 30, 31 and 32 may include clearance holes in their webs to locate the planar grid 18 of reinforcing rods in the pre-fabricated panel. That grid may comprise horizontal rods 19
35 which extend through the clearance holes 35 and are held in place by downturned ends as shown in Figure 8. In the embodiment of Figure 2, the clearance holes 35 include constricted seats 36 at their opposite upper and lower ends which are arranged to receive the rods 19.

Figures 9 and 10 illustrate a third embodiment of the panel 1. Again the third embodiment includes many of the features of the previous two embodiment and like features have been given like reference numerals.

5 In the third embodiment of Figures 9 and 10, the containment sheets 15 are maintained in at least one location at a predetermined spacing by a spacer assembly 40 and are sandwiched between two of the battens 17. In the illustrated form, the battens are formed from sheet metal but it is to be appreciated that they could also be made from timber if desired.

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In the illustrated form, the two battens 17 are fixed together by tensile ties 41 and/or spacers 42 separating the containment sheets 15. Each tie may be an elongated bolt and nut combination, a threaded rod in combination with two nuts or other tensile elements. Each spacer may be a sheet-steel,
15 angle section member or the like element able to withstand axial compression, and may be staked through the containment sheets into the battens. Preferably the spacer ends 43, apart from the self-nailing or staking formations, are profiled to correspond to the profile of the containment sheet so as to make substantially full line contact therewith.

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Thus, in all instances, the containment sheets 15 and the battens 17 are held fixably together at a predetermined spacing and the battens serve to resist bowing of the containment sheets in vertical planes.

25 The end battens 17 register with the stud 31 and are applied to the containment sheets to facilitate the affixture of wall cladding sheets, for example, plaster board sheets, to the panels once they have been assembled into a wall.

30 In an alternative arrangement, not shown, the ties may also function as spacers. For example, they may comprise rods with intermediate abutments in contact with the inner surface of the containment sheets and end abutments, for example, rivet heads or push-on fixes, in contact with the outer surface of the battens. Conveniently those rods may be externally
35 threaded and the abutment may be conventionally internally threaded nut engaged therewith.

Yet a further embodiment of the invention is disclosed with reference to Figures 11 to 15. Again the fourth embodiment of the invention includes many of the features of the earlier embodiments and like features have been given like reference numerals.

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As illustrated in Figures 11 to 13, the panel comprises two containment sheets 15, each furnished with five anchorage devices 50 and five connector elements 51. All those components are preferable made of coated, sheet-steel.

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As in the earlier embodiments, each containment sheet 15 is corrugated with the corrugations extending horizontally from one vertical edge of the sheet to the other. Each anchorage device 50 is generally angle-sectioned strip comprising an affixture flanges 52, whereby it may be fixed to a containment sheet 15 so that it extends substantially vertically from the bottom to the top of the containment sheet, and a hook sectioned coupling flange 53. The affixture flange 52 may be planar.

Alternatively it may be at least partly profiled to enable it to make area contact with the inner surface of the adjacent containment sheet 15. It will be noted that the rightmost anchorage devices 50 (as seen in Figure 11) are disposed inboard of the adjacent vertical edges of the sheets 15 by a distance approximating one half of the width of the flanges 52. It will also be noted that the flanges 52 of the leftmost anchorage devices 50 project outboard of the vertical edges of the sheets 15 to a similar extent. This is a preferred, but not essential, feature of the invention. It facilitates the location and alignment of adjacent panels during their assembly into a finished wall.

The anchorage devices 50 may be secured to the respective containment sheets 15 by any suitable fastening means. However for preference they are clinched to the sheets by row of clinches 54. That preference arises because of the speed with which multiple clinches may be applied by a continuous clinching apparatus.

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Such an apparatus is described in some detail in the complete specification of Australian Patent No. 675590 (BHP Steel (JLA) Pty Ltd). Briefly stated such apparatus comprises a rotary die assembly 100 and a co-acting rotary

- punch 101, between which two workpiece sheets to be clinched together, in this instance a containment sheet 15 a affixture flange 52, are passed. The apparatus acts to cut two parallel slits in the sheets, depresses a centre part of the material between the slits until it is clear of the sheets, and then
- 5 compresses the centre part to cause it to expand laterally so that it cannot thereafter return between the slits. Thus, continuous clinching lends itself to automatic operation, produces an effective affixture between the workpiece sheets and avoids the need for additional fastening devices.
- 10 Preferably, clinching apparatus used in the manufacture of panels according to the invention is a gang apparatus, able to clinch all of the anchorage devices to each containment sheet in a single pass.
- Each connector element 51 comprises body strap 55 with hooked coupling
- 15 flanges 56 extending along its vertical edges. It will be apparent that each connector element 51 may be moved endwisely of itself and of the corresponding anchorage devices 50 to cause their respective coupling flanges 56 and 53 to mutually engage, as may best be seen in Figure 12, to couple those components together. Following which the containment
- 20 sheets are held in the required spaced apart configuration and the connector elements are effective to resist bowing of those sheets transversely of the vertical direction.
- As in the earlier embodiments, once two or more of the above-described
- 25 panels have been assembled edge-to-edge in a building wall and secured together by fasteners extending through overlapping portions of mating containment sheets and anchorage device affixture flanges, concrete or a like filler material may be poured into the cavity between the panels, to add substance to the wall, and render it more sound proof and more fire proof.
- 30 Preferably the body straps 55 of the connector elements 51 are pierced by one or more openings 57 to enable filling material to flow from one side of each connector element to the other.
- 35 The couplings between the anchorage devices 50 and the connector elements 51 preferably provide for some play to facilitate the insertion of the connector elements. For this reason the rectangular shape of the panel as seen in Figure 11 may relax into a near rectangular parallelogram during

transport and handling of an assembled panel before the filling is put in place and allowed to set. To obviate this effect a U-shaped clip or anti-racking strap 58 may be tightly applied to an edge of the panel. That clip becomes redundant once the filling has set and may then be removed or left
5 in place at the option of the person building the wall.

Figures 16 and 17 illustrate a wall system 70 installed between two adjacent floors (103, 104) of a multistorey building. The wall system 70 incorporates the panel 1 which spans the adjacent floors and which is filled
10 with concrete 71. For ease of illustration, the steel reinforcement which locates within the concrete 71 is omitted.

The wall system 70 is designed to have good acoustic characteristics. This is achieved in part by the fact that the panel 1 is filled with concrete.
15 However, to render the wall system 70 more soundproof, an additional metal cladding panel 72 is incorporated within wall system 70. The wall panel 72 is made from sheet metal and profiled to include a plurality of ribs 73 which extend vertically along the entire length of the panel 72.

20 The ribbed panel 72 is mounted parallel to the panel 1 but is spaced from the containment sheet 15 so as to provide an air gap 79 between the panel 72 and the containment sheet 15. As best illustrated in Figure 16, the panel 72 is secured to fixing angles 76, 77 which are secured to the floors 103,104.

25 The wall system 70 includes facing sheets 74, 75 which are typically formed from plaster board. On one side of the wall the facing sheet 75 is mounted directly to battens 17 which are mounted to the containment sheet 15 of the panel 1 as described earlier. On the other opposite side of the wall
30 70, the facing panel 74 is mounted directly on the ribs 73 of the metal panel 72.

The panel 72 also includes service holes 78 which extend through the opposing side walls of the individual ribs 73. In this way electrical and
35 plumbing services can run horizontally through the service holes 78 or vertically within the cavity formed on the inner side of the ribs 73. In addition, whilst not shown, the panel 72 may incorporate insulation bonded to the inner side of the steel sheet.

An advantage of the wall system 70 is that it provides a high resistance to sound penetration in a relatively thin section wall. Typically the thickness of the wall system would be in the order of 200mm, although it is to be
5 appreciated that the dimensions could vary depending on the design requirements.

It is to be appreciated that variations and/or modifications may be made to the parts previously described without departing from the spirit or ambit of
10 the invention.

Claims

1. A modular wall panel comprising two containment sheets formed from sheet metal, and spacer means disposed between the containment
5 sheets and fixed thereto so as to prevent separation of the containment sheets, the wall panel being arranged to be filled with a settable material and wherein, to resist hydrostatic pressure induced on filling the panel with the settable material, the containment sheets are profiled to have linear stiffening formations extending along the sheets in a first direction to resist
10 outward bowing of the containment sheets in planes extending in the first direction, and the spacer means extend along the containment sheets in a direction transverse to the first direction so as to resist bowing of the containment sheets in planes extending in a second direction perpendicular to the first direction.
- 15 2. A modular panel according to claim 1, wherein the spacer means are disposed at or near respective opposite edges of the panel, and one of the spacer means is inboard of the edges of the containment sheets adjacent to it and the other spacer means outboard of the edges of the containment sheets adjacent to it.
- 20 3. A modular panel according to claim 2, wherein the distance the spacer means are disposed either inboard or outboard of the respective opposite edges of the panel is substantially the same.
4. A modular wall panel according to any preceding claim, wherein the stiffening formations are profiled to include elongated zones which are
25 displaced longitudinally from a midplane of the respective sheet.
5. A modular wall panel according to any preceding claim, wherein the stiffening formations are profiled to include corrugations extending from one edge of the sheet to the other.
6. A modular wall panel according to any preceding claim, further
30 comprising at least one rigid batten secured to an outer surface of one or both of the containment sheets, and extending transverse to the linear stiffening formations.
7. A modular wall panel according to claim 6, wherein the panel includes at least one pair of the rigid battens, each batten in the pair being
35 disposed opposite one another on respective containment sheets and being tied together by tensile means to form one of the spacer means.
8. A modular wall panel according to any preceding claim, wherein the spacer means are in the form of a sheet metal studs, the studs being

channel shaped and includes a web and a pair of flanges which extend laterally from the web, and fastener means affixing the sheets to respective flange elements.

- 5 9. A modular wall panel comprising two containment sheets formed from sheet metal and spacer means disposed between the containment sheets, the containment sheets being profiled to have linear stiffening formations extending in a first direction to resist outward bowing of the containment sheets in planes extending in the first direction, and wherein the spacer means are in the form of sheet metal studs, the studs being
- 10 channel shaped and including a web and a pair of flanges which extend laterally from the web, and fasteners fixing the sheets to respective flange elements.
- 15 10. A modular wall panel according to claim 9, wherein the spacer means extend along the sheets in a direction transverse to the first direction so as to resist bowing of the containment sheets in planes extending in a second direction perpendicular to the first direction.
- 20 11. A modular panel according to any one claims 8 to 10, wherein the fasteners affix the containment sheets to the flanges of the studs adjacent said web so as to inhibit torsional strain at the junction of the flanges and the web.
12. A modular panel according to any one of claims 8 to 11, wherein the flanges are formed as hollow flange elements.
13. A modular wall panel according to claim 12, wherein the hollow flange elements project substantially from one face of the web.
- 25 14. A modular wall panel according to claim 12, wherein each stud is generally in the form of a hollow flanged I-beam, wherein the hollow flange element projects from both faces of the web.
15. A modular wall panel according to any one of claims 12 to 14, wherein the hollow flange elements are generally triangular in cross
- 30 section.
16. A modular wall panel according to any one of claims 12 to 15, wherein the hollow flange elements include openings along their length to enable, in use, filler material to enter and at least partially fill the hollow within the flange elements.
- 35 17. A modular wall panel according to any one of claims 12 to 16, wherein the fastening means extends through opposite walls of the respective flange elements.

18. A modular wall panel according to any one of claims 1 to 7,
wherein the spacer means include a plurality of spaced apart anchorage
devices affixed to opposing faces of the containment sheets, wherein each
5 anchorage device on one sheet is in register with a corresponding
anchorage device on the other sheet, and a plurality of connector elements
wherein the anchorage devices and the connector elements have
cooperating coupling formations such that each connector element may be
coupled to an anchorage device on one containment sheet and the
10 corresponding anchorage device on the other containment sheet by being
moved endwisely of itself and of those corresponding anchorage devices to
effect mutual engagement of their respective coupling formations.

19. A modular wall panel according to claim 15, wherein each
anchorage device and each connector element is an elongated component
15 extending substantially from one edge of a containment sheet to an
opposite edge of the sheet.

20. A modular wall panel comprising two containment sheets, and a
plurality of spacer means disposed between the sheets, the spacer means
including a plurality of anchorage devices fixed to opposing faces of the
20 containment sheets and a plurality of connector elements, each anchorage
device on one sheet being in register with a corresponding anchorage
device on the other sheet, and the anchorage devices and the connector
elements having cooperating coupling formations such that each connector
element may be coupled to an anchorage device on one containment sheet
25 and the corresponding anchorage device on the other containment sheet so
as to interconnect the anchorage devices, the panel being operative to adopt
an assembled form where a cavity is formed between the sheets arranged to
be filled with a settable material and the spacer means prevent separation of
the containment sheets on filling of the cavity.

30 21. A modular panel according to claim 20, wherein each connector
element may be coupled to an anchorage device on one containment sheet
and the corresponding anchorage device on the other containment sheet by
moving endwisely of itself and of those corresponding anchorage devices
to effect mutual engagement of their respective coupling formations.

35 22. A modular panel according to either claim 20 or 21, wherein each
anchorage device and each connector element is an elongated component
extending substantially from one edge of a containment sheet to an
opposite edge of the sheet.

23. A modular panel according to any one of claims 20 to 22, wherein the containment sheets are formed from sheet metal.

24. A modular panel according to claim 23, wherein the containment sheets are profiled to have linear stiffening formations extending in a first
5 direction to resist outward bowing of the containment sheets in planes extending in the first direction, and the spacer means are mounted to the containment sheets so as to resist bowing of the containment sheets in planes extending in a second direction perpendicular to the first direction.

25. A modular panel according to claims 23 or 24, wherein the
10 anchorage devices are formed from metal brackets that include flanges that abut the containment sheets and are retained in engagement by clinches formed between the flanges and the containment sheets.

26. A modular panel according to one of claims 20 to 25, wherein the panel is movable from a collapsed form where the containment sheets are
15 in close proximity, to the assembled form and wherein the spacer means are movable from a first to a second position to allow the panel to move from its collapsed to its assembled form.

27. A modular panel according to claim 26, wherein the spacer means are operative to move between their first and second positions by relative
20 rotation of the connector elements relative to the anchorage devices to which they are coupled.

28. A modular panel according to any one of claims 1 to 8 and 10 to 18, wherein the spacers means extend in the second direction.

29. A modular wall panel according to any preceding claim, further
25 comprising a planar grid of reinforcing, the reinforcing being aligned generally parallel with, and disposed between, the containment sheets and being supported by the spacer means.

30. A modular wall panel according to claim 29, wherein the reinforcing includes horizontal rods which locate on seats disposed in the
30 spacer means.

31. A modular wall panel according to any preceding claim, including starter elements which extend from at least one of the upper or lower edges of the panel.

32. A building wall including a plurality of modular wall panels
35 according to any preceding claim, the panels being assembled edge to edge so that the containment sheets of the panels align to form a pair of containment walls of the building wall, wherein the cavity formed between the containment walls are filled with a settable material.

33. A building wall according to claim 32, wherein a plurality of rigid battens are secured to an outer surface of at least one of the containment walls.

5 34. A building wall according to claim 33, further including at least one facing panel which is secured to the battens of the at least one containment wall.

35. A building wall according to any one of claims 32 to 34, further comprising at least one acoustic panel which is disposed generally parallel to at least one of the containment walls, the acoustic panel being spaced
10 from said containment wall so as to form an air gap therebetween.

36. A building wall according to claim 35, wherein the acoustic panel is formed from a profiled metal sheet and incorporates longitudinal extending ribs.

37. A building wall according to claim 35, further including at least one
15 facing panel which is secured to the ribs of the acoustic panel.

38. A method of making a building wall including the steps of:

- (i) rigidising two metal sheets by roll-forming or press-forming linear stiffening formations therein,
- (ii) affixing a plurality of spaced apart anchorage devices to one
20 face of each of the rigidised sheets such that the anchorage devices extend along the sheets transversely of the stiffening formations,
- (iii) joining the sheets together by securing a connector element to each anchorage device on one sheet to a corresponding anchorage device on the other sheet, and
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- (iv) substantially filling the cavity between the sheets with a settable filling material.