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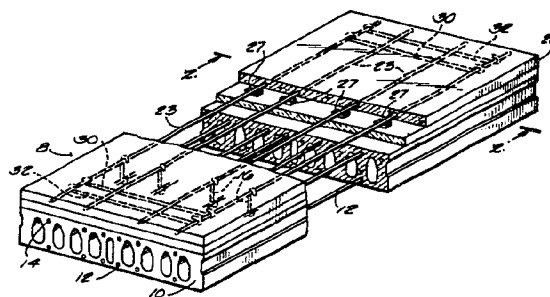
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Designated Contracting States: **CH DE GB LI SE**

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Concrete sandwich panel.

A concrete sandwich panel includes a structural pre-cast concrete panel (10), an insulative panel (20) and an outer decorative concrete panel (25). The inner (10) and outer panels (25) are integrally connected by C-shaped metal ties (16) which connect reinforcing rods (23) in the inner (10) and outer layers (25).



CONCRETE SANDWICH PANEL

To enhance the insulating capability of precast concrete wall panels, laminas of insulation have been inserted
5 between an inner structural concrete wall panel and an outer decorative concrete face panel or shell. In such constructions it is desirable that the assembly be tied together to provide no significant movement of the various lamina relative to each other. It is necessary that the
10 face panel be sufficiently integrated with the structural panel to prevent inadvertant loss thereof such as sliding off of the face shell during shipment or erection or pulling off due to wind suction. However, because of the non-uniform temperature gradient through the cross-section of
15 the composite panel differential temperature effects could cause thermal cracking of either the structural or face panel if there is no flexibility or capability of yielding in the connection between the panels. If the elastic behaviour of the sandwich wall panel is totally
20 composite there is a greater potential for thermal cracking. The present invention provides a tie system to integrate the face panel, insulation panel and structural panel to provide good performance and minimize thermal cracking and also provide sufficient integrity to maintain
25 a tight interface between the insulation and structural panel and prevent the entry of water therebetween.

According to the present invention there is provided a precast insulative concrete panel construction comprising

a first concrete panel section having longitudinally extending reinforcing rods, insulative panel sections super-imposed on said first panel section and having gaps between said sections, a second concrete panel section
5 having corresponding longitudinally extending reinforcing rods and tie means to connect said reinforcing rods of said first and second panels, to maintain said panels in unitary assembly and to allow for non-composite expansion and contraction of said panels due to temperature differ-
10 entials so that cracking of said panels due to temperature changes is minimized.

Preferably, the tie means comprises C-shaped ties having allochiral hook end portions with said end portions
15 engaged with said reinforcing rods and said ties having a thickness greater than 3.76 mm (.148 inches) and less than 12.7 mm (.5 inches).

The invention further provides a method of making a
20 composite concrete insulative panel comprising the steps of:

(a) extruding a first concrete panel section with a first set of longitudinally extending reinforcing rods;
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(b) applying an insulative panel in superimposed relationship on said first panel;

(c) inserting connector ties in engagement with the
30 reinforcing rods of said first panel section prior to setting of the concrete in said first section;

(d) applying a second insulative panel to support the connector ties between the first and second insulative
35 panel section;

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(e) supporting a second set of reinforcing rods above said insulative panels in engagement with the upstanding connector ties; and

5 (f) extruding a second concrete wall panel over said insulative panel sections.

10 The invention provides a sandwich wall panel and method of making the same which includes an insulative lamina sandwiched between a structural concrete panel and a concrete face panel. A system of integrating the panel sections and insulative lamina is provided which minimizes composite action of the panel under stress which could lead to thermal cracking due to differential temperature effects. The structure which integrates the three lamina maintains a tight interface between the insulation and the structural panel. In the preferred embodiment C-shaped ties connecting longitudinally extending reinforcing rods in both concrete panels and having a diameter of 6.35 to 4.76 mm (of 1/4 to 3/16 inch) were found to provide the desired balance between rigidity and non-composite action.

25 The method of the invention relates to the assembly of the panels wherein the C-ties are held in place, while the cast structural panel is wet, by the abutting ends of the overlying blocks of insulation. The abutting ends are pressed against the C-ties with the lower hook of the C-ties engaged with the reinforcing rods in the lower panel. The reinforcing rods for the face panel are pressed into the upper curves of the C-ties by blocks of wood supported on the insulation to properly orient and position the reinforcing rods in the upper hook portions and support the reinforcing rods until the face panel has cured.

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Further objects and features of the invention will become apparent from the disclosure.

One embodiment of the invention will now be described by way of example reference being made to the accompanying drawings in which:-

Fig. 1 is a perspective view with parts broken away showing the composite panel of the invention.

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Fig. 2 is an enlarged sectional view along line 2-2 of Fig. 1.

Fig. 3 is a plan view of the panel shown in Fig. 1 prior to deposition of the face panel.

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Fig. 4 is a schematic diagram of the steps of the method of making the panel.

Fig. 5 is a chart comparing test deflections data using 4.76 mm (3/16 inch) ties under main span load with theoretical composite and non-composite deflection.

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Fig. 6 is a chart similar to Fig. 5 using a 6.35 mm (1/4 inch tie).

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Fig. 7 is a chart similar to Fig. 5 showing deflection in a cantilever load test with a 4.76 mm (3/16 inch) tie.

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Fig. 8 is a chart similar to Fig. 7 of a cantilever load test with a 6.35 mm (1/4 inch) tie.

Although the disclosure hereof is detailed and exact to enable those skilled in the art to practice the invention,

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the physical embodiments herein disclosed merely exemplify the invention which may be embodied in other specific structure. The scope of the invention is defined in the claims appended hereto.

5.

In the drawings, Fig. 1 shows a sandwich panel 8 which includes a pre-stressed concrete structural panel section 10 which can be formed by an apparatus such as that shown in U.S.-A-3,382,304 or U.S.-A-3,979,171. The panels can be 10.16 cm., 15.24 cm., 20.32 cm., 25.4 cm., 30.48 cm., (four inches, six inches, eight, ten or twelve inches) thick. Typically, wall panels are 15.24 cm or 20.32 cm (six or eight inches) thick.

15 As the wall panel 10 is being extruded, pre-cut pieces of insulation 20, 101.6 cm (forty inches) wide and 121.92 cm (four feet) long are superimposed on the wet concrete panel section 10. Next, C-shaped ties 16 preferably formed from stainless steel are embedded in the panel and, as illustrated in Fig. 2, hooked around the strands 14. The connector ties 16 have hook shaped ends in allochiral relation. The C-ties 16 are positioned between the abutting ends 21 between adjacent insulative panels 20, as illustrated in Fig. 1 and 3. The insulative panels 20 are pressed together as the C-ties are inserted to support them in wet concrete. After the insulative panels are applied and the C-ties inserted and held in an upright position, four more reinforcing rods are laid on top of the insulation and supported in spaced relation above the insulation with small pieces of wood 27. The pieces of wood are sized to press the reinforcing rods 23 in the upper hooks of the C-ties in a tight fit. Cross ties 30 and 32 are also connected to the reinforcing rods to minimize cracking of the panel ends. A 5.08 cm (two inch) layer of concrete is then extruded on top of the insulation, encasing the top four strands, the ties and end

cross bars to form the face panel 25. The assembly is then cured overnight and the planks are cut to length and stockpiled and shipped.

- 5 The C-ties 16 can be arranged in a pattern as illustrated in Fig. 3, with four C-ties adjacent the ends of the panel, with two C-ties staggered at spaced intervals along the length of the panel. With the use of 121.92 cm (4 foot) insulation panels the C-ties 16 are spaced at
10 121.92 cm (4 foot) intervals.

Because of the insulation lamina which isolates the face panel 25 from the structural panel 10 there normally will be a non-uniform temperature gradient through the sandwich
15 panel. Accordingly the means tying the first and second panels together must accommodate thermal expansion of the panels to avoid thermal cracking. It has been found that C-shaped connectors made from 4.76 mm to 6.35 mm (3/16 inch or 1/4 inch) wire rod have been suitable to provide
20 non-composite action between the face and structural panels yet maintain sufficient integrity of the panel so the face is not lost during handling or erection or by wind suction, etc.

- 25 Tests were conducted to compare the measured deflection of the face panel with the theoretical composite deflection and the theoretical non-composite deflection when a load was applied to the structural panel. Bars measuring 3.175 mm by 25.4 mm (1/8 inch by 1 inch) were tested as
30 ties between the panels and were found to provide too much composite action which could lead to panel cracking due to differential temperature effects.

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$$\begin{bmatrix} 2 \\ 3 \end{bmatrix}$$

→ Figures ⁵4, ⁶5, ⁷6 and ⁸7 illustrate comparison of test results with theoretical calculated composite and non-composite deflections. In the tests a face tie arrangement such as that shown in Fig. 1 was employed with the ties at a 121.92 cm (4 foot) spacing. The structural panel cross-section was 15.24 cm (6 inch) pre-stressed with 5.08 cm (2 inches) of urethane insulation plus a 5.08 cm (2 inch) thick facing panel. The tests involved a panel 8.38 m (27 feet 6 inches) in length. The panels were supported at two points 160 cm (5 feet 3 inches) from the ends. The panels were loaded up by piercing the face panel and insulation and applying the load directly on the panel 10 and deflections were measured. Both cantilever and main span tests were performed. Figures ⁵4 and ⁶5 show deflection in inches (1 inch = 2.54 cm) and the load in pounds (1 pound = 0.454 kg) with the measured deflections for two separate main span tests indicated by curves A and B. These curves show essentially a non-composite action of the outer and inner panels which is suitable for a commercial sandwich panel. Similarly the → Figures ⁷6 and ⁸7 show a non-composite action in cantilever tests using the 4.76 mm and 6.35 mm (3/16 and 1/4 inch) ties. In prior tests with the use of flat iron ties 3.175 mm by 25.4 mm (1/8 by 1 inch) the test results provided a curve close to the theoretical composite deflection curve. With 9 gauge ties 3.76 mm (.148 inches) the test results provided a curve closer to the theoretical non-composite curve.

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The request for correction is allowed under R. 88 EPC / with the exception of the deleted points/.

THE HAGUE, 29. 06. 82

RECEIVING SECTION

R. K. VERHAGE

CLAIMS:

1. A precast insulative concrete panel construction comprising a first concrete panel section having longitudinally extending reinforcing rods, insulative panel sections superimposed on said first panel section and having gaps between said sections, a second concrete panel section having corresponding longitudinally extending reinforcing rods and tie means to connect said reinforcing rods of said first and second panels, to maintain said panels in unitary assembly and to allow for non-composite expansion and contraction of said panels due to temperature differentials so that cracking of said panels due to temperature changes is minimized.

2. The panel construction of Claim 1 wherein said tie means comprises C-shaped ties having allochiral hook end portions with said end portions engaged with said reinforcing rods and said ties having a thickness greater than 3.76 mm (.148 inches) and less than 12.7 mm (.5 inches).

3. The method of making a composite concrete insulative panel comprising the steps of:

(a) extruding a first concrete panel section with a first set of longitudinally extending reinforcing rods;

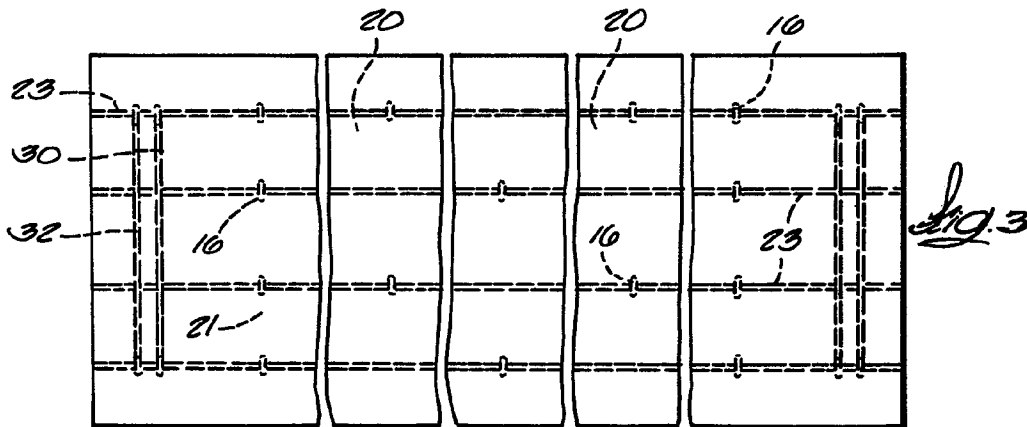
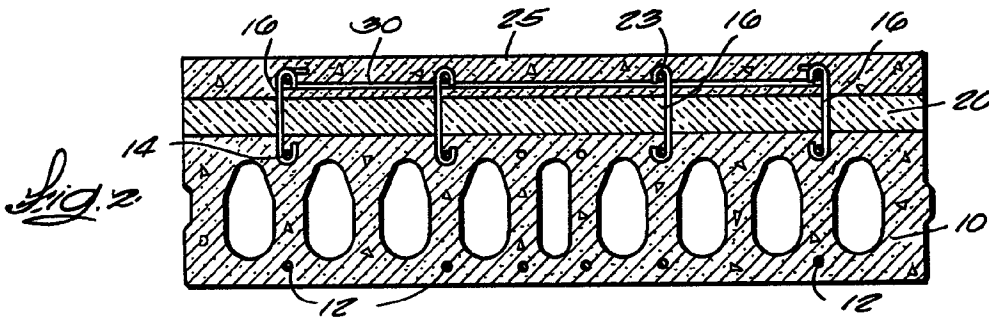
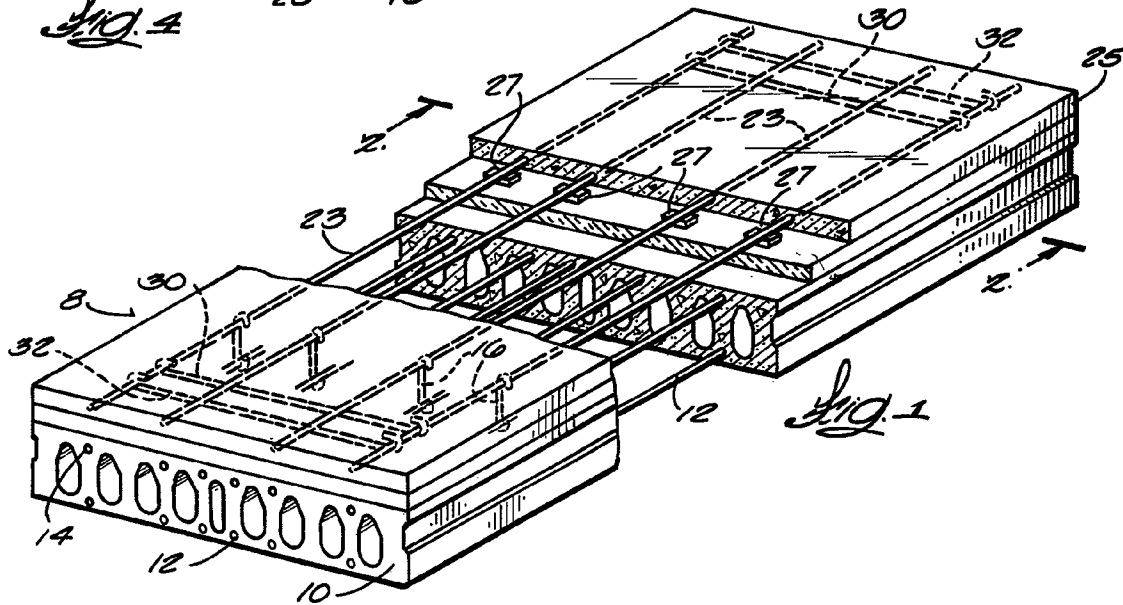
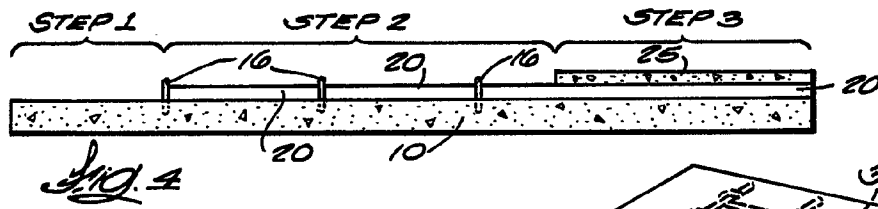
(b) applying an insulative panel in superimposed relationship on said first panel;

(c) inserting connector ties in engagement with the reinforcing rods of said first panel section prior to setting of the concrete in said first section;

(d) applying a second insulative panel to support the connector ties between the first and second insulative panel section;

5 (e) supporting a second set of reinforcing rods above said insulative panels in engagement with the upstanding connector ties; and

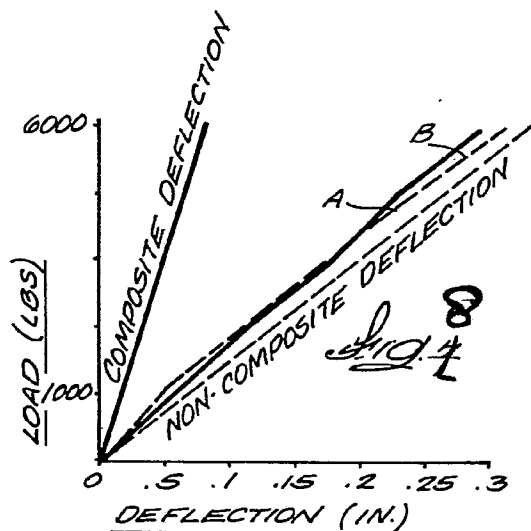
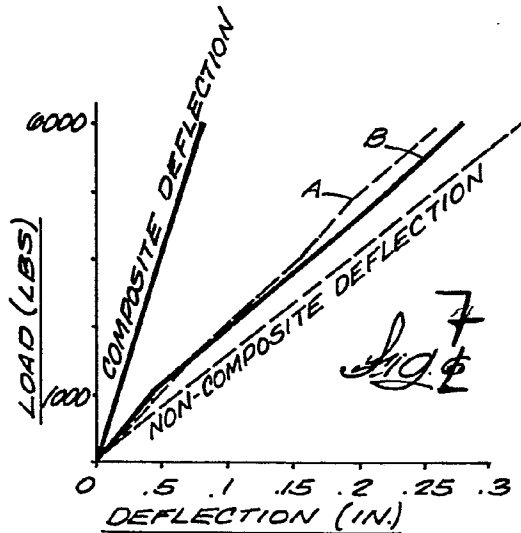
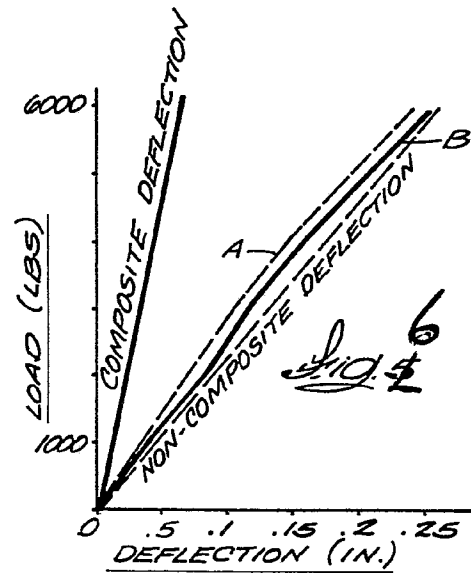
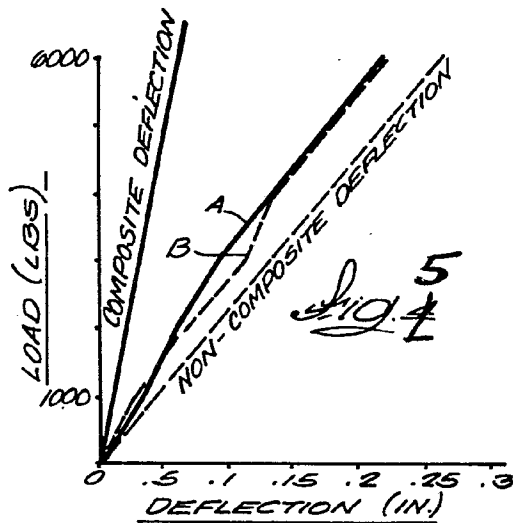
(f) extruding a second concrete wall panel over said
10 insulative panel sections.



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The request for correction is allowed under R. 88 EPC / with the exception of the deleted points /.

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EUROPEAN SEARCH REPORT

0066979

Application number

EP 82 30 2514

DOCUMENTS CONSIDERED TO BE RELEVANT			
Category	Citation of document with indication, where appropriate, of relevant passages	Relevant to claim	CLASSIFICATION OF THE APPLICATION (Int. Cl. 3)
X	US-A-3 494 088 (KORNER) * Column 3, lines 18-50; figure 3 *	1,3	E 04 C 2/26 B 28 B 19/00

X	FR-A-2 088 543 (WAERNER) * Page 2, lines 38-40; page 3, lines 1-16; figure 1 *	1,2	

X	FR-A-1 508 689 (HAEUSSLER) * Page 2, column 2, lines 29-61; page 3, column 1, lines 1-38; figure 1 *	1	

A	DE-B-1 708 768 (JAKOBSEN) * Column 2, lines 49-63; figures *	1	

A	FR-A- 741 494 (LASSAILLY) * Page 2, column 1, lines 5-41; figures *	1,2	TECHNICAL FIELDS SEARCHED (Int. Cl. 3)

A	AT-B- 323 381 (KRANEBITTER) * Page 2, lines 34-60; page 3, lines 1-8; figure 2 *	1-3	E 04 C B 28 B

The present search report has been drawn up for all claims			
Place of search THE HAGUE		Date of completion of the search 31-08-1982	Examiner DALL' ANESE D.D.
CATEGORY OF CITED DOCUMENTS			
X : particularly relevant if taken alone Y : particularly relevant if combined with another document of the same category A : technological background O : non-written disclosure P : intermediate document		T : theory or principle underlying the invention E : earlier patent document, but published on, or after the filing date D : document cited in the application L : document cited for other reasons & : member of the same patent family, corresponding document	