

- [54] **FACADE COMPOSITE PANEL ELEMENT**
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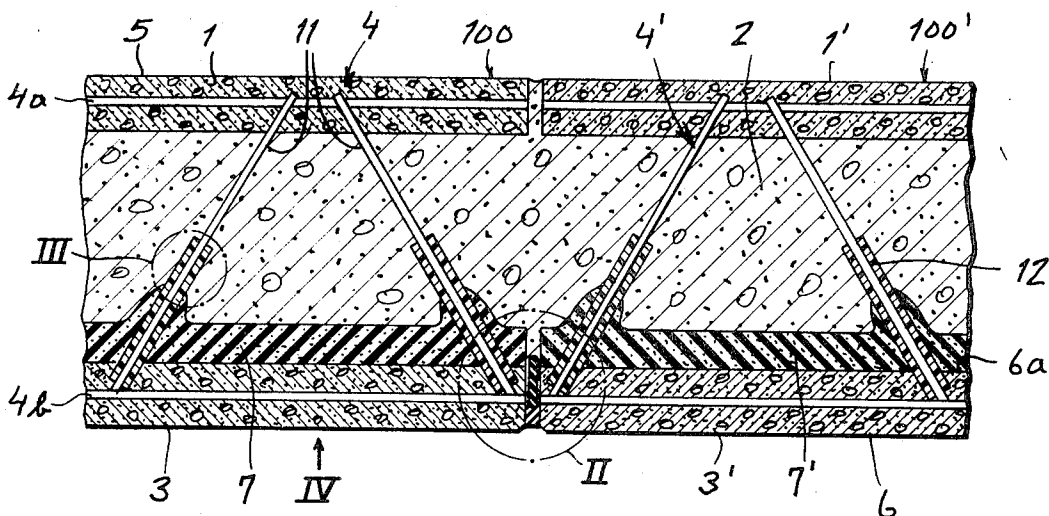
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[57] ABSTRACT

A facade-forming structural element comprises an outer slab of concrete or of like composition, an inner wall-forming slab of concrete or like composition, a core between the slabs and preferably cast in place from a gravel-containing concrete, and at least one single-shear section lattice-like reinforcing girder spanning the two slabs and embedded therein. A layer of foamed insulation, e.g., polyurethane, is disposed between the core and the facade-forming outer slab.

7 Claims, 5 Drawing Figures



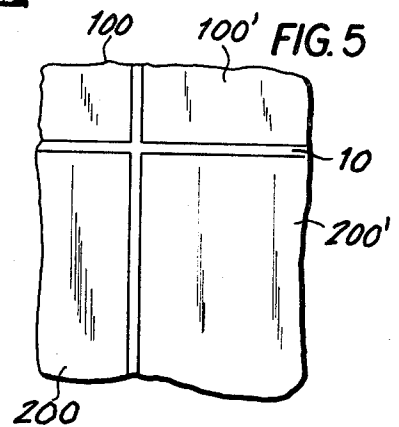
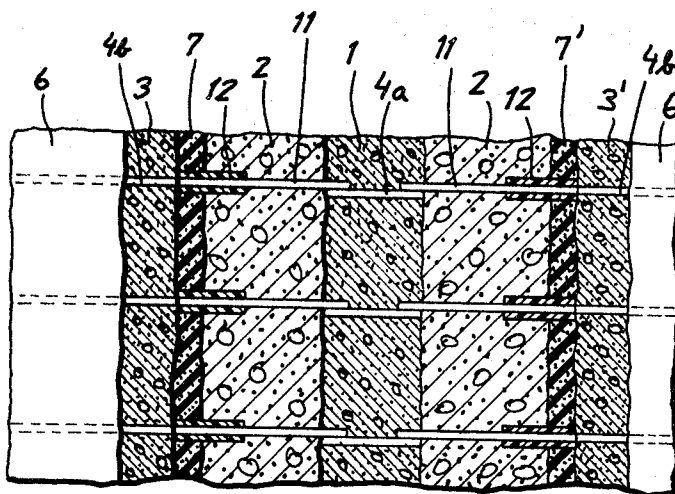
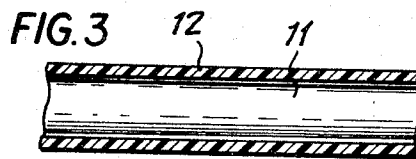
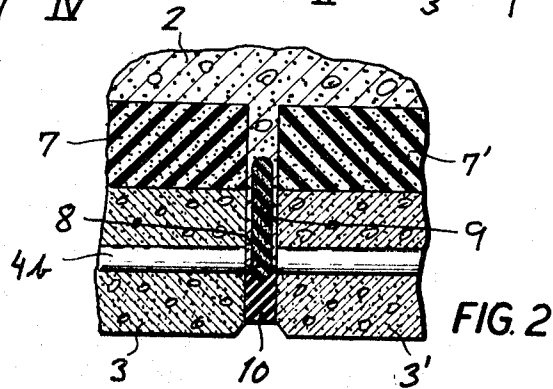
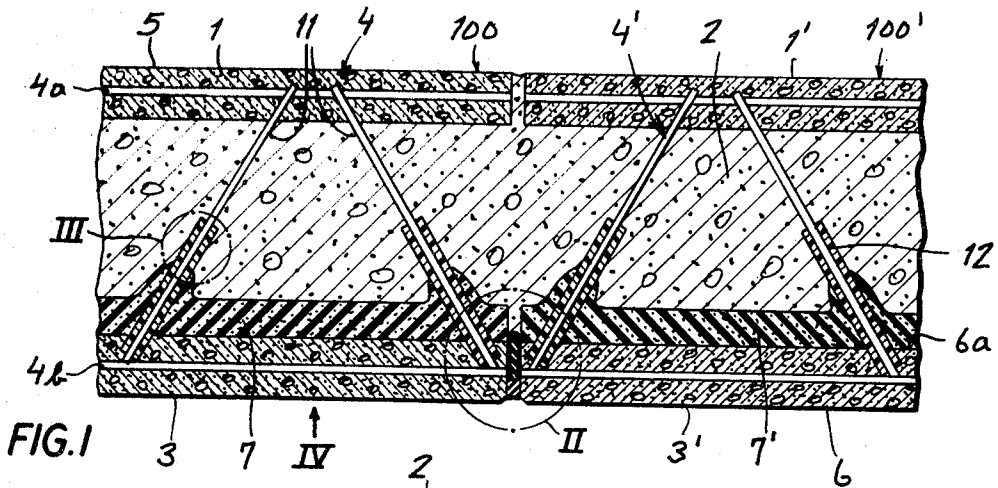


FIG. 4

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FACADE COMPOSITE PANEL ELEMENT

FIELD OF THE INVENTION

My present invention relates to sandwich plates, laminated wall structures and, especially, facade-forming building elements having an insulating character. More particularly, the invention relates to a facade-forming element for building construction in which the outer layer can form the outer finished surface of the building, the inner layer can form an internal wall thereof and a sandwich-type construction is provided to afford thermal and acoustical insulation.

BACKGROUND OF THE INVENTION

The requirements of modern construction have resulted in the development of new construction techniques for high-rise and other buildings whereby, to a large measure, portions of the structure are prefabricated (off-site construction) and are erected at the building location. It is known, in this connection, to provide sandwich constructions which have inner and outer facing elements, e.g., boards or slabs, which are joined together in a laminated or sandwich slab which can be erected on the building framework by bolting or the like. For the most part, sealing strips are provided between adjoining sandwich slabs. The term "sandwich" is used to indicate the fact that at least three layers are involved, the first being an outer layer which may form the facade and may be composed of concrete cast in the form of a plate or composed of cut stone such as marble. The inner slab, which may form an interior wall of the structure, may also be composed of concrete cast in the form of a plate, of a synthetic stone, of a natural stone or of nonmineral substances. An intervening layer of thermal insulation is generally provided between the slabs and has a dual function, namely, that of bonding the slabs together and that of constituting a heat and sound barrier. The sandwich elements can be mounted upon a masonry, structural steel or reinforced concrete framework, or upon masonry or concrete walls to improve the appearance of structure.

Conventional systems of the type described, in which facade-forming structural elements are constituted of sandwich slabs or laminated structures, is that a purely insulating layer between the inner and outer slabs or plates (shells) cannot provide the structural strength needed for maintaining the relative position of the inner and outer slabs or shells or permit the structural elements to resist compressive and shear forces. Furthermore, the insulation becomes less effective in structural terms as the spacing between the inner and outer slabs increases. In other words, the static strength of a facade-forming element according to conventional sandwich-structure techniques is unsatisfactory or insufficient. Also the insulating quality of conventional systems is poor.

OBJECTS OF THE INVENTION

It is the principal object of the present invention to provide an improved facade-forming element for building structures and the like which have greater structural strength and which is able to avoid the other disadvantages of conventional sandwich-type structures.

It is another object of the invention to provide an economically produced, conveniently erected, relatively inexpensive, long lasting and structurally strong

construction element of the character and for the purposes described.

Yet a further object of the invention is to provide a facade-forming structural element which affords permanent and high-strength bonding of inner and outer slabs together and yet provides a high degree of thermal and acoustical insulation.

SUMMARY OF THE INVENTION

These objects and others which will become apparent hereinafter are attained, in accordance with my present invention which provides a facade-forming element comprising an outer facade-or facing slab, an inner slab preferably having an inwardly facing surface designed to form an interior wall and spaced from but generally parallel to the facade slab, at least one single-shear truss-like reinforcement lattice embedded in each of the slabs and having diagonal struts extending across the space between them, a layer of gravel-containing concrete — preferably cast in place — in the space between the slabs and embedding the struts, and an insulating layer, preferably of a foamed synthetic resin, elastomer or rubber, interposed between the outer slab and the gravel-concrete core. The key elements of the facade-forming structure according to the invention are thus an inner shell or slab, a core bonded to the inner shell or slab and an outer shell or slab bonded to this core. The core comprises a filler of the gravel concrete, preferably cast in place, the struts embedded in this gravel concrete and spanning the slabs, and a layer between the gravel concrete and the outer slab of a thermal and acoustical insulation. This insulating layer between the core and the outer slab consists preferably of a polyurethane foam although similarly moisture-resistant foamed elastomeric insulating materials may be used.

Suprisingly, the sandwich construction described immediately above provides not only the considerable structural strength desired in modern building structures but also affords a degree of insulation of the wall heretofore associated with more massive structures in terms of both thermal and acoustical transmission. For example, an insulating layer having a thickness of 3 cm of polyurethane foam has the heat conductivity apart from diffusion processes, of 0.023 or approximately the same as a pumice-block masonry wall of 30 cm in thickness.

When the term "single-shear section" is used herein to describe the reinforcing lattice, it should be noted that it is intended to so designate reinforcing lattice structures which lie substantially in a single plane. This plane, which is perpendicular to the slabs, may include a chord or reinforcing bar embedded in each of the slabs and the aforementioned inclined or "diagonal" struts extending between these bars and welded or otherwise tied to them. The struts likewise lie in the shear plane. The struts may be inclined alternately in opposite directions in accordance with conventional truss construction.

I have also found it to be advantageous to restrict corrosion of the struts, upon diffusion of moisture through the outer slab and to limit cracking around the struts because of thermally induced dimensional changes by enclosing the struts at least over the portion of the length thereof adjacent the outer slab with a sleeve of a yieldable corrosion-resistant material, preferably a thermally insulating synthetic-resin sheath.

The sheath, covering or sleeve preferably reaches from the region of the outer slab or shell into the gravel-concrete core and may extend to the inner slab although it has been found desirable to terminate the sheath in the center of the concrete core. It should be noted that the sheath may begin within the body of the outer slab adjacent the latter. As a consequence of this structure, corrosive attack on the struts which tie the slabs together and anchor them to the concrete core is precluded and temperature differentials causing dimensional changes are incapable of examining the connection between the struts and the mineral bodies.

According to another feature of the invention, the inner and outer slabs are finished at a prefabricating site, e.g., by sandblasting or shotblasting concrete slabs along the outer faces of the facade-forming slab or the inner faces of the inner slabs to provide an aesthetic appearance and texture. The polyurethane foam layer may be applied along the inner face of the outer slab at the prefabricating site after the insulating sheath has been applied. This insulating sheath may, of course, be constituted from foamed polyurethane and may be molded or drawn around the strut before it is embedded in the concrete of the outer slab. When the resulting double-wall structure is erected at the construction site by conventional means not requiring discussion here, the core concrete (gravel-type concrete) can be cast in place to form the core and simultaneously, monolithically bond all the element of a single facade together. To prevent the cement liquor from running onto the exposed face of the outer slab during casting of the gravel concrete, it has been found to be advantageous to surround the outer slab with a sealing element, e.g., a sealing band, which may be composed of an elastomeric material and may bridge the gap between adjacent outer slabs. This sealing strip may be composed of sponge rubber and acts as a barrier to heat flow between the outer slabs, to moisture penetration to the underlying concrete core, and as a yielding spacer permitting thermal expansion and contraction. Any remaining gap between the slabs may be filled with a crack sealer of the thiokol type in a thickness of about 1 cm.

DESCRIPTION OF THE DRAWING

The above and other objects, features and advantages of the present invention will become more readily apparent from the following description, reference being made to the accompanying drawing in which:

FIG. 1 is a transverse cross-sectional view through a pair of facade-forming elements at a junction therebetween;

FIG. 2 is a detail view of the region II of FIG. 1;

FIG. 3 is a detail view of the region III of FIG. 1;

FIG. 4 is an elevational view taken in the direction of arrow IV of FIG. 1; and

FIG. 5 is an elevational view of a portion of a facade formed by the elements of FIG. 1.

SPECIFIC DESCRIPTION

From FIG. 1, it will be apparent that each structural element according to the present invention comprises an inner shell or slab 1 or 1' of concrete or other mineral matter, an outer slab or shell of concrete or other hardenable mineral substance as represented at 3 and 3', and a common gravel-concrete core generally designated at 2 and bridging all of the structural elements of

a particular facade or wall. Bridging the slabs of the structural elements 100 and 100', respectively, are reinforcing steel trusses 4 and 4' which are described in greater detail for the truss 4. Each truss 4 is generally planar, i.e., is a single-shear reinforcing lattice whose plane, as illustrated, is the plane of the paper in FIG. 1. A plurality of such trusses can be seen in FIG. 4 in which they lie parallel to one another in respective planes perpendicular to the plane of the paper. Each of the trusses also comprises an inner chord or reinforcing bar 4a, preferably extending the full length or width of the facade-forming element 100 and parallel to an outer chord or reinforcing bar 4b embedded in the outer slab 3 and likewise extending the full length or width thereof. Spanning the coplanar bars 4a and 4b are a multiplicity of struts 11 which are inclined alternately in opposite directions and are welded, tied or otherwise anchored to the bars 4a and 4b. The struts 11 likewise are substantially coplanar with bars 4a and 4b. The bar 4a is embedded in the inner slab 1 as are the junctions of the struts therewith.

In the embodiment illustrated in the drawing, the inner slab or shell 1 is composed of a lightweight concrete, i.e., a concrete containing expanded slag or other expanded mineral as an aggregate or filler, and has its inner surface 5 finished to the desired esthetic state. For example, if the surface 5 is to have a textured appearance, this appearance may be created by troweling the wet concrete during casting of the slab 1, by sandblasting or shockblasting, by carving or the embedding texturing materials in the slab during casting. Where a smooth appearance is desired, the surface 5 may be troweled smooth, provided with a plastic or other facing layer, polished or ground.

The outer slab or shell 3 is likewise constituted as a finished structure so that further treatment at the erection site is not required. In this case, the outer slab 3 is composed of a gravel concrete which may be sandblasted or shock-blasted along its outer surface 6 to provide a roughened texture. When a polished mineral appearance is desired, this surface can be ground by conventional processes after hardening of the concrete.

Between the core 2 and the outer slab 3 or 3', there is provided an insulating layer 7 or 7' which preferably consists of foam polyurethane and which is applied by casting, spraying or molding to the inner surface 6a of each outer slab 3 or 3' after the casting thereof. Prior to the casting of the outer slab, however, each strut 11 is surrounded by an insulating sheath 12, preferably of a thermoplastic material, so that the sheath is partly embedded in the slab 3 or 3' (FIG. 1) and extends substantially midway into the free space remaining for the casting of the concrete core 2.

As has been indicated earlier, the slabs 1, 1' and 3, 3' with the interconnecting trusses 4, 4' and cast at a prefabrication site provided with the polyurethane layers 7, 7' and given the desired surface treatments at 5 or 6. They are then delivered to the construction site and erected in, for example, an orthogonal array as shown in FIG. 5 for the structural elements 100, 100' described in connection with FIG. 1 and the identical elements 200 and 200'. Between each pair of outer slabs 3, there is inserted a sealing band of foam rubber as represented at 9 for preventing the cemented liquor from passing on to the finished surfaces of the outer slabs. I have also found it to be advantageous to provide between the mutually confronting edges 8 of the adja-

cent slabs, from the exterior in, a crack sealer 10 of a flexible thiokol in a thickness of about 1 cm, preferably by a caulking gun. The core 2 can then be cast from gravel concrete. The resulting structure has been found to be creep and deformation resistant to weathering and moisture diffusing, and can serve as a fire barrier. German Industrial Standards (DIN) 4102, 4108 and 4109 are met.

I claim: truss

1. A facade-forming structural element, comprising an inner slab, an outer slab spaced from said inner slab, at least one truss structure interconnecting said slabs, said truss structure having longitudinally extending elements respectively connected to said slabs and a plurality of diagonal elements inclined to and secured to said longitudinally extending elements and spanning said slabs, a cast-concrete core received between said slabs and embedding said diagonal strut elements of said truss at least between said elements, a thermal and acoustical insulating layer of polyurethane foam interposed between said core and said outer slab; and an insulating sheath surrounding each of said diagonal strut elements and individual thereto, each sheath extending from within said cast-concrete core and terminating in said outer slab.

2. The facade-forming structure defined in claim 1, further comprising a seal along an edge of said outer slab for sealing a gap between the outer slab and an adjacent outer slab of an adjoining structural element.

3. The facade-forming structure defined in claim 2, wherein said seal is a strip of foam rubber.

4. The facade-forming structure defined in claim 1 wherein said insulating sheaths reach from within said

outer slab to substantially the middle of said core.

5. The facade-forming structure defined in claim a wherein said insulating sheaths are composed of a thermoplastic synthetic resin.

6. The facade-forming structure defined in claim 5 wherein said truss is generally planar and comprises an inner reinforcing bar embedded in said inner slab and forming a respective one of said longitudinally extending elements, and an outer reinforcing bar coplanar with said inner reinforcing bar and embedded in said outer slab, said outer bar forming the other longitudinally extending element, said diagonal strut elements being inclined alternately in opposite directions and being anchored to said bars, said sheaths extending substantially to the junction of the respective strut element with the outer bar, said core being cast in situ from gravel concrete, said outer slab being prefabricated from gravel concrete and having a finished outer surface adapted to form the face of a building, said inner slab being formed with a finished inner surface adapted to form an exposed wall of said building, said insulating layer being composed of formed polyurethane and embedding said insulating sheaths therein, said element further comprising a generally flat sealing strip of foam rubber surrounding said outer slab.

7. The facade-forming structure comprising a plurality of structural elements as defined in claim 6, separated by said sealing strips and defining spaces opening externally between the respective outer slabs, a single core of concrete being provided for said element, said spaces being filled with a sealer.

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