STRUCTURAL SYSTEMS EMPLOYING FOAMING-IN-PLACE

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FOAMING-IN-PLACE
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ABSTRACT OF THE DISCLOSURE

Breather strips are provided in structural systems such as decks, floors, and roofs, which employ sprayed-in-place foam materials such as polyurethane, to accommodate the differences in coefficients of expansion-contraction, and in vibrations between the structural members and the foam material. The breather strip extends from the sprayed surface into the layer of foam material and has a surface to which the foam material will not bond. Where the breather strip is disposed to provide sloping mated surfaces of the foam, added strength against loads such as wind, etc., is gained.

This invention relates to structural systems that utilize the added strength provided by a sprayed-in-place closed cell foam material, such as urethane, and more specifically is directed to deck or roof constructions employing a covering material to which the foam is bonded on the underside.

A sprayed-in-place foam makes it possible to provide unique structural systems that heretofore would have been impossible or prohibitively expensive. The foam can bond to the underside of a deck, floor or roof covering material and enhance greatly the strength of the structure. The covering material may be of, for example, wood, asbestos, metal or concrete, and either assembled in place or precast. The use of such foam can reduce the system dead weight design requirements of a roof covering system by as much as 80%, reduce maintenance, painting and corrosion protection requirements normally required on the underside of such structures, and provide a structure which will have a long life and which can be erected at greatly reduced costs.

For certain types of building constructions, it is common practice to form the roof from corrugated or ribbed panels that are commercially available in lengths up to 12 feet and more and in widths up to 3 or 4 feet. Such panels are supported on purlins that are commonly made of metal. In order to make the roof water tight, it is customary to coat the upper surface with layers of insulation and building paper which are bonded to each other and to the roof with a material such as asphalt. When the interior of a building having such a roof catches on fire, the heat from the fire causes the support members to weaken and the entire roof to buckle. Gaps are formed through which the heated asphalt or similar weatherproofing material on the outer surface of the roof leaks thereby to feed and contribute to the further spread of the fire.

By use of the sprayed-in-place foam in accordance with the present invention, the foam covers the underside of the roof and the supporting structural members. The heat insulation properties of the foam material protect the roof and its supporting members from the heat of the fire; and with this type of roof construction, it is possible to provide a weatherproof roof that does not require the asphalt coating. Two advantages accrue, one being that the weight of the roof is less and therefore the roof is less likely to buckle, and the other being that even if the roof should buckle, no combustible material is available for contributing to the spread of the fire.

Foam materials may be selected or treated to be fire resistant and have self-extinguishing properties. For example, one may formulate a polyurethane foam with isocyanate. The foregoing provide important advantages toward fireproofing the system which results in advantageous fire insurance rates.

Because of the increased strength afforded by the foam material after it has been sprayed-in-place on the underside of the roof, it became possible to use a lighter construction for the roof than would otherwise be possible. For example, where metal panels are used, a lighter gauge metal may be used. It also enables the use of other materials such as asbestos panels, and this enables the use of larger spacing between purlins and girts all of which contribute to a more economical, safer and more effective roof construction.

One important feature of the present invention resides in the provision of a breather strip which may extend downwardly from the underside of a horizontally disposed structural layer. The breather strip is formed so that the foamed material does not bond to it. By providing a suitable pattern of such breather strips, it is possible to accommodate the relative movement between the conventional covering material forming the structural layer and the foam material. Where the breather strip is disposed in a direction other than vertical to thereby provide a sloping surface, the foamed material will have sloping surfaces that are mated thereby to provide added strength against all loads such as expansion, vibration, wind, live, dead, etc. The sloping arrangement of the breather strip is also desirable in that it reduces both the heat loss and moisture penetration into the foam material.

Moisture penetration in certain of the foamed materials, such as polyurethane, is a serious problem in some practical applications because the absorption of moisture in the cells of the foam causes internal expansion of the foamed material, and causes degradation of the insulation value. Even though a closed cell foam is employed to provide maximum heat and acoustical insulation and strength, steps must be taken with foamed material susceptible to moisture absorption to minimize water penetration to provide the most effective structure. For many applications, a special treatment on the exposed lower side of the foamed layer is desirable. This may be accomplished by spraying a film of a material such as a vinyl or butyl film which will form a watertight seal on the surface of the foamed material; or it is possible to adjust the spraying technique so as to form a heavy density film in the form of a layer of the foam material on the lower surface of the sprayed-in-place foam layer. Where a spray or film of another material is used to prevent moisture penetration, this spray or film may be colored with surface or internal coloring procedures to thereby provide a finished interior ceiling for the room below.

It is accordingly a primary object of this invention to provide a novel structural system employing a sprayed-in-place foam on the underside of the structure.

Another object is to provide in such a system, a novel breather strip protruding downwardly at spaced locations throughout the system to accommodate the difference in coefficients of expansion-contraction, and in vibrations between the panels and the foam material; and where the breather strip is angularly disposed relative to the vertical, the sloping surface will resist forces due to expansion, vibration, wind, live, dead, etc. loads.

Still another object of this invention is to provide a waterproof seal between such panels which serves as a roof covering, together with a suitable pattern of breather strips that enables sufficient relative movement between adjacent panels to enable the panels to move with the expansion and contraction of the foam layer and yet provide a weathertight layer.
Another important object is to reduce the moisture penetration from the underside of such a layer by application of a spray or film that may, if desired, be colored with surface or internal coloring procedures.

These and other objects of the invention will become more fully apparent from the claims and from the description as it proceeds in conjunction with the appended drawings wherein:

FIG. 1 is a pictorial view of a fragmentary section of a deck or roof showing twelve panels in a typical roof installation.

FIG. 2 is an exploded pictorial view of a portion of a side-lap joint showing the breaker strip of the present invention;

FIG. 3 is a pictorial view of a fragmentary portion of a side-lap joint showing the breaker strip secured to the lower edge of one panel;

FIG. 4 is an elevational view of a side-lap joint wherein an edge of one panel is bent downwardly to form the breaker strip;

FIG. 5 is an elevation view of an end-lap joint showing the breaker strip secured between the two panels; and

FIG. 6 is a fragmentary pictorial view illustrating the use of a two-ply corrugated panel and breaker strip in accordance with the present invention.

Referring now to the drawings, the structural system of the present invention may be advantageously employed as a roofing or deck system or a vertical wall panel, and the advantages of the present invention result in large part from use of a foam material that may be sprayed-in-place after the roof or deck upper surface is formed in place. In accordance with this invention, a foam of a closed cell material, such as urethane, can be sprayed on the underside of a roof or deck covering of a conventional building material which may, for example, be a wood deck, an asbestos deck, a metal deck, a concrete deck (precast or poured), or the like. The deck may be a roof, or it may be a floor in a multistory building.

As the foam hardens, it becomes bonded and permanently adheres to the covering material. The foam will thus provide important supporting strength for uplifting and downward deflection to the covering material.

In FIG. 1, a portion of a roof is shown with covering material in the form of rectangular panels 10 that may be ribbed or corrugated metal, asbestos, or other suitable material to the underside. The portion of the roof section shown in FIG. 1 is illustrated with only twelve panel sections 10. Each panel section 10 may be of well-known construction and may, for example, comprise a sheet of corrugated metal or preferably tough fibers of asbestos that are crisscrossed, interwoven and embedded in Portland cement. Under tremendous hydraulic pressure, this mixture may be permanently formed into a homogeneous, monolithic, corrugated sheet. When the roof section of FIG. 1 is constructed of panels, they may be supported on a grid of members such as purlings as is conventional.

If the covering material of concrete is used, it may be provided in any suitable manner.

After the covering material is in place, the foam material is thereafter sprayed-in-place on the underside of the covering material to provide the added strength and rigidity desired of the system. Whether a panel type or continuous roof is used is immaterial, as the important consideration is that some sort of surface be provided to which the foam can be sprayed-in-place. When a panel type of roof is used and added advantage results from the use of the sprayed-in-place foam in that the foam penetrates into the cracks, bonds to both sides of the system and thereby forms a waterproof seal.

Referring now to FIG. 2, two panels 12 and 14 are shown in an enlarged, exploded view with a breaker strip 16 located so as to be secured along edge 18 to panels 12 and 14 and to have a lower edge 20 which extends away from the surface of the panels on which the foam is sprayed. Breaker strip 16 is formed to have at least one surface which will not bond with the foam material. Where the foam material is urethane, breaker strip 16 may be of polyethylene.

Because the foam will not form a bond with breaker strip 16, the disposition of such breaker strip 16 across and/or along the length of the edges of the panels will prevent the expansion or shrinkage of the covering panels from having an accumulative effect over the entire area of the deck. It is not essential that a breaker strip be used on each panel; the disposition of the breaker strips will be determined by the load requirements, area, climatic conditions and other related factors.

Referring now to FIG. 3, two panels 22 and 24 are illustrated in their installed position with breaker strip 26 secured along one edge to the lower surface of panel 22 as by a suitable adhesive. Where breaker strip 26 is a flexible sheet, the force of the spray has a tendency to deflect the lower free-hanging edge of breaker strip 26 toward panel 24 thereby causing breaker strip 26 to assume a sloping position as illustrated which is at an angle other than vertical or horizontal. The sloping position is particularly advantageous because the expansion and/or contraction forces resulting from vibration, moisture absorption and temperature changes causing relative movement between the foam material and the panels will be deflected and have less shearing action on the foam installation.

To reduce moisture absorption through the lap joints between panels 22 and 24, a suitable resilient, waterproof sealant such as a bead of polybutylene, butyl or other non-drying sealants 28 is provided under the crown of a corrugation on the upper panel 24. Such a sealant is also employed at the end lap joint, as illustrated in FIG. 5 to be on opposite sides of screw 30. As the deck is constructed, the sealant is advantageously applied so that it surrounds the periphery of each panel.

To further reduce moisture absorption into foam layer 30 of FIG. 3, the lower surface 32 may be provided with a treatment to prevent or at least reduce moisture absorption therethrough as by spraying a film of waterproofing material such as a vinyl or butyl film. It is also possible to achieve this result by varying the spraying technique so that a high density layer of the foam material is formed as lower surface 32. A coloring effect may be readily effected on the lower surface 32 where desired.

In the embodiment shown in FIG. 4, panels 32 and 34 are illustrated in their assembled position, and the sealant 36 is used to waterproof the covering system. In this embodiment, the breaker strip 38 is formed by bending the edge of panel 32 to extend downwardly, preferably at a sloping angle, into the foam material 40. To perform as a breaker strip, it is necessary that the foam material does not bond to at least one surface of the downturned edge 38. This may be accomplished by coating one or both surfaces 42 and 44 of edge 38 with a suitable material that does not bond to the foam material. Where the foam material is urethane, the coating may be, for example, polyethylene. This embodiment provides the same advantages as discussed above in connection with the embodiment of FIG. 3 when edge 38 is bent to have a sloping position.

The waterproofing treatment described above may be applied on the lower surface of foam layer 40 where desired.

The treatment of an end-lap joint is illustrated in FIG. 5. Panels 46 and 48 may be secured together as by a screw fastener 50. The sealant is preferably provided, where greater or moisture is a problem, to seal the edges of the panels together. Break strip 52, which may be a flexible layer, may be either secured between the panels as illustrated or secured to the lower surface of either panel 46 or panel 48 and disposed to extend beneath the joint as illustrated in FIG. 3.
5 Other types of deck or roof structures may be used. A continuous layer of concrete or a wooden upper support surface may be utilized. The breaker strip may be employed as by being secured to the underside of such supporting layer and the foam material sprayed-in-place.

In the embodiment illustrated in FIG. 6, two-ply corrugated panels are illustrated. Panel 52 may be comprised of an upper layer 54 and a lower layer 56, and the layers staggered so that the edge of layer 54 is at 58 and the edge of layer 56 is bent downwardly and the downturned portion 60 coated so as to serve as the breaker strip. The other panel 62 may be formed of an upper layer 64 and lower layer 66. These layers are also staggered so that the edge of layer 66 is at 58 and the upper layer extends over upper layer 54 of panel 52. The waterproofing sealant 68 may be applied under the overhanging edge of layer 64 on panel 62.

The foam, because it is bonded to the covering material and being of the closed cellular type to have considerable internal cell structural strength, will tend to correspond to the expansion of the deck. As there will be a small variation in the expansion rates of the roof covering material and the foam, and as the breaker strip of the present invention for attachment to the sides and/or ends of roof panels at desired locations, is a material which will not develop a bond with the foam, the expansion or shrinkage in both directions of the covering sheet will not present an accumulative effect on the entire deck or roof structure. The breaker strip, when suitably located and designed as described will effectively control insulating values and expansion and contraction problems without affecting the increased structural value of the system or the waterproofing due to the use of resilient compounds in the joints.

What is claimed and desired to be secured by United States Letters Patent is:

1. A structural member having two dimensions much greater than the third dimension thereby to provide a large surface area and having on said large surface area a sprayed-in-place layer of foamed material, said foamed material being of the type having a closed cell structure and bonding to the surface area of said structural member, said structural member comprising a substantially horizontal disposed deck against the lower side of which the foamed material is sprayed-in-place; and breaker strip means extending from said surface area into the thickness of said layer of foamed material, said breaker strip means having a surface to which said foamed material will not bond and being disposed in a pattern to permit relative expansion and shrinkage between the materials of the structural member and the foam without detrimentally affecting the structural value of the combination, and wherein the breaker strip means comprises a flexible member having one edge secured to the underside of said deck and a lower free-hanging edge, the degree of flexibility being such that the force of the spray will deflect the lower free-hanging edge of the breaker strip means upwardly toward, but not against, the lower surface of said deck to thereby provide greater resistance to temperature, vibration and moisture absorption forces.

2. The structural member as defined in claim 4 wherein the underside of the layer of foamed material is made waterproof to reduce moisture penetration from the underside.

3. A structural member having two dimensions much greater than the third dimension thereby to provide a large surface area and having on said large surface area a sprayed-in-place layer of foamed material, said foamed material being of the type having a closed cell structure and bonding to the surface area of said structural member, said structural member comprising a panel against the lower side of which the foamed material is sprayed-in-place; and breaker strip means extending from said surface area into the thickness of said layer of foamed material, said breaker strip means having a surface to which said foamed material will not bond and being disposed in a pattern to permit relative expansion and shrinkage between the materials of the structural member and the foam without detrimentally affecting the structural value of the combination, and wherein the breaker strip means comprises a flexible member mounted on the underside of said panel and having a lower free-hanging edge, the degree of flexibility being such that the force of the spray will deflect the lower free-hanging edge of the breaker strip means upwardly toward, but not against, the lower surface of said panel to thereby provide greater resistance to temperature, vibration and moisture absorption forces.

4. The structural member as defined in claim 3 wherein the underside of the layer of foamed material is made waterproof to reduce moisture penetration from the underside.

5. A method of forming a deck structure employing a foamed-in-place material comprising the steps of: providing a supporting structure having a lower surface of a material to which said foamed material will bond and with dimensions in two directions much greater than the thickness of the supporting structure; mounting a flexible sheet of a material to which the foamed material will not bond to suspend from the lower surface of said supporting structure; and thereafter spraying said foam material in place on said lower surface in such manner as to cause said flexible sheet to assume a sloping position while extending substantially through said foam material.

6. The method of claim 5 further comprising the step of: treating the lower surface of said foamed material to prevent penetration by moisture from the exposed lower surface.

7. A method of forming a deck structure system comprising the steps of: providing a supporting structure having an upper waterproof surface with dimensions in two directions much greater than the thickness of the supporting structure; applying a foam of a material that bonds with the underside of said supporting structure, said material being of the type forming a closed cellular structure; and treating the lower surface of said foamed material to prevent penetration by moisture from the exposed lower surface wherein the treating step is effected by varying the spray of the foam material to provide a high density layer along said exposed lower surface.

References Cited

UNITED STATES PATENTS
3,331,173 7/1967 Elsner ---- 156—300 X
3,045,295 7/1962 Pochon 52—273 X

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