ABSTRACT

A molded building panel which is durable, fire-retardant, weather resistant and which provides an insulating inner core has a variegated skin resembling a hand-split shake, shingle or other surface with a density of from 25 to 60 pounds per cubic foot and an integral, insulating, low-density, foam core of a density ranging from 4 to 12 pounds per cubic foot. The skin surface of the panels is sealed with an elastomeric, ultra-violet, stabilized polymer incorporating minor amounts of a fire retardant. The panels are designed to be interlocked with one another in conjunction with sealing means to seal them against leakage. Each of the panels has cast-in-place clips for securing the panels to rafters of a roof or to studding in the event of its use as exterior siding for a building.

4 Claims, 5 Drawing Figures
PEAKED ROOF STRUCTURE OF POLYURETHANE MOLDED BUILDING PANELS WITH INTEGRAL, BONDED, LOW-DENSITY URETHANE INSULATION BACKING

BACKGROUND OF THE INVENTION

This application is a continuation-in-part of Ser. No. 225,548, filed Feb. 11, 1972, now abandoned.

FIELD OF THE INVENTION

This invention relates to a durable, fire-retardant, fabricated building panel of variable-density, closed-cell, polyurethane foam.

PRIOR ART RELATING TO THE DISCLOSURE

The traditional way of fabricating a building has been to construct a framework, including vertical studs and horizontal plates, attach a weatherproof barrier to one side thereof and an attractive surface to the other or interior side thereof. Traditionally, insulation is placed between the two walls such that the wall forms a barrier for heat loss as well as keeping wind, rain and other undesirable elements out of the interior of the structure. Needless to say, the steps of building the framework, attaching the outer wall, placing the insulation in place and then attaching the inner wall consumes a large number of man hours and thus becomes expensive. Further, if the worker, when placing the insulation in frames in place, is not careful he will leave gaps which will tend to decrease the value of the insulation.

Various structural methods have been introduced which cut down the number of man hours required to build a structure. These approaches have included the use of 4 x 8 sheets of plywood or alternatively using prefabricated walls including all of the elements of a unit size and constructing with the building block concept. All of the structures, however, have still required the insertion of insulation between the studs as a separate step on the building site or during the fabrication of the wall. Whereas the concept of backing a wall surface with an insulative product is known to be old, as taught by the U.S. Pat. No. 3,362,119 granted to Murphery, U.S. Pat. No. 3,025,198 granted to Dunn, and the concept of having an insulated panel likewise is old as illustrated by U.S. Pat. No. 3,258,841 to Butcher. Butcher fabricates an entire wall structure including studs and plates with an insulant material foamed in place thus interlocking the various elements such as the studs to each other as well as to one of the wall surfaces.

Other patents, such as U.S. Pat. No. 3,619,343, disclose a plastic roof product of open-cell, expanded polyolefins having a sealant placed on the exposed surface of the expanded sheeting. Moog, U.S. Pat. No. 3,410,044, describes a foamed, plastic-based construction brick having a low-density, foamed core and high-density, smooth skin. Belgian Pat. No. 640,453 describes interlocking roofing panels having a hard plastic outer surface and a foamed core.

The primary objects of this invention are to provide fabricated building panels for use as roofing or exterior siding of a building of a particular variable-density, closed-cell, polyurethane foam wherein the outer surfaces of the panels are coated with an elastomeric sealant providing adequate durability against weathering. Other objects of this invention are to provide building panels incorporating cast-in-place clips for securing the panels to studs or rafters for interlocking the panels together. Other objects of this invention are to provide a building panel having a tough, high-density, polyurethane foam outer surface and an integral interior insulating core of low-density, polyurethane foam; to provide a building panel which can be easily and quickly applied having an exterior configuration simulating hand-split shakes, shingles, clapboard or other particular surface; to provide unitary, prefabricated, durable building panels wherein the exterior surface may be colored to any desired color and which is sealed against damage by weathering; to provide a building panel wherein the expansion and contraction characteristics caused by heat and/or cold will not cause physical separation of the panels relative to one another; and to provide a prefabricated building panel including a mechanically interlocked high-density polyurethane foam outer skin and a low-density, polyurethane foam inner core which do not separate during thermal stress.

BRIEF DESCRIPTION OF THE DRAWINGS

FIG. 1 is a perspective view of a building panel having an exterior skin configuration resembling a hand-split shake roof and which embodies the principal features of the present invention;

FIG. 2 is a horizontal cross-section through the panel of FIG. 1;

FIG. 3 is a vertical cross-sectional view of two adjacent panels of the type illustrated by FIG. 1 showing the manner of securing the panels to a structural building element such as a rafter or stud and the configuration of the clips cast into the panels;

FIG. 4 is a plan view of the abutting panels of FIG. 3;

FIG. 5 illustrates the preferred method of securing panels resembling a hand-split shake roof or rafter spaced on 16 inch centers.

DETAILED DESCRIPTION OF THE INVENTION

Referring to FIG. 1, a building panel is illustrated having an exterior configuration resembling that of hand-split cedar shakes for roofing or exterior siding. The building panel of this invention may have any configuration, such as clapboard, or may be made to simulate other natural materials. As shown in FIG. 1, the panel 1 has an exterior surface 2 including horizontal lap lines 3 and vertical separation lines 4, such that the appearance is that of siding or roofing made of individual, hand-split cedar shakes placed in horizontal rows.

Referring to FIG. 2, the panel is fabricated in a mold having an inner surface configured with the design which the finished panel is to assume. The panel has a high-density, polyurethane foam outer surface 5 having a density ranging from 25 to 60 pounds per cubic foot and an inner, low-density polyurethane foam core 6 having density ranging from 4 to 12 pounds per cubic foot. The inner core provides insulating qualities to the building panel and is mechanically interlocked with the high-density skin of the panel so that the high-density and low-density portions are not subject to separation by thermal or other such stresses. Fabrication of the building panels illustrated by FIG. 1 is carried out by first coating the interior surface of the configured portion of a mold with a parting agent to facilitate removal of the finished product. Then, a high-density, polyurethane foam having a density ranging from 25 to 60 pounds per cubic foot, and preferably around 30
pounds per cubic foot, is sprayed into the lower portion of the mold to a thickness ranging from ¾ to 2 inches in thickness and preferably about three-eighths inch. The material used is preferably a hydroxy-bearing polyol mixed in equal quantities with an isocyanate. Either the isocyanate or the polyol may incorporate an extremely low-boiling fluorocarbon. On mixing of the polyol and isocyanate, heat is generated which causes the low-boiling fluorocarbon to volatize, foaming the resulting resin material. The foamed resin is then sprayed into the mold. Before the high-density foam layer cures, a low-density, polyurethane inner core of a density ranging from 4 to 12 pounds per cubic foot is sprayed into the lower mold on top of the high-density foam. The urethane foam is preferably the same variety, only utilizing greater amounts of fluorocarbon gas from an external source to reduce the density of the resulting product to between 4 and 12 pounds per cubic foot.

Following introduction of the low-density foam, the mold is closed with an upper mold portion and the entire panel allowed to cure. The components preferably used in the preparation of the polyurethane foam have a cream time of about 60 seconds and a de-mold time of 10 to 12 minutes, are stable in about 2 hours and have an ultimate cure time of 24 or more hours. It is preferred to add a quantity of an inert carrier such as pumice to the polyol ranging from 2 to 7 wt. %, preferably 5 wt. %. A flexible polyol may also be admixed with the polyol component making up the majority of the composition to make the product less brittle on removal from the mold.

Following curing, the panel is removed from the mold and the exterior surface of the mold is sprayed with a sealant which is ultra-violet stabilized and which incorporates inert fillers rendering the coating substantially fire-retardant. A preferable protective coating is an elastomeric, polyvinyl pre-polymer manufactured and sold under the tradename DECADERM from Liquid Plastics of Preston, Great Britain. The outer polyurethane panel may be colored by (1) introduction of a pigment into the high-density foam which forms the outer surface of the panel with concurrent use of a clear sealant or by (2) use of a naturally colored, high-density foam layer over which is added a pigmented sealant.

It is desirable that the building panel have inert materials added to it to achieve greater fire-retardant qualities even though the polyurethane foam has, in and of itself, significant fire-retardant qualities.

The building panels are generally manufactured in sizes for securing to rafters or studs spaced on 16 or 24 inch centers. Generally, the sheets are made in the following sizes: 32 inches × 48 inches, 48 inches × 48 inches, and 48 inches × 96 inches. FIG. 3 shows a vertical cross-section of two abutting panels. The lower edges of each panel is provided with a recessed portion 7 having an upper wall 8 meeting with a back wall 9. The back wall is provided with an indented portion 10. The recessed portion 7 extends the full length of the lower edge of the building panel. Clips 11, of metal or other suitable material, are cast in place during the molding process in the respective lower corners of each of the building panels, as illustrated by FIG. 4. The clip 11 includes a projecting tab portion 12 which projects beyond the back wall 9 of the recessed portion 7.

The upper edge of each of the building panels includes a rear wall 13 having an integral projection 14 which mates with the indented portion 10 in the back wall of the recessed portion of an adjacent building panel to interlock or key the building panels together. Clips 15 are cast in the upper corners of each of the building panels as illustrated by FIG. 4, each clip having a lower tab portion 16 which projects beyond the plane of the back wall 13 a sufficient distance for a nail, staple or other means to be driven through the tab portion to secure the panel to a rafter or a stud 17. Spaced above the tab portion is a base member 18 of the clip to which are secured integral legs 19 and 20 which secure the clip in the cast building panel. A slot 21 between the base 18 and the tab 16, which mates with the tab portion 12 of the adjacent panel, is provided. Referring to FIG. 5, showing installation of building panels resembling a hand-split shake roof, the panels are generally started at the gutter line. The tab portions 12 of clips 11 along the lower marginal edge of each panel are bent down and secured by staples or nails through the tab of the rafter. The tabs 16 at the top edge of each building panel are secured to the rafters by staples or nails that pass through the rafter. Additional panels are installed in side-by-side relation to the initially installed panel with a sealant spread along the side edges of the abutting panels to seal them together. A preferable sealant is an epoxy polysulfide sealant manufactured by A.D.C.O. of Michigan Center, Michigan which is sufficiently elastomeric to allow expansion and contraction of the building panels without loss of sealing. When one row of panels is completed, a second row of panels is installed, with the lower edges of the second row of panels interlocking with the upper edges of the lower row of panels, as illustrated by FIG. 3. A sealant 23 is used between the abutting panels. Preferably, the rows of panels are staggered relative to one another as illustrated by FIG. 5 in order to eliminate a series of straight line joints.

When hips and valleys are part of the roof system, the sheets may be cut along a diagonal by a saw and adjacent sheets fitted together using an adhesive sealant between the adjoining surfaces. It is preferable to use a valley underlayment of polyethylene or polyvinylchloride film of sufficient thickness.

The following examples are included as exemplary of the invention but are not to be considered limiting in any manner.

EXAMPLE 1

A polyurethane pre-polymer sold under the tradename POLYLITE 841 by Reichold Chemical Company, incorporating about 5% pumice on a weight basis and 5% of a flexible polyol sold by Wyandotte Industries, was mixed in equal weight ratios with an isocyanate catalyst sold under the tradename POLYLITE 745 by Reichold Chemical Company. The polyurethane pre-polymer incorporated a low-volatile fluorocarbon blowing agent. The urethane mixture was sprayed into the inner part of a mold having an inner surface configuration resembling that of hand-split shakes to a thickness of about three-eighths inch and a density of about 30 pounds per square foot. Before the high-density urethane skin cured, additional fluorocarbon blowing agent was injected into the mixture of urethane pre-polymer and catalyst in an amount sufficient to yield a foam product having a density of about 12 pounds
per cubic foot. This low-density foam was sprayed into the mold over the high-density skin and the mold closed with an upper mold portion. The foamed product in the mold was allowed to cure for about 24 hours. The building panel was removed from the mold and a protective sealant coating of an elastomeric, polyvinyl prepolymer incorporating asbestos powder and stabilized against ultra-violet radiation was coated over the exterior surface of the panel. The preferred sealant is one sold under the tradename DECADEX by Liquid Plastics of Preston, Great Britain.

EXAMPLE II

A building panel was made in the same manner as described with respect to Example I, only using a polyol (Part A of B-12-60) of Polymir, Inc. of San Leandro, California, mixed in equal quantities with an isocyanate catalyst (Part B of B-12-60). The polyol pre-polymer in this instance included a quantity of a volatile fluorocarbon blowing agent which, when mixed with the isocyanate and pre-polymer, volatized to give a foamed product ranging in density from 25 to 60 pounds per cubic foot.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. A roof structure comprising:
   - spaced rafter extending from the peak of the roof,
   - rows of side-by-side, prefabricated, durable, fire-retardant building panels bridging the gaps between the rafters and secured thereto, each roof panel comprising a unitary, variable-density, closed-cell, polyurethane foam panel having an outer, variegated skin surface resembling a hand-split shake roof of natural wood with a density from 25 to 60 pounds per cubic foot and an inner, integral, insulating, low-density, polyurethane foam with a density ranging 4 to 12 pounds per cubic foot,
   - an ultra-violet stabilized sealant coating over the exterior surface of each panel, a continuous recessed portion along the lower edge of each panel extending the entire length of the lower edge for mating and keying with the upper edge of an abutting roof panel,
   - means for securing the panels to the rafters, such means including (1) clips cast into each of the upper corners of each panel, each clip provided with an inwardly extending slot and tab portion extending beyond the terminating upper edge of each panel through which means are driven into the rafter to secure the panel to the rafter, and (2) clips cast into each of the lower corners of the panel within the recessed portion, each clip having a tab extending outwardly into the recessed portion mating with the slot of the clips in the upper edges of an abutting panel, and a sealant between the abutting edges of each panel.

2. A durable, fire-retardant, insulating building panel having a surface simulating a natural building material and comprising:
   - a planar, unitary, variable-density, closed-cell, polyurethane foam panel having an outer variegated skin of one-eighth inch to 2 inches thick resembling a natural building material with a density of from 25 to 60 pounds per cubic foot, an inner, integral, insulating, polyurethane foam layer with a density of from 4 to 12 pounds per cubic foot, and an elastomeric, polyvinyl sealant coating applied to the outer surface of the high-density foam layer incorporating an ultra-violet stabilizer and fire-retardant,
   - a continuous recessed portion along the entire length of the lower edge of the panel for mating and keying with the upper edge of an abutting panel, a first set of clips cast into each of the upper corners of the panel, each clip provided with an inwardly extending slot and a tab portion extending beyond the upper edge of the panel through which means are inserted to secure the panel to a support member, and a second set of clips cast into each of the lower corners of the panel within the recessed portion, each of these clips having a tab portion extending into the recessed portion and mating with the slot of the first set of clips of an abutting panel.

3. The building panel of claim 1, substantially rectangular shaped, wherein the outer and inner layers are formed of a polyurethane made by reacting a polyol having multiple hydroxy groups with an isocyanate in the presence of a catalyst and a low boiling point, volatile fluorocarbon blowing agent to form a multi-branched, rigid polyurethane polymer.

4. The building panel of claim 1 wherein the polyurethane incorporates an inert filler ranging from 2% to 7% by weight.