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(54) EXTERIOR ROOFING SURFACE COMPRISED OF FOAM AND CEMENT COATING

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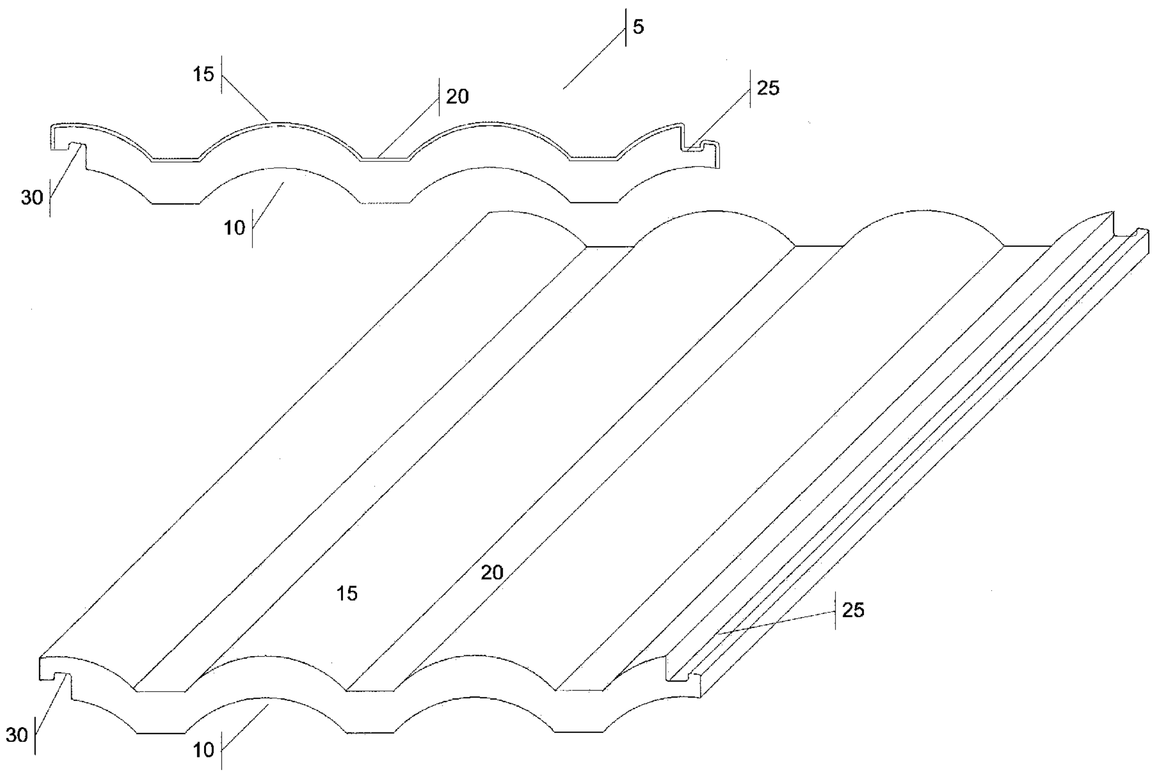
(57) ABSTRACT

An external roofing surface comprised of foam and a cement coating that is Class A fire-resistant under the UL 790 standard, insect resistant, very strong and extremely lightweight is disclosed. The roofing surface is also easily shaped by a number of shaping techniques, which allows for a more aesthetically pleasing appearance and can be used to make a roofing system that interlocks and has channels for underside ventilation. A cement coating is applied to the roofing surface, imparting it with excellent water repellant properties and increasing its strength, durability, and aesthetic appeal. The roofing surface may also optionally be reinforced with various materials to increase the strength and durability. The roofing surface may optionally be coated with a second coating material or a sheathing material to impart a desired strength, durability and/or aesthetic look.



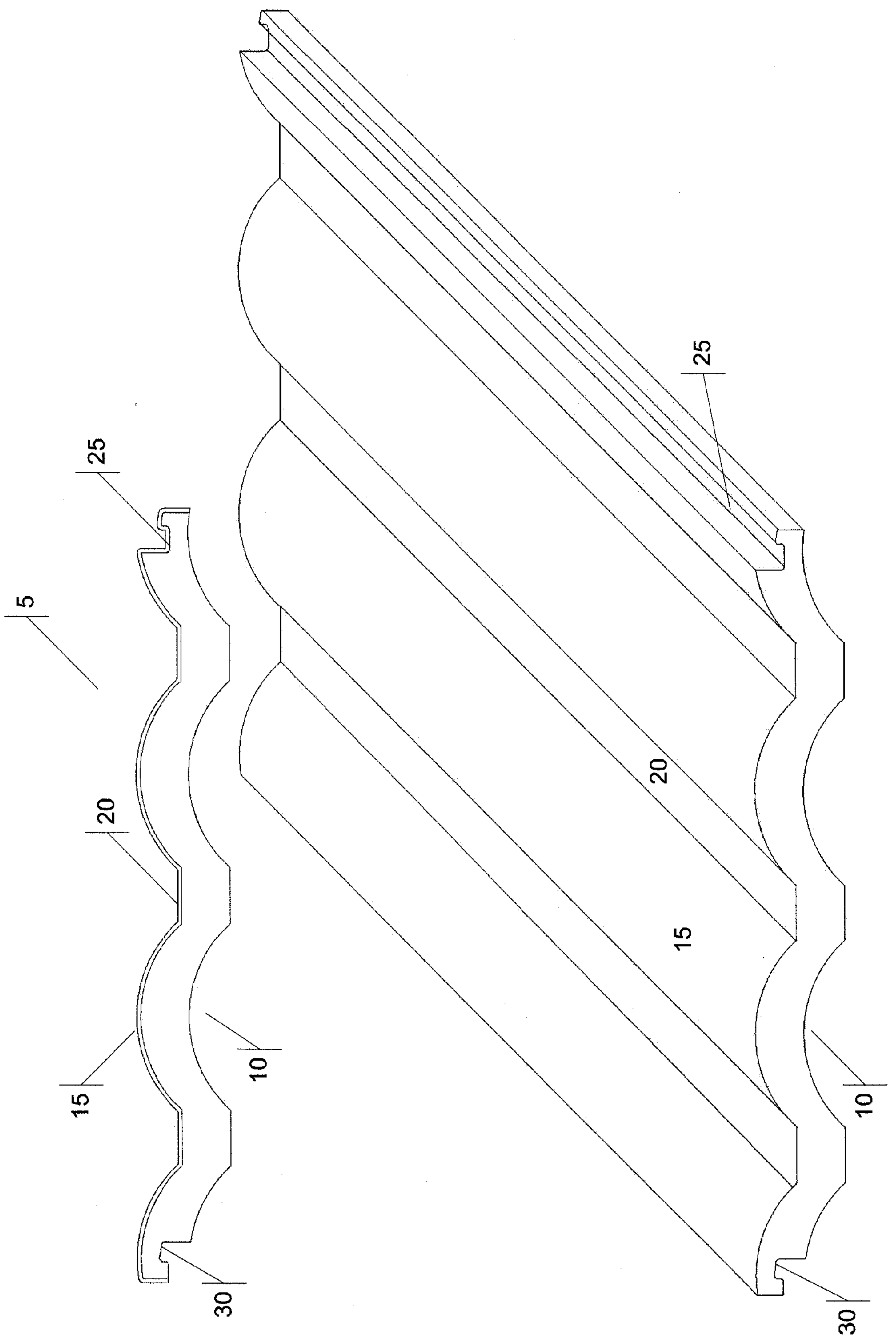


FIGURE 1

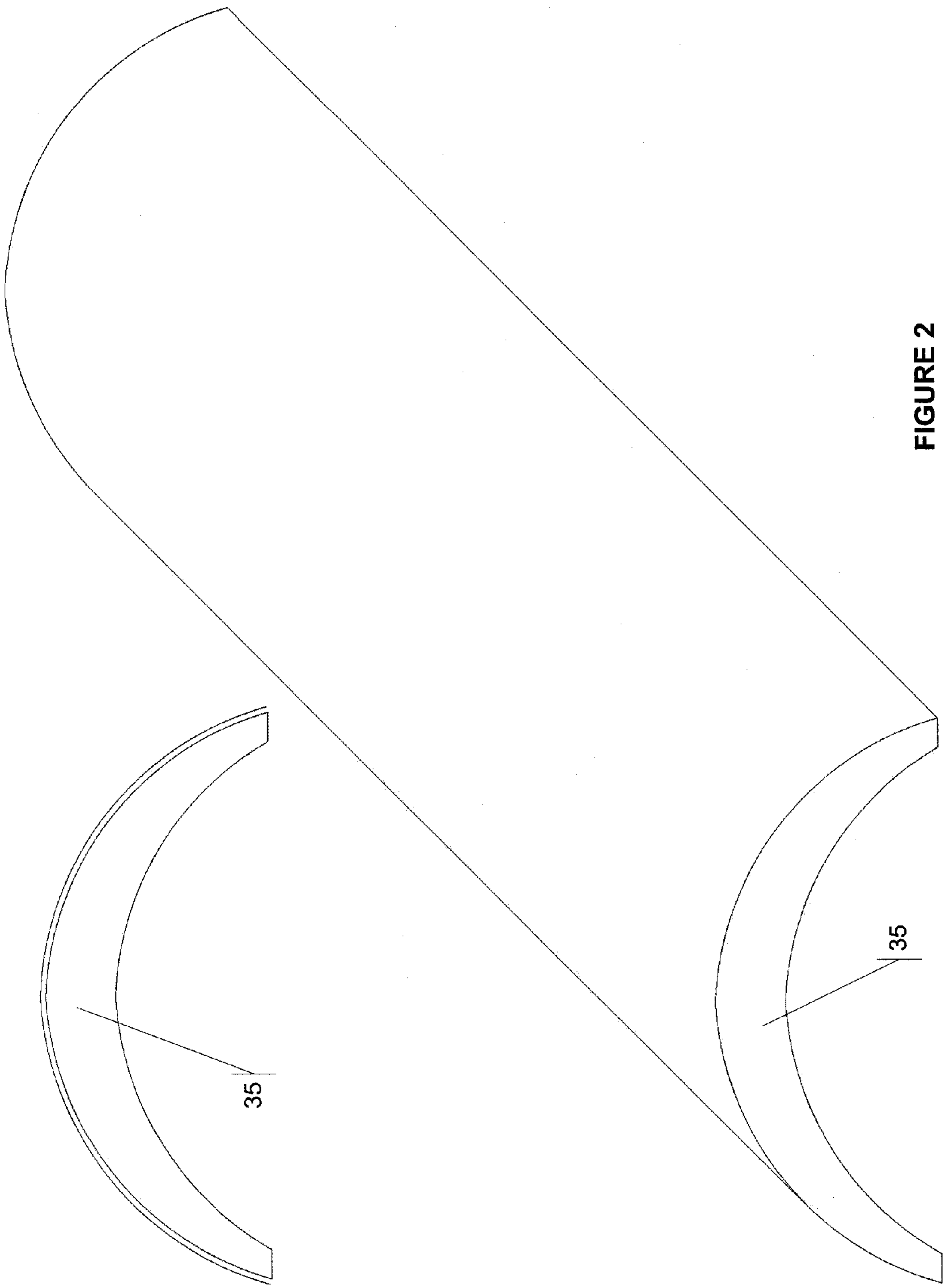


FIGURE 2

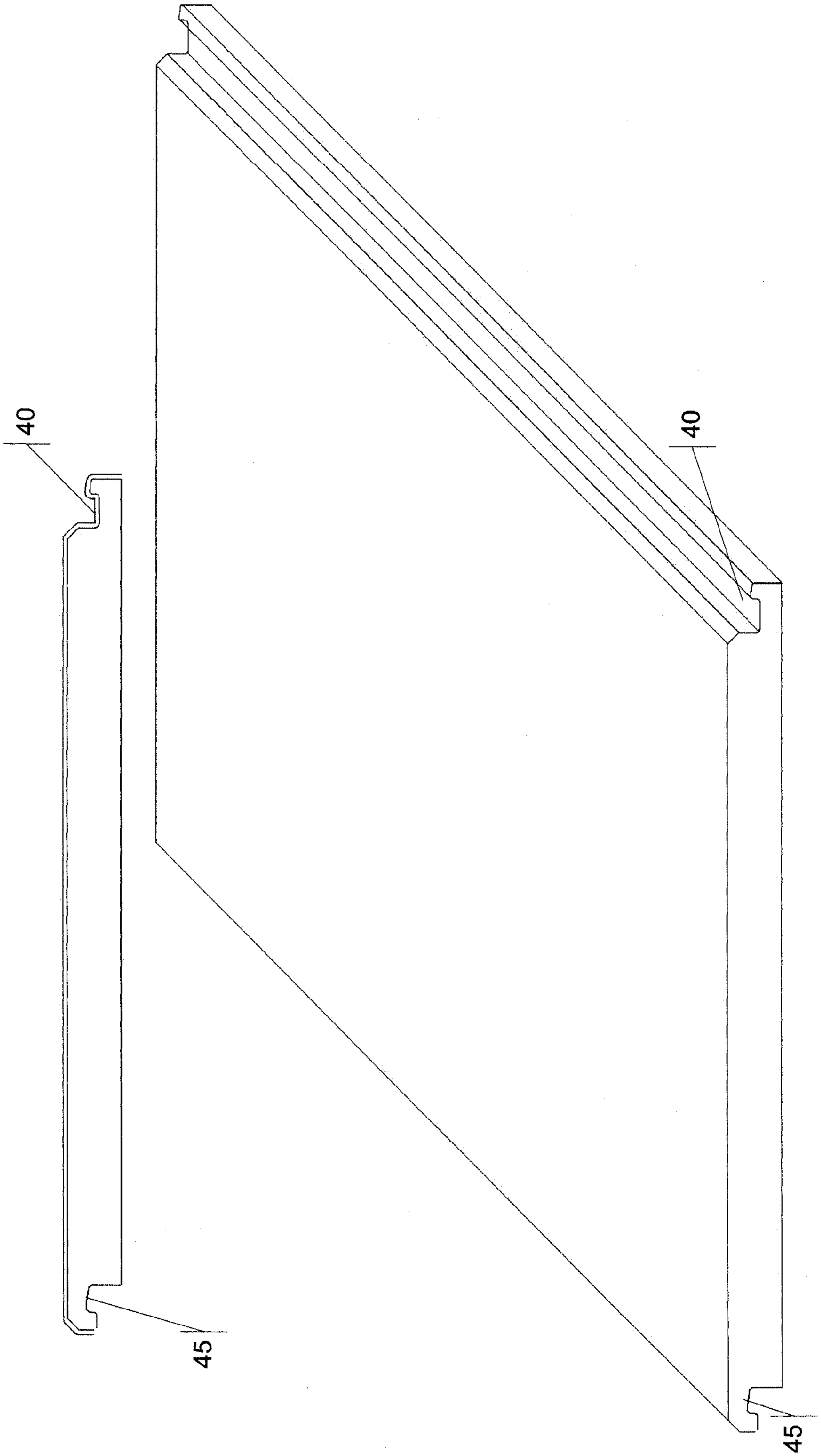


FIGURE 3

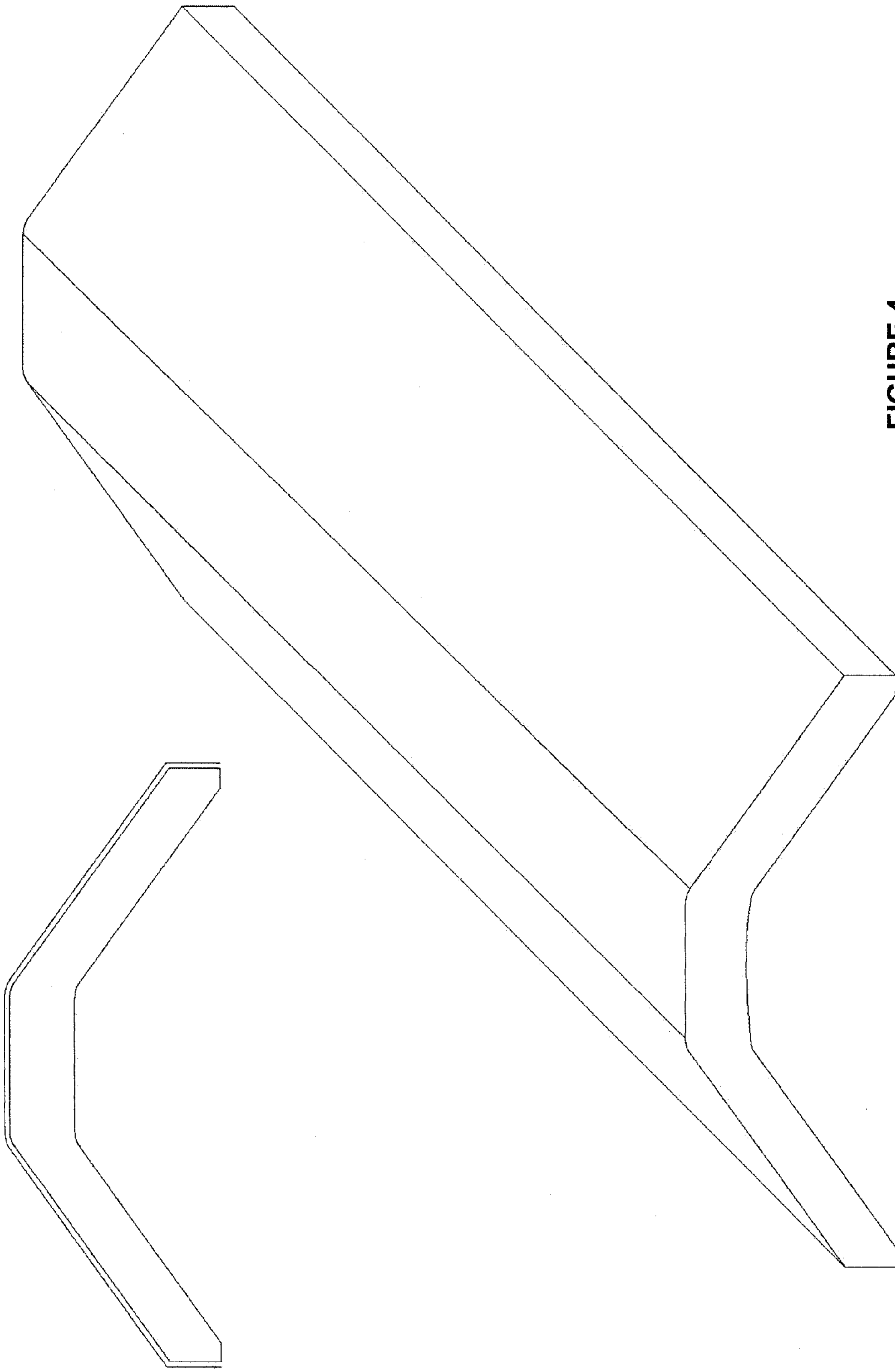


FIGURE 4

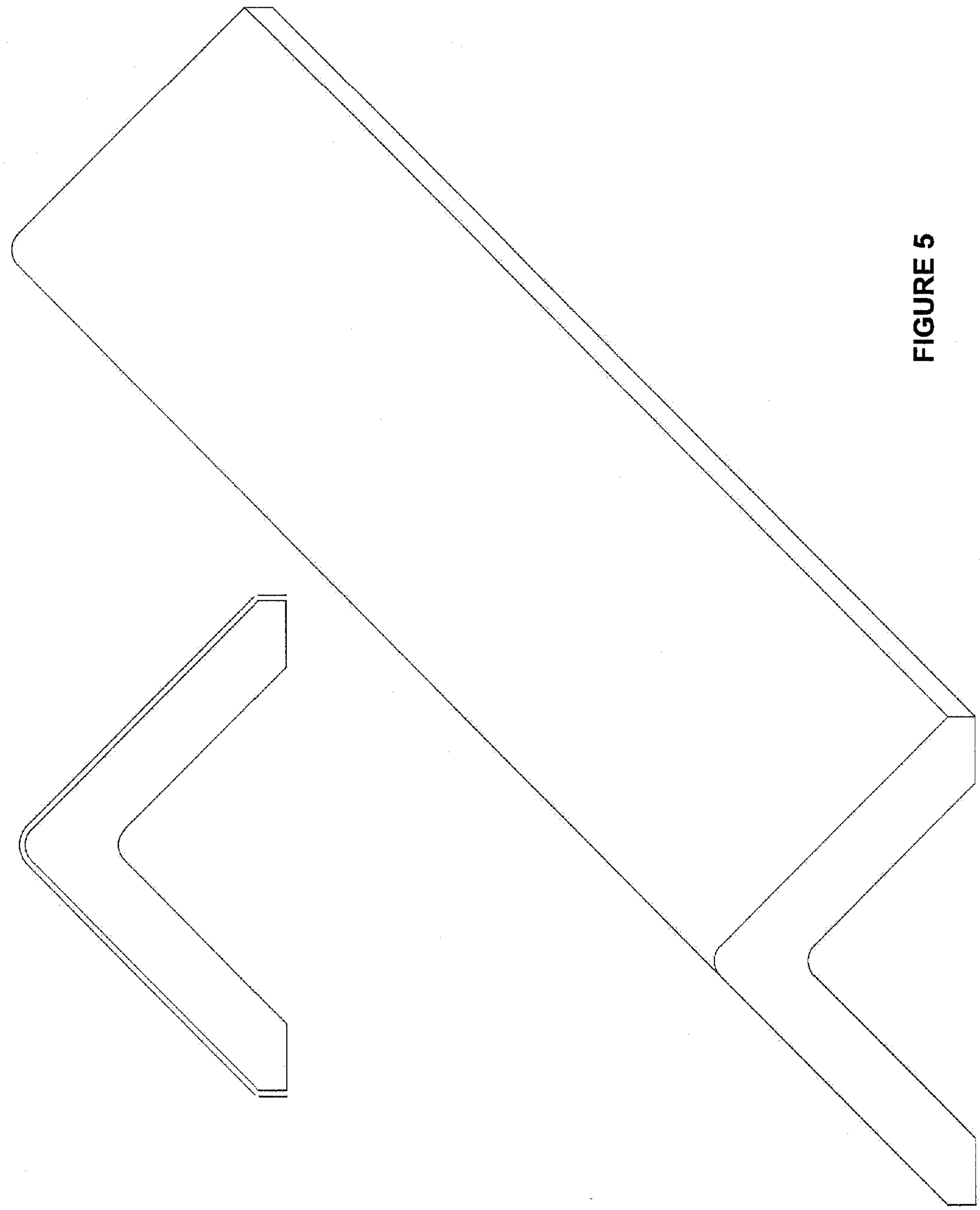


FIGURE 5

EXTERIOR ROOFING SURFACE COMPRISED OF FOAM AND CEMENT COATING

1. CLAIM OF PRIORITY

[0001] The present continuation-in-part patent application claims priority to U.S. patent application Ser. No. 11/348,173 filed on Feb. 6, 2006 by inventor Wilbur Dale McIntire, which is a continuation-in-part of U.S. provisional patent application 60/717,608 filed on Sep. 17, 2005 by inventor Wilbur Dale McIntire. The contents of these patent applications are incorporated herein by reference.

2. THE FIELD OF THE INVENTION

[0002] This invention relates to building products and, more particularly, to an external roofing surface comprised of foam and a cement coating.

3. THE BACKGROUND

[0003] Roofing surfaces have been used since ancient times to provide a weatherproof seal to living enclosures. Two of the most common types of roofing surfaces are tiles and shingles.

[0004] Tiles are extremely popular in current construction and are commonly made of clay or cement. They have many beneficial attributes including aesthetic appeal, non-ignitability, weather resistance and longevity. However, they also have several drawbacks because they are extremely heavy and very fragile. In fact, stepping on these tiles generally creates enough stress to break them. One way of increasing their strength is by adding thickness to the tile; however this added strength comes at the cost of significantly increased weight.

[0005] The other types of common roofing surfaces are asphalt and wood shingle. Asphalt is fire resistant but provides very little additional strength to the roof, and consequently wears over time. Asphalt roofs commonly must be replaced every 10 to 15 years. Wood shingles also must be replaced because they suffer from rot and have the added detriment of not being completely fire resistant. Both of these shingle types are also very limited in their aesthetic appeal. Whereas with concrete/clay tiles you can select non-planar shapes, shingles are generally sheet-like structures with no shape options.

[0006] Providing a weatherproof seal is a roofing surface's fundamental purpose. Roofs are generally sloped to shed rain and snow effectively. When the pitch of the roof is steep, the installation, maintenance and support of the roofing surface becomes an issue. Workmen may step on the roofing surface during construction or repairs, so the strength of the tiles is a major concern. The tiles often have a weak point at the overlap regions or at their unsupported centers. Breaking tiles effectively defeats the fundamental purpose of a roof by exposing the interior of the structure to water. Thus, the roofing surface must be strong and durable.

[0007] Strength is also important to the manufacture, shipping and handling of the roofing surface. The stronger the roofing surface material, the less will be lost due to shipping and installation breakage. But strength cannot come at the price of increased weight. The shipping cost for such weighty cargo can be significant, and tolling on the environment because of high emissions during transport. Also, a heavy roof requires a sizeable substructure, which also impacts the environment by requiring more lumber. And ultimately a heavy roof can be a safety hazard in an accidental roof collapse.

[0008] The porosity of roof tiles is also very important in climates with a repetitive freeze-thaw cycle. The more porous a roof surface is, the more water it will absorb. Once that water freezes, the roofing surface can split or crack, compromising the weatherproof seal.

[0009] Another important feature of a roofing system is its insulation attributes. Asphalt shingles have a very low insulation rating, meaning that heat is allowed to cross the roof structure. In the winter, heat escapes the roof, while in the summer heat enters the structure. In either event, the energy costs in managing the heat transfer are significant. Therefore, a roofing system that enjoys a high insulation rating will promote significant energy savings.

[0010] A roofing system should also resist damage on the underside. Roofing surfaces often obstruct free flow of air on the underside. Air movement is beneficial because it evacuates condensation that can form on the underside, as well as any moisture that may have leaked through a crack in the roofing surface. Without ventilation, however, the moisture can begin to compromise the roof by rotting away the roof's support. When the moisture freezes it may compromise the roofing surface by affecting the joints. Unfortunately, most conventional roofs do not have sufficient ventilation.

[0011] An important feature of a roofing surface is its ability to protect the roof deck below it by resisting fire, both from direct exposure to burning materials or flames and indirect exposure to fire from adjacent burning materials. A roof deck may be combustible, formed of wood such as sheathing boards or plywood, or noncombustible, formed of metal, concrete, or poured gypsum. Roof tile manufacturers submit their roofing surfaces to testing laboratories, such as Underwriters Laboratories Inc.® (UL), that test the roofing surfaces using proprietary test standards. Testing may result in a Class A, B, or C rating, or no rating at all, with the A rating being the most rigorous; thus providing the best fire protection. The rating gives consumers an indication of the roofing surface's effectiveness against external fire hazards.

[0012] As particularly applied to roof covering, UL has issued a standard entitled "*UL Standard for Safety for Standard Test Methods for Fire Tests of Roof Coverings, UL* 790", Eighth Edition, Dated Apr. 22, 2004 (the "UL 790 standard") to test the fire protection characteristics of a particular product. To receive a Class A rating under the UL 790 standard, a roofing surface must pass Class A tests, demonstrating it is effective against severe fire test exposures, affords a high degree of fire protection to the roof deck underneath the roofing surface, does not slip from its position, and is not expected to produce flying brands. A brand is a charred piece of wood or ember. Class B roof surfaces are only effective against moderate fire test exposures, affording a moderate degree of fire protection to the roof deck, while Class C roof surfaces are effective against light fire test exposures, only offering a light degree of fire protection to the roof deck.

[0013] For non-wood shake roofing surfaces, the UL 790 standard employs three tests: Intermittent Flame, Spread of Flame and Burning Brand. These tests simulate fire sources originating from outside a building on which the roofing surface is installed. For all three tests, the roofing surface is first installed over a test roof deck. In addition, a twelve mile-per-hour air current, simulating wind, flows uniformly over the top of the roofing surface during each of the tests. The

Intermittent Flame test demonstrates a roofing surface's resistance to flames from adjacent burning material. During a Class A test, a 1400° F. (+/−50° F.) gas flame is intermittently applied to the roofing surface for fifteen four-minute cycles (two minutes flame on, two minutes flame off) to simulate the ebb and flow of fire. During each cycle, the flame is applied for two minutes, then turned off for two minutes. After the last application of fire, the air current is maintained until all evidence of flame, glow, and smoke has disappeared from the roofing surface.

[0014] The Burning Brand test exposes the roofing material to a burning brand, or block of wood, to simulate exposure to burning materials such as a burning ember produced in a large fire. Class A tests use a twelve inch-by-twelve inch brand that is ignited by exposure to flame for five minutes, during which time the brand is rotated to present each surface to the flame. The burning brand is then placed on the roofing surface. The test continues until the brand is consumed and until all evidence of flame, glow, and smoke has disappeared from the roofing surface and the underside of the roof deck, or when the roof deck fails due to flame penetration, or burn-through, to the underside of the deck. The burning brand must fully extinguish without burning through or igniting the roof deck.

[0015] And third, a Spread of Flame test ensures there will be no significant lateral spread of a flame on the roof deck. In a Class A test, the roofing surface is exposed to a gas flame of 1400° F. for ten minutes or until such time as the spread of flame, or flaming of the roofing surface being tested, permanently recedes from a point of maximum spread, whichever is shorter.

[0016] Successful completion of each of these tests requires that no portion of the roofing surface be blown or fall off the test deck in the form of flaming or glowing brands, that the roof deck not be exposed by breaking, sliding, cracking, or warping of the roofing surface, and that no portion of the roof deck fall away in the form of glowing particles. In addition, at no time during the tests can there be any sustained flaming of the underside of the deck. Sustained flaming is considered uninterrupted flaming for five seconds or more. In addition, for the Spread of Flame Class A test, the flaming of the roofing surface cannot spread beyond six feet and there can be no significant lateral spread of flame from the path directly exposed to the test flame.

[0017] Currently available roofing surfaces may provide Class A, B, or C fire resistance protection, depending on the fire-resistance properties of the specific roofing material and compliance with the manufacturer's installation instructions. However, some roofing surfaces have not undergone certification testing and may not designate any level of protection. In addition to cost, strength, porosity, insulation rating, ventilation properties, and aesthetic appeal, consumers consider the increased fire protection afforded by a Class-A certified roofing surface to be a highly desirable feature.

[0018] What is needed therefore is a roofing surface that is lightweight, strong, and fire-resistant and has a high insulation rating. Such a surface should also have various cross-sectional shapes to increase aesthetic appeal and finally should offer ventilation to the underside. Thus, a roofing system is provided in accordance with the invention that obtains several structural advantages, manufacturing advantages and advantages in installation.

4. SUMMARY OF THE INVENTION

[0019] An external roofing surface comprised of foam and a cement coating is disclosed. The roofing surface is certified Class A fire-resistant under the UL 790 standard, very strong and extremely lightweight. The surface also resists insects including termites and carpenter ants. Various types of foam may be used; including expanded polystyrene, high density foam, Styrofoam, blue board, polystyrene, injection foams, MDI monomer, polyurethane resins, extruded foam, expanded polystyrene, expanded plastic foam, expanded polyethylene and nylon. The foam is also easily shaped by a number of shaping techniques (including hotwire, extrusion, casting, routing, punching, cutting, drilling, hand carving, infusion, laser cutting, and water jet cutting), which allows for a more aesthetically pleasing appearance and can be used to make a roofing system that interlocks and has channels for underside ventilation.

[0020] A cement coating is applied to the foam. The coating includes one or more additives that impart excellent water repellant properties to the roofing surface and also increase its strength, durability, and aesthetic appeal. Reinforcement materials may also be applied internally or externally to the roofing surface. These materials may include fiberglass mesh, shopped fiberglass, polypropylene fibers, metal mesh, polyurethane mesh, nylon mesh, and polymers. A second coating of paint, cement, concrete, polyurethane, vinyl, latex, oil, metal, epoxy, plastic and copolymers may also be applied for enhanced strength, durability, or aesthetic appeal.

5. BRIEF DESCRIPTION OF THE DRAWINGS

[0021] FIG. **1** depicts a cross-sectional view and overall view of a novel foam and cement tile with an interlocking area.

[0022] FIG. **2** depicts a cross-sectional view and overall view of a novel foam and cement tile.

[0023] FIG. **3** depicts a cross-sectional view and overall view of a novel foam and cement tile with an interlocking area.

[0024] FIG. **4** depicts a cross-sectional view and overall view of a novel foam and cement ridge cap tile.

[0025] FIG. **5** depicts a cross-sectional view and overall view of a novel foam and cement ridge cap tile.

6. DETAILED DESCRIPTION

[0026] An external roofing surface comprised of foam and a cement coating is disclosed and overcomes the deficiencies that mar conventional roofing systems. The roofing surface is fire-resistant, insect resistant, very strong and extremely lightweight. One embodiment of the external roofing surface is comprised of expanded polystyrene (EPS). EPS is generally produced from a mixture of about 95% polystyrene and 5% gaseous blowing agent (e.g. pentane). The solid plastic can be expanded into a foam by using heat, usually steam. During the pre-expansion, steam softens the plastic resin causing the pentane to expand the plastic into beads at least 100 times their original size. As long as the plastic is exposed to steam, the pentane expands enlarging the size of the beads by filling the voids with trapped air. Before all of the pentane is displaced by air, the pre-expanded bead is then placed into a mold of any shape or block that can be easily cut. Polystyrene can also be extruded and is commonly known by the trade name Styrofoam®.

[0027] The foam can be manufactured such that the surface is treated to be weatherproof—i.e., the ability to withstand exposure to weather without damage. For example, the foam may be extruded, cast or laser cut (as described below), which may result in a smooth surface that may be inherently weatherproof. Or, as described below, materials can optionally be added internally or externally to the foam, which may increase the foam's strength and water resistance.

[0028] The large void space makes EPS foam very lightweight and thus requires much less rigid structural supports. This, in turn, reduces construction costs and saves valuable lumber.

[0029] An added advantage of EPS is that it is an exceptionally good insulation material. Because the foam generally consists of air-filled pockets—in some instances 0.2-0.5 mm across with polystyrene walls about 0.001 mm thick—the polystyrene walls occupy only about 2% of the total volume. Air is a very poor conductor of heat, thus little heat can move through the EPS structure. The roof therefore acts as an insulator that cuts down on construction costs (less insulation needed elsewhere, smaller heating and air conditioning equipment, etc.) and cuts down on the buildings energy costs.

[0030] EPS also creates a tile that is much more durable than conventional materials. In comparison to clay tiles that are very brittle and will break during shipment and installation, a foam-based tile can be dropped on the ground and stepped on without damaging it. Because it is so lightweight, it is easier to handle, install and does not pose the danger of accidental injury from a falling tile. EPS is also weather and insect resistant and does not wear as easily as other convention roofing materials.

[0031] While the roofing surface has been described as comprised of EPS, other types of foam would be apparent to those skilled in the art. Those foams include high density foam, Styrofoam®, blue board, polystyrene, injection foams, MDI monomer, polyurethane resins, extruded foam, expanded polystyrene, expanded plastic foam, expanded polyethylene and nylon.

[0032] a. Shaping the Foam

[0033] In one embodiment of the roofing surface, a roofing tile is constructed of EPS. This type of foam can be purchased in large blocks that measure 49"W×37"H×96"L. The block is cut and shaped to size by using a computer assisted cutting machine. Before cutting however, the precise cuts must be programmed into the computer. For the shape depicted in FIG. **1**, the cross sectional shape **5** is programmed into the computer first. The block is then placed on the computer assisted cutting machine, in this case hot wire, which cuts the block into several tiles that are 96" long. To assist in shipping, handling and installation, the 96" long tiles are further cut into 18" sections by the computer assisted machine.

[0034] In another method of shaping, the foam is extruded into the desired shape. For example, again referencing FIG. **1**, the foam can be extruded through a die that yields the cross-sectional shape **5**. This is advantageous because it negates the first shaping step described above and cuts down on wasted material. The extruded foam block, with the desired cross-sectional area, could further be separated into the desired sections (i.e., 18" in the embodiment above). This can be accomplished by interrupting extrusion when the desired length is achieved, or by cutting the extruded foam to the desired length by any of the shaping methods described herein.

[0035] In yet another shaping method embodiment, the foam can be cast into the desired shape. By injecting the foam, which is still in an unhardened state, into a preformed cast, no other shaping methods may be necessary. This again cuts down on material waste.

[0036] These shaping techniques can be used to provide channels on the underside of the tile that promote ventilation. For example, the foam can be extruded in the shape depicted in FIG. **1**, which shows a ventilation channel **10**. The channel may reduce the amount of condensation on the underside of the roof, which will cut down on the deleterious effects of condensation. Examples of other cross sectional shapes are shown in FIGS. **2** to **5**.

[0037] These shaping techniques can also be used to provide reinforcement structures such as ribs, ridges and channels. FIG. **1** depicts ridges **15** and channels **20** that add strength and aesthetics. The shaping technique employed can also be used to preferentially shape more foam on areas that need more strength, such as the unions between tiles where conventional tiles often fail. FIG. **2** depicts a tile that has more foam placed on the top of the arch **35**.

[0038] These shaping techniques can also be used to manufacture interlocking tiles. For example, the tiles may have appropriate ridges, channels and fastening points to allow the interlocking of successive rows of roof tile, with the bottom edge of each row overlapping the top edge of a lower row along the line. Tiles shaped and installed in this layout produce an effective moisture barrier and an aesthetically pleasing appearance. For example, FIG. **1** depicts an interlocking area **25** that would mate with interlocking area **30**. FIG. **3** also has a similar interlocking feature where area **40** mates with are **45**. While the shaping of the tiles is described with reference to a computer-assisted hotwire, extrusion and casting, other shaping methods would be apparent to those skilled in the art. Those methods may include, but are not limited to, routing, punching, cutting, drilling, hand carving, infusion, laser cutting, and water jet cutting. They may further include any of these methods controlled or assisted by a computer. It should also be apparent that these shaping techniques could be used to form several shapes and sizes of tiles, such as those depicted in FIGS. **1-5**.

[0039] b. Reinforcement Materials and Methods

[0040] Generally, reinforcement can be applied internally or externally to the foam. In one embodiment of an external reinforcement material, a self-adhesive fiberglass mesh is applied to the exterior of the foam after shaping. The mesh provides added strength to the foam. Other types of mesh may also be used and would be apparent including: shopped fiberglass mesh, polypropylene fiber mesh, metal mesh, polyurethane mesh, nylon mesh, and polymer-based mesh.

[0041] Non-mesh materials may also be applied to the exterior of the foam. For example, the copolymer known in the trade as Elotex® FX2320 may be appropriate. It is a redispersible binder based on a copolymer of ethylene and vinyl acetate. In the cured state, this polymer has a high strength, has an excellent freeze-thaw cycling resistance, is very flexible and impact resistant. It also adheres very strongly to foam. Alternatively, Elotex® product FX2300 can be used in place of FX2320. More information on Elotex™ FX2320 and FX2300 may be obtained by contacting ELOTEX AG or by visiting www.elotex.com.

[0042] Reinforcement applied internally may also increase strength. One method introduces nylon or fiberglass fibers to the foam prior to curing. Adding co-polymers and plastics to the non-cured foam may also strengthen it. In yet another embodiment, adding a fiberglass mesh that is imbedded in the foam provides added strength. Of course several other types of embedded structures may be used; including shopped fiberglass, polypropylene fibers, metal mesh, polyurethane mesh and nylon mesh.

[0043] While reinforcement is described with reference to above embodiments, other reinforcement materials and methods would be apparent to those skilled in the art. Instead of applying a certain material (or in conjunction therewith), structural modifications can also be used for reinforcement. Ridges, ribs or channels may be introduced to the foam structure of the roofing tile such that forces applied to the surface of the tile are more effectively balanced. Additional foam may be added to areas on the tile that may need more strength, such as the union between tiles where conventional tiles often fail. Alternatively or in conjunction, additional reinforcement material may be added to the areas that require more strength.

[0044] c. Coating Materials and Methods

[0045] A cement coating is applied to the surface of the foam and may serve one or more of the following general attributes: appearance, protection, and strength. Specific attributes may include high compressive and tensile strength, corrosion resistance, temperature durability, inertness and colorfastness. The coating material may also serve the function of the reinforcement materials discussed above.

[0046] The coating is made from a cement mixture. Specifically, the mixture may include the following components: cement, sand, fly ash, pigment, water, hydration agent, and a waterproofing agent. The mixture is prepared and applied to the surface of the tile. The mixture is then dried, so as to harden it and affix it to the foam. This drying may simply be done at room temperature or by exposing the coating to heat. It is also important to note that depending on the coating material, drying may not be necessary.

[0047] Another coating material known by the trade name "Blue Eagle Brand Eaglebond" is available from Eagle Building Materials at 1407 N. Clark, Fresno, Calif. 93703-3615. This material is a proprietary blend of cement modified with redispersible powders, copolymers and inert aggregate. This coating is mixed as per the instructions of the vendor and applied to the foam. The vendor further recommends a curing time of at least 24 hours before performing any further work.

[0048] The coating may optionally be comprised of a copolymer agent such as Elotex® FX2320 described above.

[0049] Elotex® also makes sealing and waterproofing agents that may optionally be used. SEAL80, as it is known in the trade, is a redispersible, silane based waterproofing/water-repellency agent. It may be used alone or mixed with the cement coating already described. If mixed with cement and other dry additives, SEAL80 provides between 0.2 and 2.0% of the dry mixture. SEAL80 is very hydrophobic and offers excellent water repellancy. The effect of adding SEAL80, with its high degree of water repellency and hydrophobicity, is to decrease permeation of water into the cement coating and decrease the absorption of water by the coating. In its cured state, SEAL80 also provides the additional benefits of resisting dirt and slightly improving the final strength, bending tensile strength, compressive strength and abrasion resistance of the final coating. Alternatively, Elotex® product ERASEAL120 can be used in place of SEAL80. In addition to the SEAL80 properties noted above, ERASEAL 120 has the additional advantage of minimizing any potential color change in the final coating. More information on Elotex® SEAL80 and ERASEAL 120 may be obtained by contacting ELOTEX AG or by visiting www.elotex.com.

[0050] Another Elotex® product, HD1501, can also be used to greatly enhance the coating's strength and resistance to weather. A redispersable binder based on a copolymer of vinyl acetate and vinyl verstate, HD1501 is particularly suitable in cement-based systems where it provides a high final strength and increased flexural strength and abrasion resistance in its cured state. HD1501 also increases cohesion and adhesive bond strengths, particularly when used on polystyrene foam products. HD1501 increases plasticity and flexibility, such that it provides greatly improved resistance to freeze-thaw cycles and reduced cracking. As with SEAL80, HD1501 increases the water repelling and waterproofing properties of the cement coating and decreases the absorption of water by the coating. Alternatively, Elotex® products HD1500 and HD 1510 may be used in place of HD1501. More information on Elotex® HD1500, 1501 and 1510 may be obtained by contacting ELOTEX AG or by visiting www.elotex.com.

[0051] Finally, ELOSET® CP3901 can be used by itself or in combination with the above products to enhance the coating's performance. CP3901 is a water dispersible natural polymer that is designed to impart water retentive properties in cement coatings and to ensure the proper level of cement hydration. Again, more information on Elotex™ ELOSET® CP3901 may be obtained by contacting ELOTEX AG or by visiting www.elotex.com.

[0052] Several other coatings would be apparent to those of ordinary skill in the art, such as, materials that may strengthen, protect and/or improve the appearance of the foam. These coatings may include paint, cement, concrete, polyurethane, vinyl, latex, oil, metal, epoxy, plastic and copolymers. These coating may also be a sheathing structure such as metal, plastic, and natural rock.

[0053] In some cases it may be favorable to coat the entire tile. For example, where condensation may collect on the interior surface of the tile, a coating material may help protect the integrity of the foam. Another alternative is to apply the coating to only the surface of the foam that will be exposed to the elements. Or, different coatings may be applied to different surfaces to optimize the resilience of the tile. For example, a less durable coating may be applied to surfaces that are not exposed to the elements, while a more durable coating is applied to the surface that is exposed. Also, one or more layers of different coatings may be used. Various implementations would be obvious to one skilled in the art.

[0054] In one embodiment the coating mixture shown in Table 1 is used and applied to the EPS foam in two separate coatings. First, the EPS foam is shaped in one of the methods described above. Then fiberglass netting with a density of 5 oz./yd^2 is applied to the top surface of the roofing surface. Fiberglass netting with a density of 2.5 oz./yd^2 is also applied to the bottom surface of the roofing surface. Then a ⅛" cement coating (see Table 1) is applied to the top surface and allowed to cure. A second 1/16" thick coating is applied to the top surface and a similar 1/16" thick coating is applied to the bottom surface. These coating may optionally have pigments to add color to the final roofing surface. After curing, the roofing surface may be installed.

TABLE 1

Cement Coating Mixture	
Material	Approx. % of Dry Weight
Cement	34
Sand	58
Fly Ash	.3
Water dispersible natural polymer, hydration agent	.02
Redispersable (vinyl copolymer) water-repellency agent	4.7
Redispersible silane based water-repellency agent	.28

[0055] c. Fire Protection Test Results

[0056] The roofing surface described herein is designated by Underwriters Laboratories Inc.® (UL) for installation as a Class A prepared roof covering under the UL790 standard, for use on either combustible or noncombustible roof decks when the roofing surface is applied as intended. The combination of light weight (due to EPS composition) and superior fire resistance allows someone additional time to exit a burning building without fear of the roof caving in as it may in the case of heavier clay and concrete roofing tiles.

[0057] The roofing surface's Class A resistance to external fire provides significant assurances and greatly increases its effectiveness. The roofing surface passed three rigorous UL certification tests to attain a Class A certification. Specifically, the roofing surface passed Intermittent Flame tests, during which a 1400° F. gas flame was intermittently applied to the roofing surface during fifteen four-minute cycles and a twelve mile-per-hour air current flowed over the roofing surface. No portion of the roofing surface was blown or fell off the roof deck in the form of flaming or glowing brands, nor was the roof deck exposed by breaking, sliding, cracking, or warping of the roofing surface. No part of the combustible 15/32 inch plywood roof deck (the roof deck used during the certification process) fell away in the form of glowing particles, nor did it sustain flaming on its underside.

[0058] The roofing surface also passed Burning Brand tests, in which a twelve inch-by-twelve inch brand was ignited and placed on the roofing surface. Test observations were made until the brand was consumed and testing ceased. No portion of the roof surface was blown or fell off the roof deck in the form of flaming or glowing brands, and the roofing surface protected the roof deck such that it was not exposed by breaking, sliding, cracking, or warping of the roofing surface. The underside of the roof deck experienced no sustained flaming, and no portions of the roof deck fell away in the form of glowing particles.

[0059] In a Spread of Flame test, the roofing surface was exposed to a gas flame of 1400° F. for ten minutes. With a maximum spread of flame of 3.5 feet and no significant lateral spread of the flame from the path directly exposed to the test flames, the roofing surface passed the test. As with the other tests, no portion of the roofing surface was blown or fell off the roof deck in the form of flaming or glowing brands, the roof deck was not exposed by breaking, sliding, cracking or warping of the roof surface, and no portions of the roof deck fell away in the form of glowing particles.

[0060] Thus, the roofing surface is certified to carry the UL Class A listing mark for Prepared Roof Covering Materials. This certifies the roofing surface is effective against severe fire test exposures, under which it affords a high degree of fire protection to the roof deck. The roofing surface is also certified not to slip from its position and is not expected to produce flying brands during severe fire test exposure. In sum, this significant degree of fire resistance is a particularly advantageous and effective feature.

[0061] The embodiments above provide a roofing surface that is certified Class A fire-resistant under the stringent UL 790 standard. The surface is strong, lightweight and resists insects including termites and carpenter ants. The surface promotes a healthier environment because of it is light weight which (1) cuts down on transportation exhaust emission and (2) requires less lumber to support the surface. Also, the foam used in the roofing surface acts as an insulator that cuts down on construction costs (less insulation needed elsewhere, smaller heating and air conditioning equipment, etc.) and cuts down on the buildings energy costs.

[0062] Having described the methods and structures in detail and by reference to several preferred embodiments thereof, it will be apparent that modifications and variations are possible without departing from the scope of the invention defined in the following claims. Moreover, the applicant expressly does not intend that the following claims "and the embodiments in the specification to be strictly coextensive." *Phillips v. AHW Corp.,* 415 F.3d **1303**, **1323** (Fed. Cir. 2005) (en banc).

1. An external roofing surface comprising:

a structure comprised of foam and a cement coating applied to the foam;

wherein the cement coating further comprises a redispersable additive comprising a vinyl copolymer and a silane based agent;

wherein the additive imparts the following attributes to the cement coating: increased water repellency, increased final strength, increased flexural strength, increased abrasion resistance, increased flexibility, improved resistance to freeze-thaw cycles, and reduced cracking;

the structure further comprises a reinforcing structure selected from a group consisting of: ridges, ribs, channels, and combinations thereof, and

wherein the roofing surface meets or exceeds the Class A certification requirements of the UL 790 Standard as issued by the Underwriter Laboratories.

2. An external roofing surface comprising:

a structure comprised of foam and a cement coating applied to the foam;

wherein the cement coating further comprises a redispersable additive;

wherein the additive imparts the following attributes to the cement coating: increased water repellency and decreased absorption of water; and

wherein the roofing surface meets or exceeds the Class A certification requirements of the UL 790 Standard as issued by the Underwriter Laboratories.

3. The roofing surface of claim **2**, wherein the additive is a vinyl copolymer and wherein the additive imparts the following additional attributes to the cement coating: high final strength; increased flexural strength, and increased abrasion resistance.

4. The roofing surface of claim **2**, wherein the additive is a vinyl copolymer and wherein the additive imparts the following additional attributes to the cement coating: increased flexibility, improved resistance to freeze-thaw cycles, and reduced cracking.

5. The roofing surface of claim **2**, wherein the additive is a silane based agent and wherein the additive imparts the following additional attributes to the cement coating: increased final strengths, improved bending tensile strength and improved compressive strength.

6. The roofing surface of claim **2**, wherein the additive is a silane based agent and wherein the additive imparts the following additional attributes to the cement coating: reduced susceptibility to dirt and improved abrasion resistance.

7. The roofing surface of claim **2**, wherein the cement coating further comprises a water dispersible natural polymer that imparts water retentive properties to the cement coating.

8. The roofing surface of claim **2**, wherein the foam comprises EPS and the structure further comprises a fiberglass reinforcing mesh.

9. The roofing surface of claim **2**, wherein the structure is shaped.

10. The roofing surface of claim **2**, wherein the structure is shaped by using a shaping technique selected from a group consisting of: hotwire, routing, laser cutting, punching, extrusion, cutting, drilling, casting, infusion and combinations thereof.

11. The roofing surface of claim **2**, wherein the structure is shaped by using computer assistance.

12. The roofing surface of claim **2**, wherein the foam is selected from a group consisting of: high density foam, blue board, polystyrene, injection foams, MDI monomer, polyurethane resins, extruded foam, expanded polystyrene, expanded plastic foam, expanded polyethylene, nylon and mixtures thereof.

13. The roofing surface of claim **2**, wherein the structure further comprises a reinforcing material selected from a group consisting of: foam, fiberglass mesh, shopped fiberglass, polypropylene fibers, metal mesh, polyurethane mesh, nylon mesh, polymers and mixtures thereof.

14. The roofing surface of claim **13**, wherein the reinforcing material is internal to the foam.

15. The roofing surface of claim **13**, wherein the reinforcing material is external to the foam.

16. The roofing surface of claim **15**, wherein the structure further comprises a second reinforcing material selected from a group consisting of: foam, fiberglass mesh, shopped fiberglass, polypropylene fibers, metal mesh, polyurethane mesh, nylon mesh, polymers and mixtures thereof.

17. The roofing surface of claim **2**, wherein the structure further comprises a reinforcing structure selected from a group consisting of: ridges, ribs, channels, and combinations thereof.

18. The roofing surface of claim **2**, wherein the structure further comprises a second coating material.

19. The roofing surface of claim **18**, wherein the second coating material is selected from a group consisting of: paint, cement, concrete, polyurethane, vinyl, latex, oil, metal, plastic and mixtures thereof.

20. The roofing surface of claim **2**, wherein the structure further comprises a sheathing structure.

21. The roofing surface of claim **20**, wherein the sheathing structure is selected from a group consisting of: metal, plastic, natural rock and mixtures thereof.

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