"SELF-ADHESIVE ROOFING LAMINATE HAVING SELF-EDGE SEALING PROPERTIES"

This invention relates to laminates containing bituminous waterproofing layers adapted for waterproofing and sealing structures.

Flexible sheet-like laminates of support films and self-adhesive bituminous waterproofing layers pre-formed in the factory have been successfully employed in roofing applications as substitutes for the more conventional waterproofing membranes which are constructed at the job site by plying together one or more layers of bitumen-saturated paper or felt and bituminous adhesives. The pre-formed, self-adhesive laminate-membranes offer many advantages including factory controlled preparation, avoidance of heating equipment and handling of hot materials at the job site, as well as many performance advantages.

Flexible pre-formed laminates of the afore-mentioned type and their use to form waterproofing layers in various kinds of building structures are described for example in U.S. Patent Nos. 3,741,856, 3,853,682, and 3,900,102 to John Hurst. Such patents describe in particular the preparation of flexible laminates containing a support material, for example a layer of a polymeric or metallic film, and a layer

of self-adhesive, or pressure-sensitive adhesive, bitumen-elastomer waterproofing composition. As discussed in particular in U.S. Patent 3,900,102, such laminates may ideally be constructed in the plant in the form of a roll with a protective sheet, for example siliconized paper applied against the self-adhesive bituminous waterproofing layer, transported to the job site, and thereafter applied to a substrate adhesive side down, each successive laminate strip being made to overlap the edge of the previously-applied strip of laminate to ensure a continuous waterproofing seal.

In Canadian Patent No. 1,008,738 to Everett R. Davis, improved waterproofing laminates of the type described in the aforementioned U.S. patents are described which utilize as the support material for such laminates, cross-laminated or biaxially oriented polymeric films. As discussed in the Canadian patent, such support films were found to provide laminates which exhibit reduced wrinkling following adhesion to a substrate and subsequent exposure to heat, for example, exposure to the sun. In recent years, flexible pre-formed laminates utilizing cross-laminated high density polyethylene films as the support layers for self-adhesive waterproofing layers of asphalt-rubber composition have been successfully applied in the form of overlapping strips to the rooftops of a variety of types of buildings to form long-lasting protective

membranes against the passage of water and moisture. Protective coatings containing for example inert aggregates, pigments, metal flakes, etc., have been applied to the exposed surfaces of the overlapped laminates which significantly increase the life of the waterproofing laminate-membrane. However, there is a continuing need in the art for improved flexible laminates for use as waterproofing membranes for roofs of buildings and the like.

The present invention provides improved pre-formed laminates having particular utility in constructing waterproofing layers upon roofs of buildings and the like. The new laminates are constructed of a layer of waterproofing pressure-sensitive or self-adhesive bituminous composition non-releasably adhered to an upper and preferably thinner flexible support layer comprised of materials of differing coefficient of linear thermal expansion arranged to give a desired self-sealing ability to the laminate. The laminates are preferably prepared with a further layer of protective material adjacent to the adhesive layer which is easily removable from the adhesive layer without damage thereto prior to application of the laminate to the substrate to be waterproofed. The laminate may additionally have protective coatings and/or films applied to the upper support layer before

or after installation upon the substrate to be waterproofed.

In the accompanying drawings:

Figure 1 is a perspective cross-sectional view of a roofing laminate according to the invention;

Figure 2 is a cross-sectional view of a preferred laminate construction of the invention exhibiting a "built-in" edge sealing ability;

Figure 3 is a view in cross-section of two overlapped laminates of the invention exhibiting a "built-in" edge sealing ability; and

Figure 4 is a perspective, cross-sectional view of a roof waterproofed according to the invention.

In Figure 1, the new roofing laminate is shown as comprised of a comparatively thick layer of self-adhesive bituminous waterproofing composition 1, adhered to a comparatively thinner support layer 7 which is made up of laminations 2 and 3 of separate, different, flexible sheet materials, for example two, different synthetic polymeric films. The layers 1, 2 and 3 are well-bonded to one another, that is, are not separable from one another normally without physical damage resulting to one or more of the layers. Layers 2 and 3 are adhered to one another by a thin layer of adhesive, not shown in the drawing, the sole

function of which is to adhere the two layers together. The self-adhesive bituminous waterproofing layer 1 normally has sufficient adhesive properties that additional adhesive to bond it thoroughly to the support layer 7 is not necessary. To protect the surface of the bituminous adhesive layer remote from layer 7, a removable protective sheet 4, of, e.g., siliconized paper is applied thereto. The sheet 4 adheres sufficiently to the bituminous adhesive to keep it in place during handling of the laminate, but is easily removable therefrom without physical damage to the layer 1.

The roofing laminate shown in Figure 2 has a width ("w"), e.g. 36 inches (91.4 cm), less than its length ("l"), e.g. 60 feet (18.3 m), and can conveniently be packaged in the form of a roll which is simply unrolled at the job site. Thereafter the protective sheet 4 is removed and the exposed surface of the bituminous adhesive layer 1 placed adjacent the substrate (5 in Figs. 2, 3, and 4) to be waterproofed. Another like strip of waterproofing laminate (Figure 3) is then placed adjacent to the laminate, care being taken to overlap the edges of each laminate a short distance in the manner shown for example in Figures 3 and 4 of U.S. 3,900,102 to Hurst. An additional continuous protective coating 6 in Figure 4, may then be applied

to the exposed surfaces of the overlapped laminates.

The self-adhesive or pressure-sensitive bituminous waterproofing layer 1 useful herein is preferably of the type described in the aforementioned patents. The adhesive composition comprises a mixture of (a) a bituminous material and (b) natural or synthetic polymer, preferably a rubber or other elastomer polymer. The amount of polymer employed in such compositions is typically from about 1 to 100, preferably about 20 to 50, percent by weight of the bituminous material. The term "bituminous material" as used herein includes compositions containing asphalt, tar such as coal tar, or pitch. The bituminous adhesive may be reinforced with fibres and/or particulate fillers. The adhesive composition may also contain a conventional extender component such as mineral oil. Suitable polymers include thermoplastic polymers such as polyethylene and the like. As aforementioned, the preferred polymer component is rubber which may be a virgin rubber or reclaimed rubber which is blended into the bitumen and preferably an extender oil component preferably at elevated temperature to form a smooth mix. Generally, suitable adhesive compositions have softening points (measured by the Ring and Ball method) of 70° to 120°C., preferably 75° to 100°C., and penetration values of 50 to 400, preferably 50 to 100 dmm. at 25°C (150 g/5-ASTM D217),

and are thermoplastic in nature.

As mentioned in the aforementioned patents, in order to give optimum sealing and waterproofing performance the adhesive layer should be at least 0.010 inch (0.25 mm) thick and preferably in the range of 0.025 to 0.200 inch (0.635 to 5 mm) thick. The adhesive layer can be comprised of one or more layers of the aforementioned bituminous adhesive, not necessarily of the same composition, to give an adhesive layer within the overall aforementioned thickness range. Further, the adhesive layer can have a reinforcement such as an open weave fabric, gauze, scrim or the like located therein to strengthen it. The adhesive layer 1, at least at its surface remote from support sheet 3, is pressure-sensitive and tacky at normal ambient temperature in order that it be self-adhesive to the substrate. The bituminous adhesive layer serves to form a continuous waterproofing covering which is elastic and self-sealing against punctures at high and low temperature.

The support layer 7 is comprised of a laminate which has been bonded to the layer 1 of adhesive. The support layer 7 serves as a strength imparting and supporting member in the laminate and also as a barrier to prevent moisture vapour transmission through the laminate. Thus while of less thickness than that of

the bituminous waterproofing layer 1, the support layer 7 should be of sufficient thickness to impart e.g. tear and puncture resistance to the laminate. The support layer 7 suitably has a thickness in the range of from 0.002 to 0.025 inches (0.05 to 0.635 mm), preferably from 0.004 to 0.010 inches (0.1 to 0.25 mm.).

The preferred sheet materials for use in the layer 7 are films of synthetic organic polymers such as polyethylene, polypropylene or other polyolefin; polyamide, polyester, e.g. polyethylene terephthalate, polyurethane, polyvinyl chloride, a copolymer of vinyl chloride and vinylidene chloride, synthetic rubber such as polychloroprene or butyl rubber. It is desirable that the upper sheet of film 3 have optimum weatherability characteristics. Thus polymeric films, e.g., may be rendered opaque, for example by the incorporation therein of a material such as carbon black to render the film non-translucent. Protective coatings and films such as thin pigmented coatings and films can be applied in the factory to the surfaces of the sheet 3 to be exposed to the weather.

Cross-laminated polymeric films and biaxially-oriented polymeric films are desirable synthetic polymer films for use in the layer 7. As discussed in the

aforementioned Canadian patent, such films are more dimensionally stable when laminated to bituminous adhesive of the type employed herein, adhered to a roof substrate, and exposed to heat from, e.g., the sun. Any film-forming synthetic polymer or copolymer which can be oriented (biaxially or cross-laminated) is useful. Biaxially oriented films of such polymers as polyolefins, e.g. high and low density polyethylene, vinylidene chloride, polystyrene, polyvinyl chloride, rubber hydrochloride, polyethylene terephthalate, etc., are commercially available. Especially useful films are biaxially oriented polyolefin and cross-laminated polyolefins. Preferred polymeric films for use in the support layer 7 are cross-laminated high density polyethylene films and biaxially oriented polyesters such as polyethylene terephthalate, desirably containing a filler such as carbon black to render the film opaque.

The layer of sheet material 2 positioned beneath layer 3 is selected to have a coefficient of linear thermal expansion less than that of the upper sheet material 3 leading to self-adhesive waterproofing laminates exhibiting a "built-in" edge sealing ability.

After adherence to the roof substrate of such laminates, the edges of the laminate will bend to curl downwardly towards the substrate in a "self-sealing" fashion after a period of time has elapsed. This is because in actual practice the adhered laminates are exposed to repeated periods of heating and cooling due to changes in atmospheric temperature. Since the upper flexible sheet layer 3 in the support has a thermal expansion coefficient greater than the underlying sheet layer 2 in the support and the two layers are intimately bonded to one another, the edges of the laminate tend to curl downwardly, effecting an enhanced waterproofing seal at its edges. This downward curl becomes irreversible because the thermoplastic bituminous adhesive retains the laminate in the downwardly curled position. The sheet materials 2 and 3 of differing linear thermal expansion coefficients employed in the support layer should be materials having (a) a substantially "lay-flat" appearance and (b) a relatively good thermal dimensional stability per se. By "substantially lay-flat appearance" is meant, that, when laid flat and non-adhered onto a flat, horizontal surface, the upper and lower surfaces of the sheet materials will be substantially parallel to such horizontal surface and exhibit substantially no curling upwardly or downwardly. By "good thermal dimensional stability" is meant that the sheet materials when exposed

to elevated temperature exhibit substantially no shrinkage or at least do not shrink to an extent which would interfere with the desired "self-sealing" effect of the laminate described above. Should one or both of the sheet materials 2 or 3 employed in the support layer 7 for example have a substantial degree of curl before application of adhesive layer 1, or shrink substantially when heated, the inherent curl or shrinkability of the material could interfere with the aforedescribed desired "self-sealing" ability of the laminate occasioned by use of the layers of differing linear thermal expansion co-efficients. The lower layer 2 of sheet material is preferably of lesser thickness than the upper layer 3 of sheet material in the support layer 7.

One example of a construction to exhibit the above described "built-in" edge sealing ability after adhesion to a roof substrate is the laminate shown in the attached drawings and described in our co-pending application No 81 18060 (2 078 612) filed on even date herewith, employing for example a layer of high density polyethylene having substantially "lay flat" characteristics and good thermal stability as described above as the first layer 3 of sheet material, and aluminum foil as the second layer 2 (which also has such "lay-flat" and "dimensional stability" properties). However, such a construction, being within the claims of our said co-pending application, is disclaimed from the present application as mentioned in greater detail hereinbelow.

Since the polythylene film has a linear thermal coefficient approximately 5 times as great as that of the aluminum film (Table I), the edges of the adhered laminate will bend or curl downwardly towards the adhesive layer as shown in Figures 2 and 3, in a "self-sealing" fashion after exposure to fluctuation in atmospheric temperature.

The self-sealing downward edge-curling shown in Figure 2 and 3 can be promoted by adhering to the face of sheet material 2 remote from film 3 an additional layer (not shown) of a lay flat sheet, for example a film of good dimension stability as described above and of lesser thickness than sheet 3 and having a thermal expansion coefficient lower than sheet 3. Similarly, the degree of downward edge-curling shown in Figures 2 and 3 can be offset or controlled to a desired extent by using as such additional sheet or film adhered to the face of metal 2 remote from sheet 3, a film having a linear thermal expansion coefficient greater than sheet 2.

The desired self-sealing downward edge curl shown in Figures 2 and 3 is obtained by preferably employing as the upper layer 3, lay flat polymeric films of good dimensional stability and having linear thermal expansion coefficients at least about twice as great as that of layer 2. Preferred synthetic polymer

films 3 for use in achieving the desired "self-sealing" properties of the laminates of the invention are those films which possess a linear thermal expansion coefficient greater than 30×10^{-6} per unit length per degree Fahrenheit (greater than 5.4×10^{-5} per degree Celsius). The linear thermal expansion coefficient of several films and foils are listed in Table I below.

TABLE I

FILM (FOIL)	Approximately Linear Thermal Coefficient per °F (°C)
Polyester	10 (18)
Aluminum	12 (22)
Polyvinyl fluoride	28 (50)
Nylon (polyamide)	55 (99)
Polycarbonate	36 (65)
Polymethyl methacrylate	39 (70)
Polyethylene	66 (119)

The "life" of waterproofing membrane layers formed using the waterproofing roofing laminates of the invention can be increased by the application of protective coatings, 6 in Figure 4, thereover at the job site following installation of the laminates upon the roof substrate. Such "field-applied" coatings are now in conventional use in connection with waterproofing laminates of the type described in the aforementioned

patents and have been found to add significantly to the endurance of the laminate-membranes. The coatings further protect the exposed synthetic polymer support films from harmful ultra-violet radiation and weather damage. Conventional "field-applied" coatings for this purpose are generally bitumen-, e.g. asphalt, based compositions, containing plasticizers, fillers, antioxidants, pigments, etc. Reflective particles in such coatings, such as particles or flakes of metal such as aluminum, reduce the temperature of the laminate-membrane layer. The protective coatings are typically applied to the surfaces of the installed laminate-membrane layer in thickness of from 0.002 to 0.070 inches (0.05 to 1.8 mm).

~~The invention is further illustrated by the~~ following examples.

Example 1

Three sample laminates useful for waterproofing purposes were constructed and tested for tendencies to curl at their edge after exposure to high and low temperatures. The construction of each laminate (Nos. ~~1 to 3) is shown in Table II.~~

~~the difference being that in place of the 7 mils thick~~ (0.2 mm) protective coating used in Table II, a thin, protective coating of "Surlyn" brand ionomer resin ("Surlyn" is a trademark of DuPont de Nemours, E.I. & Co.) was factory applied to the surface of the aluminum foil remote from polymer film "A" to give it weather protection. Approximately one month later a visual observation made of the applied laminate strip showed the edges tending ~~to curl upwardly away from the substrate.~~

While the roofing laminate strip of the present invention has been described in connection with its usage in the formation of a continuous waterproofing membrane upon a roof where for practical reasons a laminate having a width of at least ~~about~~ 36 inches (91.4 cm) is desired, strips having narrower dimensions can be utilized in other roofing applications. For instance, strips of the inventive laminate having a width of about 4 inches (10 cm) can be used to cover the joints between, e.g. insulation boards in roofs. Also, for, e.g., use as flashing strips in roofing applications, the laminate strips of the invention may have a width of, e.g. 12 inches (30 cm).

In our copending application No 81 18060, we describe and claim a waterproofed roof construction comprising a roof substrate and a continuous waterproofing layer adhered thereto made up of a plurality of strips of preformed, flexible waterproofing laminate, the said preformed laminates including an upper support layer of synthetic polymer film, a thin layer of metal positioned beneath and directly adhered to the support layer and a layer of waterproofing, pressure-sensitive bituminous adhesive composition which is beneath and adhered to the metal layer, said adhesive layer being adhered to the said roof substrate. We also claim a preformed, flexible roofing laminate in the form of a continuous strip having a length greater than its width and including an upper support layer of synthetic polymer film, a thin layer of metal position beneath and adhered directly to the support layer, a layer of waterproofing, pressure-sensitive bituminous adhesive composition which is beneath and adhered to the metal layer, and removable means to protect the surface of the adhesive composition remote from the said metal layer. Constructions and laminates which are within the scope of those claims are hereby disclaimed from the present application insofar as they may also be within the scope of the claims of this application.

CLAIMS

1. A waterproofed construction comprising a substrate having a continuous adherent waterproofing layer, the said waterproofing layer comprising a plurality of pre-formed, flexible pressure-sensitive adhesive waterproofing laminates, the said pre-formed laminates being comprised, prior to application to the said substrate, of an upper support layer (a) laminated to a lower layer (b) of waterproofing, pressure-sensitive, thermoplastic bituminous adhesive composition, adjacent to the said substrate, the said support layer (a) comprising first and second layers of flexible sheet material laminated together, the said second layer being between the said first layer and the said lower layer (b) of adhesive composition, the said first layer having a higher coefficient of linear thermal expansion than the said second layer, the said upper support layer (a) having relatively good thermal dimensional stability and exhibiting substantially "lay-flat" appearance prior to lamination to the said adhesive layer (b), so that, because of the said differing coefficients of thermal expansion, the edges of the said laminates are caused to curl downward towards the said substrate after application of the said laminates to the said substrate and exposure to elevated temperature.

2. A construction according to Claim 1 wherein the said adhesive composition comprises a mixture of a polymer and bitumen.

3. A construction according to Claim 2 wherein the said polymer is natural or synthetic rubber and the said bitumen is asphalt.

4. A construction according to Claim 2 or 3, wherein the said adhesive composition additionally contains mineral oil.

5. A construction according to any of Claims 1 to 4, wherein the said upper support layer (a) has a thickness of from 0.002 to 0.025 inches (0.05 to 0.635 mm), and said adhesive layer has a thickness of at least 0.010 inch (0.25 mm).

6. A construction according to any of Claims 1 to 5, wherein the said upper support layer (a) contains a sheet of a film of a polyolefin, polyamide, polyester, polyurethane, polyvinyl chloride, a copolymer of vinyl chloride and vinylidene chloride, or a synthetic rubber.

7. A construction according to Claim 6, wherein the said polymer film is a cross-laminated polymeric film or a biaxially-oriented polymeric film.

8. A construction according to Claim 6 or 7, wherein the said film comprises high density polyolefin or polyethylene terephthalate.

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9.A construction according to any of Claims 6, 7 or 8 wherein the said polymer film is employed as the said first layer of sheet material in the said laminates.

10. A construction according to any of Claims 1 to 8, wherein the said laminates are in the form of a continuous strip having a width of at least 36 inches (91.4 cm) and a length greater than said width.

11. A construction according to any of Claims 1 to 10, wherein the said laminates, prior to application to the said substrate, have a protective coating or film on the surface of the said upper support layer (a) remote from the said adhesive layer (b).

12. A construction according to Claim 11, wherein the said protective coating or film is pigmented.

13. A construction according to Claim 12, wherein the said pigment is carbon black.

14. A construction according to any of Claims 1 to 10, having a continuous protective coating over the said waterproofing layer applied after the formation of said waterproofing layer on the said substrate.

15. A construction according to Claim 14, wherein the said protective coating is a bitumen-containing composition.

16. A construction according to Claim 14 or 15, wherein the said protective coating contains metal particles.

17. A construction according to Claim 1, wherein the said second layer of the sheet material in the said upper support layer (a) is of lesser thickness than the said first layer of sheet material in the said upper support layer (a).

18. A construction according to Claim 1, substantially as hereinbefore described with reference to the accompanying drawings.

19. A preformed, flexible pressure-sensitive adhesive roofing laminate for use in forming a construction as claimed in Claim 1, comprising an upper support layer (a) laminated to a lower layer (b) of waterproofing, pressure-sensitive thermoplastic bituminous adhesive composition, the said support layer (a) comprising first and second layers of flexible sheet material laminated together, the said second layer being between the said first layer and the said lower layer (b) of adhesive composition, the said first layer having a higher coefficient of linear thermal expansion than the said second layer, the said upper support layer (a) having relatively good thermal

dimensional stability and exhibiting substantially "lay-flat" appearance prior to lamination to the said adhesive layer (b) so that the edges of the said laminates are caused to curl downwards after application to a substrate and exposure to elevated temperature.

20. A preformed, flexible pressure-sensitive adhesive roofing waterproofing laminate, the said laminate being in the form of a continuous strip having a length greater than its width and being comprised of an upper support layer (a) having a thickness of from 0.002 to 0.025 inches (0.05 to 0.635 mm) laminated to a lower layer (b) of waterproofing, pressure-sensitive, thermoplastic bituminous adhesive composition having a thickness of at least 0.010 inches (0.25 mm), the said adhesive layer (b) being provided with means to protect its surface remote from the said upper support layer (a) prior to use, the said support layer (a) being comprised of first and second layers of flexible sheet material laminated together, the said second layer of sheet material being positioned between the said first layer of sheet material and the said lower layer (b) of adhesive composition, the said first layer of flexible sheet material having a higher coefficient of linear thermal expansion than the said second layer of sheet material, the said upper support layer (a) having relatively good thermal dimensional

stability and exhibiting substantially "lay-flat" appearance prior to lamination to said adhesive layer (b), so that because of the said differing coefficients of thermal expansion, the edges of the said roofing laminate are caused to curl downward when the said laminate is used and exposed to elevated temperature.

21. A laminate according to Claim 20, wherein the said protective means comprises a layer of sheet material removable from the said adhesive without substantial damage thereto.

22. A laminate according to any of Claims 19 to 21, wherein the said adhesive composition comprises a mixture of a polymer and bitumen.

23. A laminate according to Claim 22, wherein the said polymer is natural or synthetic rubber and the said bitumen is asphalt.

24. A laminate according to Claim 22 or 23, wherein the said adhesive composition additionally contains mineral oil.

25. A laminate according to any of Claims 19 to 24, wherein the said width is at least 36 inches (91.4 cm).

26. A laminate according to any of Claims 19 to 25 having a protective coating or film applied to the said upper support layer (a) on its surface remote from the said adhesive layer (b).

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27. A laminate according to Claim 26, wherein the said protective coating or film is pigmented.

28. A laminate according to Claim 27, wherein the said pigment is carbon black.

29. A laminate according to any of Claims 19 to 28, wherein the said upper support layer (a) contains a sheet of a film of a polyolefin, polyamide, polyester, polyurethane, polyvinyl chloride, a copolymer of vinyl chloride and vinylidene chloride or a synthetic rubber.

30. A laminate according to Claim 29, wherein the said polymer film is a cross-laminated polymeric film or a biaxially-oriented polymeric film.

31. A laminate according to Claim 29 or 30, wherein the said film comprises high density polyolefin or polyethylene terephthalate.

32. A laminate according to any of Claims 29, 31 or 32, wherein the said polymer film is employed as the said first layer of the sheet material in the said laminate.

33. A laminate according to any of Claims 19 to 32, wherein the said second layer of sheet material in the said upper support layer (a) is of lesser thickness than said first layer of sheet material in said upper support layer (a).

34. A laminate according to Claim 19 or 20, substantially as hereinbefore described.