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(54) COATING CEMENTITIOUS SURFACES

(71) We, MONIER LIMITED, formerly Concrete Industries (Monier) Limited, a company incorporated under the laws of the State of New South Wales, Australia, of 6—8 Thomas Street, Chatswood, N.S.W. 2067, Australia, do hereby declare the invention, for which we pray that a patent may be granted to us, and the method by which it is to be performed, to be particularly described in and by the following statement:—

This invention relates to the coating of cementitious substrates with polymeric materials. In particular, it relates to the coating of an uncured cementitious surface with polymeric material. In one preferred embodiment, the invention relates to the manufacture of cement roof tiles having a polymeric coating. Although the invention will be described herein primarily with reference to the manufacture of roof tiles, it should be understood that the invention is not limited to the manufacture of tiles, but may also be used in the manufacture of other building elements, of concrete slabs, of cement rendered walls, and a wide variety of other uses.

Concrete roof tiles are commonly made either by a process of pressing or a process of extrusion, both of which processes are well known. The extrusion process is in general use today since it provides better efficiency by producing more tiles per unit of time.

To cater for consumer demand for tiles having a variety of colours, it is usual to coat cement tiles immediately after their formation with a cement slurry containing a pigment which gives the face of the tile its desired colour. Such a coating is described as a "colour coat". It is also known to apply a polymeric coating over the colour coat to give the tile a more pleasing, shiny surface, and to prevent deterioration of the tile through weathering and through efflorescence which takes place when the unprotected colour coat is attacked by atmo-

spheric carbon dioxide and water. Such polymeric coatings have previously been applied as a solution of polymer (such as acrylic esters) in an organic solvent. The use of such solutions has two major drawbacks. The first is that the solvents employed are expensive and contribute significantly to the cost of producing the finished tile. Secondly, these solvents evaporate into the atmosphere where they can cause pollution problems and constitute a fire hazard.

Since polymeric coating materials generally, and acrylic polymers in particular, are readily obtainable in the form of water based emulsions, it would be desirable to employ such water based emulsions for the purpose of applying polymeric coatings to roof tiles and other cementitious substrates. In spite of the benefits which might be expected from the avoidance of organic solvents, previous attempts to apply emulsion coatings to uncured cement slurries of the type previously referred to on a commercial scale have proved unsuccessful.

Tile extrusion machines in commercial use today turn out from 60 to 130 tiles per minute. Standard tiles are 16 inches (about 40 cm) long. Thus, any delay in applying the various coatings to the tile necessitates a production line whose length increases by from 80 to 175 feet (about 26 to 57 metres) for every minute taken in applying the various coatings. It follows that in the commercial production of tiles, it is economically essential that the colour coat and the polymeric coat be applied almost immediately after the tile is formed.

If a polymer emulsion is applied directly on to an uncured cementitious layer (for example a layer which has aged less than five minutes), it has been found that calcium hydroxide formed on the hydration of the cement in the colour coat migrates to the outer surface of the polymer emulsion layer where it reacts with atmospheric carbon dioxide. This reaction destroys the water re-

pellent properties of the coating, and also ruins its appearance, producing an unsightly film of calcium carbonate.

According to the present invention there is provided a method of coating an uncured cementitious substrate such as a colour coat, preferably within a matter of seconds of the application of the colour coat itself, which method comprises applying to said substrate an aqueous emulsion of a film-forming polymeric material to which has been added, after formation of the emulsion, at least one soluble soap.

The present inventor has discovered that by adding a small quantity of a soap to the polymer emulsion, the presence of the soap in the emulsion can overcome the problems previously discussed, apparently by preventing the migration of calcium hydroxide to the polymeric layer. It is believed that the calcium hydroxide formed by hydration of the cement in the colour coat layer reacts with the soap to form a calcium soap whose insolubility in the emulsion layer prevents the formation of any scum or the deterioration of the polymeric layer.

The invention also provides a method of making a concrete tile comprising the steps of casting, extruding, drawing or otherwise forming the body of the tile, applying a cementitious slurry to the surface of said body and, before the slurry layer has cured, applying to said layer an aqueous emulsion of a film-forming polymeric material to which has been added, after formation of the emulsion, at least one soluble soap.

The invention has utility with a variety of polymer emulsions but the preferred polymer emulsions are emulsions of acrylic polymers of the type presently employed (in organic solutions) to coat roof tiles. Preferred emulsions are polymers of acrylate or methacrylate esters or copolymers thereof which may or may not have undergone some degree of cross linking with other compounds. The types of compounds used for this purpose are well known to those in the industry; typical examples being acrylic acid and glycidyl methacrylates.

Other polymers which may be employed include vinyl ester homopolymers (such as polyvinyl acetate); vinyl ester co-polymers such as acetate Versatate ("VERSATIC" is a registered Trade Mark) and acetate itaconate co-polymers; co-polymers of styrene and acrylate and/or methacrylate esters; polyvinyl chloride; polyvinylidene chloride; co-polymers of vinyl chloride and vinylidene chloride; co-polymers of vinyl chloride and/or vinylidene chloride with acrylate and/or methacrylate esters.

One polymer emulsion which gives particularly satisfactory results contains methyl methacrylate and butyl acrylate in the

weight ratio of 55 to 45 and has a total non-volatile content of 50 by weight.

Soaps which may be employed in the practice of the invention include the lithium, sodium, potassium, and ammonium soaps of carboxylic acids of the general formula $R-COOH$ where R is an alkyl chain, branched or unbranched, saturated or unsaturated, and hydroxylated carboxylic acids such as ricinoleic acid or hydroxy stearic acid, containing from 4 to 20 carbon atoms; lithium, sodium, potassium and ammonium soaps of "rosin acids" such as abietic acid; di-carboxylic acids including "dimer acids" and "trimer acids"; and oxygenated acids such as the naphthenic acid of commerce. Thus, the soap may be selected from lithium, sodium, potassium, and ammonium soaps of fatty acids and one soap which gives highly satisfactory results is the potassium soap of the coconut oil fatty acids whose fatty acid constituents are lauric acid and myristic acid, with lesser quantities of palmitic, caprylic, capric, oleic, stearic, linoleic and caproic acids. Another soap which gives highly satisfactory results is the potassium soap of palmitic acid. Yet another soap which gives suitable results and is readily available is the potassium soap of tall oil, a by-product of the paper industry. The soap should be added to the emulsion in the appropriate amounts to give the desired observable effect. Typically, the soap is added to the polymer emulsion in the proportion from 0.2 to 10 parts of soap per hundred parts of polymer in the emulsion. The soap may most conveniently be incorporated as an aqueous solution.

The solids content of the emulsion is not critical, but is preferably such that the total non-volatile content is between 20% and 60% by weight. In practice, it has been found desirable to use an emulsion of the highest solids content which can conveniently be handled.

Description of the Preferred Embodiment

The present invention may be performed as a final step in the extrusion process which is generally practiced today for the formation of concrete tiles. As in conventional concrete tile extrusion processes, concrete is first deposited by extrusion on to metal pallets. The metal pallets not only provide the support for the tiles during formation and curing but also provide a means of shaping the underside configuration of the tiles.

The tile machine is part of a closed conveyor circuit which receives a stream of metal pallets. As the pallets are propelled through the machine, a release agent is sprayed on to the upper surface of each pallet. During the forward movement of both pallet and deposited concrete, a power driven roller is engaged. This roller primarily

reduces the concrete to a partly compacted ribbon lying on the stream of pallets. Running against the outgoing surface of the roller is a wedge-shaped plate known as a slipper. The ribbon of concrete is thus trapped, and during the forward movement of the pallet stream and the ribbon of concrete, both roller and slipper impart the desired contour to the top surface of the tile. A cross configuration guillotine knife divides the ribbon at each pallet joint into the separate tiles.

The cut tiles, still in stream, then pass under a surface finishing device which applies the "colour coat" in the form of a coloured cementitious slurry. Although it is not essential to do so, the cut tiles may be heated immediately before the colour coat is applied. It is believed that such heating has the effect of partially drying the colour coat as soon as it is applied, by withdrawing moisture into the body of the tiles.

Within seconds of applying the colour coat, the cut tiles pass through a coating zone at which a polymer emulsion containing a soap according to the invention is applied. The polymer emulsion may be applied by any suitable means, such as a spray or a rotary brush. Such means have previously been employed for coating tiles with organic polymer solutions.

It has been found advantageous to employ some means of drying the emulsion immediately after its application. This may be achieved, for example, by means of a hot air blower, or by infrared or microwave radiation. It has been found that such accelerated drying enhances the water repellency of the polymer coating, and it is believed that this is a result of the quicker breaking of the emulsion under forced drying.

In one embodiment of the invention, an improved polymeric coating may be obtained by the application of heat to the colour coat immediately before the emulsion coating is applied. Such heating may be achieved by means of a hot air blower, by infrared or microwave radiation, or by other suitable means. It is believed that heating at this stage promotes more rapid breaking of the emulsion, possibly by partial drying of the colour coat which consequently draws water from the emulsion.

WHAT WE CLAIM IS:—

1. A method of coating an uncured cementitious substrate which method comprises applying to said substrate an aqueous emulsion of a film-forming polymeric material to which has been added, after formation of the emulsion, at least one soluble soap.

2. A method according to claim 1, wherein said soap is present in an amount

of from 0.2 to 10 parts per hundred parts by weight of polymer in the emulsion, and is selected from the group consisting of the lithium, sodium, potassium and ammonium soaps of acids from the group consisting of carboxylic acids of the general formula $R-COOH$ (where R is a saturated or unsaturated, branched or unbranched, alkyl chain), hydroxylated carboxylic acids containing from 4 to 20 carbon atoms, rosin acids, di-carboxylic acids and oxygenated acids.

3. A method according to claim 2 wherein said soap is selected from the group consisting of lithium, sodium, potassium and ammonium soaps of fatty acids.

4. A method according to any one of claims 1 to 3, wherein said polymeric material is selected from the group consisting of acrylic polymers, vinyl ester homopolymers and co-polymers, co-polymers of styrene with acrylate and/or methacrylate esters, polyvinyl chloride, polyvinylidene chloride, co-polymers of vinyl chloride and vinylidene chloride, and co-polymers of vinyl chloride and/or vinylidene chloride with acrylate and/or methacrylate esters.

5. A method according to claim 4, wherein said emulsion has a total non-volatile content of from 20% to 60% by weight.

6. A method according to claim 4 or claim 5, wherein said polymeric material comprises a polymer of acrylate or methacrylate esters or copolymers thereof which may or may not have undergone some degree of crosslinking with other compounds.

7. A method according to any one of claims 1 to 6, wherein said cementitious substrate comprises the outer surface of a concrete tile.

8. A method of making a concrete tile comprising the steps of casting, extruding, drawing or otherwise forming the body of the tile, applying a cementitious slurry to the surface of said body and, before the slurry layer has cured, applying to said layer an aqueous emulsion of a film-forming polymeric material to which has been added, after formation of the emulsion, at least one soluble soap.

9. A method according to claim 8, wherein said body is heated immediately before the slurry is applied.

10. A method according to claim 8 or claim 9, wherein the slurry layer is heated immediately before the emulsion is applied.

11. A method according to any one of claims 8 to 10, wherein the surface of the tile is heated after the emulsion is applied to enhance breaking of the emulsion.

12. A method according to any one of claims 8 to 11 wherein said soap is present in an amount of from 0.2 to 10 parts per hundred parts by weight of polymer in the emulsion, and is selected from the group

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reduces the concrete to a partly compacted ribbon lying on the stream of pallets. Running against the outgoing surface of the roller is a wedge-shaped plate known as a slipper. The ribbon of concrete is thus trapped, and during the forward movement of the pallet stream and the ribbon of concrete, both roller and slipper impart the desired contour to the top surface of the tile. A cross configuration guillotine knife divides the ribbon at each pallet joint into the separate tiles.

The cut tiles, still in stream, then pass under a surface finishing device which applies the "colour coat" in the form of a coloured cementitious slurry. Although it is not essential to do so, the cut tiles may be heated immediately before the colour coat is applied. It is believed that such heating has the effect of partially drying the colour coat as soon as it is applied, by withdrawing moisture into the body of the tiles.

Within seconds of applying the colour coat, the cut tiles pass through a coating zone at which a polymer emulsion containing a soap according to the invention is applied. The polymer emulsion may be applied by any suitable means, such as a spray or a rotary brush. Such means have previously been employed for coating tiles with organic polymer solutions.

It has been found advantageous to employ some means of drying the emulsion immediately after its application. This may be achieved, for example, by means of a hot air blower, or by infrared or microwave radiation. It has been found that such accelerated drying enhances the water repellency of the polymer coating, and it is believed that this is a result of the quicker breaking of the emulsion under forced drying.

In one embodiment of the invention, an improved polymeric coating may be obtained by the application of heat to the colour coat immediately before the emulsion coating is applied. Such heating may be achieved by means of a hot air blower, by infrared or microwave radiation, or by other suitable means. It is believed that heating at this stage promotes more rapid breaking of the emulsion, possibly by partial drying of the colour coat which consequently draws water from the emulsion.

WHAT WE CLAIM IS:—

1. A method of coating an uncured cementitious substrate which method comprises applying to said substrate an aqueous emulsion of a film-forming polymeric material to which has been added, after formation of the emulsion, at least one soluble soap.

2. A method according to claim 1, wherein said soap is present in an amount

of from 0.2 to 10 parts per hundred parts by weight of polymer in the emulsion, and is selected from the group consisting of the lithium, sodium, potassium and ammonium soaps of acids from the group consisting of carboxylic acids of the general formula $R-COOH$ (where R is a saturated or unsaturated, branched or unbranched, alkyl chain), hydroxylated carboxylic acids containing from 4 to 20 carbon atoms, rosin acids, di-carboxylic acids and oxygenated acids.

3. A method according to claim 2 wherein said soap is selected from the group consisting of lithium, sodium, potassium and ammonium soaps of fatty acids.

4. A method according to any one of claims 1 to 3, wherein said polymeric material is selected from the group consisting of acrylic polymers, vinyl ester homopolymers and co-polymers, co-polymers of styrene with acrylate and/or methacrylate esters, polyvinyl chloride, polyvinylidene chloride, co-polymers of vinyl chloride and vinylidene chloride, and co-polymers of vinyl chloride and/or vinylidene chloride with acrylate and/or methacrylate esters.

5. A method according to claim 4, wherein said emulsion has a total non-volatile content of from 20% to 60% by weight.

6. A method according to claim 4 or claim 5, wherein said polymeric material comprises a polymer of acrylate or methacrylate esters or copolymers thereof which may or may not have undergone some degree of crosslinking with other compounds.

7. A method according to any one of claims 1 to 6, wherein said cementitious substrate comprises the outer surface of a concrete tile.

8. A method of making a concrete tile comprising the steps of casting, extruding, drawing or otherwise forming the body of the tile, applying a cementitious slurry to the surface of said body and, before the slurry layer has cured, applying to said layer an aqueous emulsion of a film-forming polymeric material to which has been added, after formation of the emulsion, at least one soluble soap.

9. A method according to claim 8, wherein said body is heated immediately before the slurry is applied.

10. A method according to claim 8 or claim 9, wherein the slurry layer is heated immediately before the emulsion is applied.

11. A method according to any one of claims 8 to 10, wherein the surface of the tile is heated after the emulsion is applied to enhance breaking of the emulsion.

12. A method according to any one of claims 8 to 11 wherein said soap is present in an amount of from 0.2 to 10 parts per hundred parts by weight of polymer in the emulsion, and is selected from the group



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- consisting of the lithium, sodium, potassium and ammonium soaps of acids from the group consisting of carboxylic acids of the general formula $R-COOH$ (where R is a saturated or unsaturated, branched or unbranched alkyl chain), hydroxylated carboxylic acids containing from 4 to 20 carbon atoms, rosin acids, di-carboxylic acids and oxygenated acids.
13. A method according to claim 12 wherein said soap is selected from the group consisting of lithium, sodium, potassium and ammonium soaps of fatty acids.
14. A method according to any one of claims 8 to 13, wherein said polymeric material is selected from the group consisting of acrylic polymers, vinyl ester homopolymers and co-polymers, co-polymers of styrene with acrylate and/or methacrylate esters, polyvinyl chloride, polyvinylidene chloride, co-polymers of vinyl chloride and vinylidene chloride, and co-polymers of vinyl chloride and/or vinylidene chloride with acrylate and/or methacrylate esters.
15. A method according to claim 14, wherein said emulsion has a total non-volatile content of from 20% to 60% by weight.
16. A method according to claim 14 or claim 15, wherein said polymeric material comprises a polymer of acrylate or methacrylate esters or copolymers thereof which may or may not have undergone some degree of crosslinking with other compounds.
17. A cementitious substrate coated by the method claimed in any one of claims 1 to 7.
18. A concrete tile made by the method claimed in any one of claims 8 to 16.
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