A method of applying a new surface to an existing surface. The method comprises applying a bituminous emulsion bonding layer to the existing surface; destabilizing the bituminous emulsion bonding layer; and applying a bituminous mixture to the bituminous emulsion bonding layer.
DESTABILIZED BITUMINOUS BONDING LAYER
CROSS REFERENCE

[0001] Not Applicable.

BACKGROUND OF THE INVENTION

[0002] 1. Field of the Invention

[0003] This invention relates generally to a method of applying a bituminous mixture to an existing surface, and more particularly, but not by way of limitation, to a method of applying a bituminous emulsion bonding layer and a thin layer of cold-applied bituminous mixture to an existing surface by destabilizing the bituminous emulsion bonding layer immediately before applying the bituminous mixture.

[0004] 2. Description of the Related Art

[0005] It is often desirable to place a new layer on an existing surface, such as a road, to improve the ride and serviceability of the surface. The dominant materials of choice for the construction, repair, and maintenance of roads are hot mix bituminous mixtures.

[0006] Hot mix bituminous mixtures are generally produced in a central location and transported to the application site. As any hot bituminous products are transported, they lose heat. If the temperature of a hot mix bituminous mixture becomes too low, the mixture becomes difficult to handle and place and it becomes difficult to achieve a durable surface. Thus, there are limits as to how hot mix bituminous mixtures can be transported.

[0007] Hot mix plants heat one or more aggregates to temperatures generally in excess of 150° C. Hot bituminous materials are added to the aggregates and mixed. The resultant hot bituminous mixture is transported to the road upon which it is to be applied. The hot mix bituminous mixture may be additionally heated prior to transportation to further elevate the temperature to account for cooling that will inevitably occur during transportation. However, there is an effective upper limit on mixture temperatures, either due to the cost to heat the mixture or the degradation of the hot bituminous product.

[0008] Areas beyond the maximum haul distances for hot mix bituminous mixtures have few options for the construction, repair, and maintenance of roads. One option is the use of cold-applied bituminous mixtures, which utilize similar aggregates as those used in hot mix bituminous mixtures, but preferentially use emulsified binders. These cold-applied bituminous mixtures may be produced on site for immediate use, obviating excessive haul distances.

[0009] Cold-applied bituminous mixtures utilize an aggregate system generally known in the art. This aggregate system is mixed with a suitable quantity of bituminous binder. The bituminous binder may be either emulsified or solvent cut back. The bituminous emulsions may also contain additives and/or solvents to increase the workability or other desirable properties of the resultant mixture. Cold-applied bituminous mixtures may be applied to a surface, such as a road, by conventional equipment, including any mixture application equipment known to those skilled in the art.

[0010] Cold-applied bituminous mixtures are much more difficult to apply to a surface, such as a road, than hot mix bituminous mixtures. A cold-applied bituminous mixture may have less lubricity than a similar hot mix bituminous mixture, and may thus require greater shearing forces to be suitably applied, as lower lubricity requires higher shearing forces to handle and place the product. To better utilize bituminous cold-applied mixtures, specialized equipment has been developed to apply these stiffier mixtures. U.S. Pat. No. 7,316,520 issued to Grubba on Jan. 8, 2008 describes a low area shearing device better capable to apply cold-applied bituminous products. Likewise, U.S. Pat. No. 6,543,962 issued to Wells on Apr. 8, 2003 details an apparatus similar to traditional paving screeds, but has the added capability of placing extra pressure on the mixture, enabling better use of cold-applied bituminous mixtures. The '520 patent and the '962 patent are incorporated herein by reference.

[0011] Lubricity can be altered in cold-applied bituminous mixtures. Generally, increasing amounts of solvent in the mixture may increase lubricity and allow easier handling and placement. The disadvantage to increasing solvent is that it results in a tender mixture until a sufficient amount of solvent evaporates. Also, solvent emissions produce a negative environmental impact. Therefore, an ideal cold-applied bituminous mixture contains no solvents.

[0012] Lubricity of the mixture may also be somewhat aided by the utilization of very soft asphalts. Although handling and laydown may be enhanced, however, the ultimate rheological properties of the mixture may be compromised. The bituminous mixture may remain soft and may push, shove, or not while in service.

[0013] A bonding layer may be used to ensure an adequate bond between the road surface and the cold-applied bituminous product. Generally, a bituminous bonding layer is used to increase adhesion between a road surface and the mixture to be applied. These bituminous bonding layers may be applied hot, as solvent diluted, or emulsified.

[0014] Bituminous emulsions are routinely used to bond bituminous mixtures to the road. Typically, the bituminous emulsion bonding layer is applied to a road and allowed to partially or completely dry. This drying allows coalescence of the dispersed bituminous component and eventually builds toughness of the layer. Next, the mixture application equipment and support vehicles enter the roadway to apply the bituminous mixture. The tires of these vehicles tend to adhere to the bituminous bonding layer and transport it to undesirable adjacent areas. This loss of bituminous bonding layer may degrade the desirable bond between the surface and the bituminous mixture.

[0015] A bituminous emulsion bonding layer tends to be extremely slick or slippery when first applied to a roadway. In conventional applications, the bituminous emulsion bonding layer is applied and allowed to partially or completely dry before a bituminous mixture is applied. The partially or completely dried bituminous emulsion bonding layer provides sufficient adhesion to the road surface and suitable internal cohesion whereby the placement of the bituminous mixture is not hindered.

[0016] Specialized equipment has been developed to apply both a bituminous product, like a bituminous emulsion bonding layer, as well as a bituminous mixture. This concurrent application eliminates any equipment or support vehicle tires from contacting the bituminous bonding layer. One such device is described in U.S. Pat. No. 5,069,578 issued to Bense et al. on Dec. 3, 1991, which patent is incorporated herein by reference.

[0017] The apparatus of the '578 patent is better known as a spray paver and has been used successfully with hot mix bituminous mixtures for many years. The spray paver helps
build a better bond between the road surface and the bituminous mixture. A preferred use of the '578 spray paver is the combination of a bituminous emulsion bonding layer that is sprayed on the road surface immediately before a hot bituminous product. The water-laden bituminous emulsion bonding layer, when in contact with the hot bituminous product, partially boils and builds a suitable adhesive bond between the road surface and the bituminous mixture. However, the apparatus of the '578 patent is not as successful with cold-applied bituminous mixtures.

[0018] The '578 spray paver does not allow the bituminous emulsion bonding layer to partially or completely dry before application of the bituminous mixture, which is applied within five (5) seconds of the application of the bituminous emulsion bonding layer. A hot bituminous mix will boil off some of the water in the bituminous emulsion bonding layer and greatly accelerate the cohesive build of the bituminous emulsion bonding layer, thereby eliminating any application problems of the bituminous mixture. The use of a cold-applied bituminous mixture with the '578 spray paver is more problematic. The combination of the non-dried bituminous emulsion bonding layer, which is very slick, and the cold-applied bituminous mixture, which has lower lubricity, produces a situation where the mixture has a propensity to slide on the bonding layer. This slippage is a result of the high shearing forces required to apply the cold-applied bituminous mixture and the low frictional component of the slick bituminous bond layer.

[0019] To remedy this phenomenon, the thickness or weight of the mixture is increased until no tearing occurs. Applying a greater mixture layer thickness may increase the weight per unit area of the cold-applied bituminous mixture, and this extra material increases the normal force, resulting in a greater frictional coefficient between the mixture and the bonding layer. There may be a point where a sufficient amount of mixture is applied such that the mix can withstand the shearing forces exerted by the application equipment without slipping on the bonding layer and creating tears in the surface. Thus, cold-applied bituminous mixture may be successfully applied at high application rates, but extra material is costly. As the application equipment attempts to apply thinner and thinner layers of cold-applied bituminous mixture, the mixture will tear as it slides on the slick bituminous emulsion bonding layer. Increasing the thickness of the cold-applied bituminous mixture is valuable for remote areas not suitably served by central bituminous hot mix plants, but the cost of the resulting surface is excessively high.

[0020] Additionally, when a cold-applied bituminous mixture is applied while the bituminous emulsion bonding layer is not sufficiently coalesced, the mixture may move under post placement compaction. This pushing and shoving may produce a surface that is not sufficiently dense and the desired thickness and smoothness may be compromised.

[0021] Combining the '578 spray paver with either the '520 patent or the '962 patent does not remedy the application inabilities. The problem is a combination of the slick bituminous emulsion bonding layer and the stiff cold-applied bituminous mixture, which tends to slide on the slick bituminous emulsion bonding layer. Applying a greater shearing force to the bituminous mixture only increases the slippage and creates greater tearing of the cold-applied bituminous layer.

[0022] Although the '578 patent discusses the use of the spray paver with a bituminous emulsion bonding layer and cold-applied bituminous mixtures, the only successful method to create such a surface is to apply a sufficiently thick layer of the cold-applied bituminous mixture. The drawback is the excessive amounts of materials that are required to produce a paved surface that can be applied without tearing, shoving, or sliding either during application by a spray paver or by post placement compaction.

[0023] Based on the foregoing, it is desirable to utilize a spray paver with a bituminous emulsion bonding layer and a cold-applied bituminous mixture at minimal thickness without tearing, shoving, or pushing of the layer.

SUMMARY OF THE INVENTION

[0024] In general, in a first aspect, the invention relates to a method of applying a new surface to an existing surface. The method comprises applying a bituminous emulsion bonding layer to the existing surface; destabilizing the bituminous emulsion bonding layer; and applying a bituminous mixture to the bituminous emulsion bonding layer.

[0025] The step of destabilizing the bituminous emulsion bonding layer may occur within 15 seconds or within 5 seconds of applying the bituminous emulsion bonding layer to the existing surface. The step of destabilizing the bituminous emulsion bonding layer may occur before, during, or after the step of applying the bituminous emulsion bonding layer to the existing surface, or a combination thereof. The bituminous mixture may be a cold-applied bituminous mixture. The bituminous mixture may be applied with a thickness of less than 4.5 cm or less than 2.5 cm. The bituminous emulsion bonding layer and the bituminous mixture may be applied with a spray paver. The step of applying the bituminous mixture to the bituminous emulsion bonding layer may occur within 5 seconds of the step of applying the bituminous emulsion bonding layer to the existing surface.

[0026] The bituminous emulsion bonding layer may be destabilized with a destabilization agent and the destabilization agent may be selected based on the bituminous emulsion bonding layer. The step of destabilizing the bituminous emulsion bonding layer may be achieved by counter ion attack, destabilization chemicals, pH change, temperature change, precipitation of a surfactant system, driers, chemical or physical dehydration, or HLB imbalance causing phase inversion, and the like.

[0027] The bituminous emulsion bonding layer may be a cationic emulsion and the step of destabilizing the bituminous emulsion bonding layer may comprise applying an anionic surfactant solution to the cationic emulsion. The anionic surfactant solution may have a concentration that is increased to accelerate the step of destabilizing the bituminous emulsion bonding layer. The anionic surfactant solution may be a sulfonate mixed with water. The anionic surfactant solution may have a concentration of at least about 0.05% of a sulfonate by weight of the water.

[0028] The bituminous emulsion bonding layer may be a cationic emulsion with a pH and the step of destabilizing the bituminous emulsion bonding layer may comprise changing the pH of the cationic emulsion. Changing the pH of the cationic emulsion may comprise creating a destabilization solution by mixing an alkali in water. The alkali may be sodium hydroxide at a concentration of at least about 0.01% by weight of the water.

[0029] The bituminous emulsion bonding layer may be an anionic emulsion and the step of destabilizing the bituminous emulsion bonding layer may comprise applying a cationic surfactant solution to the anionic emulsion. The cationic sur-
factant solution may have a concentration that is increased to accelerate the step of destabilizing the bituminous emulsion bonding layer. The cationic surfactant solution may be fatty acid imidazoline mixed with water. The cationic surfactant solution may have a concentration of at least about 0.05% of fatty acid imidazoline by weight of the water.

[0030] The bituminous emulsion bonding layer may be an anionic emulsion with a pH and the step of destabilizing the bituminous emulsion bonding layer may comprise changing the pH of the anionic emulsion. Changing the pH of the anionic emulsion may comprise creating a destabilization solution by mixing an acid in water. The acid may be acetic acid at a concentration of at least about 0.01% by weight of the water.

[0031] The bituminous emulsion bonding layer may be an anionic emulsion with an anionic fatty acid salt and the step of destabilizing the bituminous emulsion bonding layer may comprise precipitating the anionic fatty acid salt with a divalent metal ion in water solution. The divalent metal ion in water solution may be at least about 0.01% Calcium Chloride by weight.

[0032] The bituminous emulsion bonding layer may comprise water and the step of destabilizing the bituminous emulsion bonding layer may comprise sequestering the water in the bituminous emulsion bonding layer, rendering the bituminous emulsion bonding layer unstable. Sequestering the water in the bituminous emulsion bonding layer may comprise applying sequestering agents to the bituminous emulsion bonding layer. The sequestering agents may comprise silica gels, chalk, clay-based desiccant, Portland cement, fly ash, or combinations thereof. The sequestering agents may be applied to the bituminous emulsion bonding layer before, during, or immediately after the application of the bituminous emulsion to the existing surface.

[0033] The step of destabilizing the bituminous emulsion bonding layer may comprise engineering a destabilization component into the bituminous emulsion bonding layer. The destabilization component may be a surfactant that has a high cloud point, turbidity point, phase inversion temperature, or combination thereof. The destabilization component may be a nonionic surfactant that becomes insoluble in water under normal road surface temperatures. The destabilization component may comprise a polyoxyethylene group.

[0034] The bituminous emulsion bonding layer may be a cationic emulsion and the step of destabilizing the bituminous emulsion bonding layer may comprise applying an anionic bituminous emulsion utilizing a sodium salt of a fatty acid to the bituminous emulsion bonding layer. The bituminous emulsion bonding layer may be a cationic emulsion and the step of destabilizing the bituminous emulsion bonding layer may comprise applying anionic SBR latex to the bituminous emulsion bonding layer.

[0035] In a second aspect, the invention relates to a surface layer comprising: an existing surface; a destabilized bituminous emulsion bonding layer applied to the existing surface; and a bituminous mixture applied to the destabilized bituminous emulsion bonding layer. The bituminous mixture may be cold-applied bituminous mixture. The bituminous mixture may have a thickness of less than 4.5 cm or of less than 2.5 cm.

[0036] The destabilized bituminous emulsion bonding layer may comprise a bituminous emulsion and a destabilization agent. The destabilization agent may be applied to the bituminous emulsion within 15 seconds or within 5 seconds after the bituminous emulsion was applied to the existing surface.

[0037] The bituminous emulsion may be a cationic emulsion and the destabilization agent may be an anionic surfactant solution and/or an alkali solution. The anionic surfactant solution may be a sulfonate mixed with water. The anionic surfactant solution may have a concentration of at least about 0.05% of a sulfonate by weight of the water. The alkali solution may be sodium hydroxide mixed with water at a concentration of at least about 0.01% by weight of the water.

[0038] The bituminous emulsion may be an anionic emulsion and the destabilization agent may be a cationic surfactant solution and/or an acidic solution. The cationic surfactant solution may be fatty acid imidazoline mixed with water. The cationic surfactant solution may have a concentration of at least 0.05% of fatty acid imidazoline by weight of the water. The acidic solution may be acetic acid mixed with water at a concentration of at least about 0.01% by weight of the water.

[0039] The destabilization agent may be a sequestering agent. The sequestering agent may be silica gel, chalk, clay-based desiccant, Portland cement, fly ash, or combinations thereof. The destabilization agent may be a surfactant that has a high cloud point, turbidity point, phase inversion temperature, or combination thereof. The destabilization agent may be a nonionic surfactant that becomes insoluble in water under normal road surface temperatures. The destabilization agent may comprise a polyoxyethylene group. The bituminous emulsion may be a cationic emulsion and the destabilization agent may be an anionic bituminous emulsion utilizing a sodium salt of a fatty acid. The bituminous emulsion may be a cationic emulsion and the destabilization agent may be anionic SBR latex.

DETAILED DESCRIPTION OF THE INVENTION

[0040] The devices, compositions, and methods discussed herein are merely illustrative of specific manners in which to make and use this invention and are not to be interpreted as limiting in scope.

[0041] While the devices, compositions, and methods have been described with a certain degree of particularity, it is to be noted that many modifications may be made in the details of the construction and the arrangement of the elements and components without departing from the spirit and scope of this disclosure. It is understood that the devices, compositions, and methods are not limited to the embodiments set forth herein for purposes of exemplification.

[0042] In general, in a first aspect, the invention relates to a method of applying a bituminous emulsion bonding layer and a thin layer of cold-applied bituminous mixture to an existing surface by destabilizing the bituminous emulsion bonding layer immediately before applying the bituminous mixture. As noted above, it is difficult to use a spray paver with cold-applied bituminous mixtures because there is insufficient time for the bituminous emulsion bonding layer to coalesce prior to application of the cold-applied bituminous mixture, because the cold-applied bituminous mixture must be applied thickly, and because the cold-applied bituminous mixture has low lubricity, all of which combine to produce slippage, tearing, shoving, and pushing. A destabilizing agent, when appropriately applied to a bituminous emulsion bonding layer, may sufficiently promote coalescence and build adequate cohesive strength within the bonding layer to allow for thinner application of cold-applied bituminous mixtures atop the bonding
layer when applied by a spray paver. The bituminous mixture may have a resultant thickness of less than 4.5 cm, preferably less than 3 cm, more preferably less than 2.5 cm, and most preferably less than 1.5 cm. The type of destabilization agent may be dependent on the properties of the emulsified bituminous emulsion.

Examples of existing surfaces upon which the method may be practiced include roads, streets, interstates, parking lots, airport runways, airport taxiways, and the like. The existing surfaces may be constructed of any material known in the art for such types of surfaces, such as pavement, jointed Portland concrete cement, and the like.

Bituminous emulsion bonding layers may be cationic, anionic, zwitterionic, amphoteric, nonionic, and the like. Additionally, the bonding layer may contain other additives suitable for use in bitumens, such as polymers, crosslinking agents, vulcanization agents, accelerators, extenders, fluxing agents, and the like. The additives used for fabricating the bonding layer may be selected based on the desired properties of the bonding layer. Suitable polymers are described in U.S. Pat. No. 4,154,710 issued to Maldonado et al. on May 15, 1979, and in U.S. Pat. No. 4,145,322 issued to Maldonado et al. on May 20, 1979, both of which are hereby incorporated herein by reference.

The destabilization of a bituminous emulsion bonding layer may be achieved in many ways, including but not limited to counter ion attack, destabilization chemicals competing with the emulsion surfactant system, pH change, temperature change, precipitation of the surfactant system, the use of driers, chemical or physical dehydration, HLB imbalance causing phase inversion, and the like.

Cationic emulsions like CRS-2 are routinely stabilized with a cationic surfactant like an amine. Cationic surfactants include but are not limited to imids, amids, amidoamines, imidazolines, and the like. These surfactants may be pH adjusted and/or salted with an acid, including but not limited to hydrochloric acid, acetic acid, phosphoric acid, and the like. These systems may owe their ability to emulsify a bituminous material, in part or in whole, to the pH adjustment or salting of the nitrogen group.

Anionic emulsions like RS-2P are routinely stabilized with an anionic surfactant like salts of fatty acids. Anionic emulsifiers include but are not limited to carboxylates, sulfates, sulfonates, phosphates, and the like. These surfactants may be pH adjusted and/or salted with an alkali, including but not limited to sodium hydroxide, potassium hydroxide, and the like.

Zwitterionic or amphoteric surfactants exhibit both a cationic and anionic functional group, and have the unique ability to form either a cationic or anionic emulsion. Zwitterionic surfactants include but are not limited to betaines, lecinthins, sulfobetaines, and the like.

Nonionic emulsions are routinely stabilized with a nonionic surfactant like ethoxylated nonylphenol. Anionic emulsifiers include but are not limited to fatty alcohols, block co-polymers, glycol ethers, and the like. These surfactants may be pH adjusted with alkali or acid.

Pickering emulsions are a unique class of emulsions whereby a solid creates a boundary between the oil phase (bitumen) and water to stabilize the system.

A cationic emulsion may be destabilized by, but not limited to, counter ion attack, pH change, the use of driers or dehydration chemicals, and the like. Counter ion attack of a cationic bituminous emulsion may be caused by applying an anionic surfactant solution to the cationic emulsion. The concentration of the anionic surfactant may be increased to accelerate the destabilization. A non-limiting example comprises an anionic surfactant alkyl or aryl sulfonate like decylbenzenesulfonate salt mixed in water to create a destabilization solution. A sulfonate concentration of at least about 0.05%, preferably at least about 0.2%, most preferably at least about 1% by weight of the solution water is suitable to destabilize a CRS-2P emulsion in an acceptable period of time. Other types of anionic surfactants may achieve the same result. The solution may be applied at a rate of 0.1% to 99% by weight of the cationic emulsion. Alternately, changing the pH of a cationic emulsion may cause destabilization. A non-limiting example comprises an alkali mixed in water to create a destabilization solution. Sodium hydroxide at a concentration of at least about 0.01%, preferably at least about 0.2%, most preferably at least about 1% by weight of the solution water is suitable to destabilize a CPS-2P emulsion in an acceptable period of time. Other types of strong or weak alkalis may achieve the same result. The solution may be applied at a rate of 0.1% to 99% based on the weight of the cationic emulsion. The destabilizing solution may be applied to the bituminous emulsion bond layer within 15 seconds of the bond layer being applied to a surface, more preferably within 10 seconds, most preferably within 5 seconds.

An anionic emulsion may be destabilized by, but not limited to, counter ion attack, precipitation, pH change, the use of driers or dehydration chemicals, and the like. Counter ion attack of an anionic cationic bituminous emulsion may be caused by applying a cationic surfactant solution to the anionic emulsion. The concentration of the cationic surfactant may be increased to accelerate the destabilization. A non-limiting example comprises a cationic surfactant fatty acid imidazoline mixed in water to create a destabilization solution. A fatty acid imidazoline concentration of at least about 0.05%, preferably at least about 0.2%, most preferably at least about 1% by weight of the solution water is suitable to destabilize a RS-2P emulsion in an acceptable period of time. Other types of cationic surfactants may achieve the same result. The solution may be applied at a rate of 0.1% to 99% by weight of the anionic emulsion. Alternately, changing the pH of an anionic emulsion may cause destabilization. A non-limiting example comprises an acid mixed in water to create a destabilization solution. Acetic acid at a concentration of at least about 0.01%, preferably at least about 0.2%, most preferably at least about 1% by weight of the solution water is suitable to destabilize a RS-2P emulsion in an acceptable period of time. Other types of strong or weak acids may achieve the same result. The solution may be applied at a rate of 0.1% to 99% by weight of the anionic emulsion. Another non-limiting example is the use of a divalent metal ion in a water solution used to precipitate an anionic fatty acid salt that has been used as a surfactant. An RS-2 emulsion emulsified with an anionic fatty acid salt may be destabilized by a destabilization solution containing at least about 0.01% Calcium Chloride by weight, preferably at least about 0.1% Calcium Chloride, more preferably at least about 0.25% Calcium Chloride, and most preferably at least about 0.5% Calcium Chloride. The solution may be applied at a rate of 0.1% to 99% by weight of the anionic emulsion. The destabilization solution may be applied to the bituminous emulsion bond layer within 15 seconds of the bond layer being applied to a surface, more preferably within 10 seconds, most preferably within 5 seconds.
Those skilled in the art know that weak acids or bases would require higher concentrations as compared to strong acids or bases. Also, those skilled in the art know that, if quicker destabilization is desired, higher concentrations of destabilization agents, stronger destabilization agents, or higher rates of destabilization solution will need to be applied, or combinations of all three. Also, this is analogous to anionic and cationic surfactants that have higher or lower ionic strength.

A universal solution to destabilizing most if not all bituminous emulsion bonding layers is to seed the water, rendering the emulsion unstable. Sequestering agents include but are not limited to silica gels, chalk, clay based desiccant, Portland cement, fly ash, and the like. These destabilizing materials may be applied to the bituminous emulsion immediately before, during, or immediately after application of the bituminous emulsion to the surface, as well as combinations of all three. A non-limiting example is the application of a fine particle size Bentonite clay powder at a rate of at least about 0.10%, preferably at least about 0.25%, more preferably at least about 0.5%, and most preferably at least about 1% by weight of the bituminous emulsion bonding layer. The clay may be distributed into the emulsion as it is sprayed onto the surface. The destabilizing material may be applied to the bituminous emulsion bond layer within 15 seconds of the bond layer being applied to a surface, more preferably within 10 seconds, most preferably within 5 seconds.

Destabilization component may be engineered into the bituminous emulsion bonding layer. A surfactant that has a high cloud point, high turbidity point, and/or high phase inversion temperature (PIT) may be utilized as an internal mechanism for destabilization. One non-limiting example is the use of a nonionic surfactant that becomes insoluble in water under normal road surface temperatures. Surfactants containing polyoxyethylene groups are known in the art to have a distinct phase inversion temperature (PIT). As the polyoxyethylene group increases in size, the PIT increases. To build a destabilization technique into a bituminous emulsion bonding layer, a nonionic surfactant with a suitably large polyoxyethylene group may be chosen to produce the bituminous emulsion. This emulsion may be stored at temperatures in excess of the PIT. When the bituminous emulsion is applied, the lower temperature of the road surface cools the emulsion quickly. Since the PIT of the surfactant is chosen to be above the temperature of the road surface, the surfactant destabilizes upon cooling, and the bituminous emulsion becomes destabilized quickly upon application.

Combinations of the foregoing may be sufficient to achieve the destabilization of the bituminous emulsion bonding layer. As a non-limiting example, an anionic bituminous emulsion utilizing a sodium salt of a fatty acid could be used as a destabilizing agent when applied to a cationic bituminous emulsion bonding layer like CRS-2P. The anionic emulsion contains both free alkali and anionic fatty acid salts, both of which would serve to destabilize the CRS-2P.

Alternately, anionic SBR latex, which may be a dispersion of a polymer in a potassium stearate, may be used as a destabilizing agent for CRS-2P. Although the SBR latex contains polymer, it also contains a potassium salt of a fatty acid and free alkali.

Although the destabilized bituminous emulsion bonding layer is particularly useful when a cold-applied bituminous mixture is applied by a spray paver, it is also useful when a warm-mix bituminous mixture is utilized. Additionally, the use of a spray paver is not necessary. The destabilization technique is equally valid when the bituminous emulsion bonding layer is not drying or coalescing sufficient quickly, regardless of application technique. This is quite possible when the ambient environment is cold and/or humid, thus slowing if not preventing drying and/or coalescence of the bituminous emulsion bonding layer.

Example 1

A test trial was executed on the US 150 access road in Deaneville, Ill. The existing bituminous surface was milled to the existing concrete surface. Two cold-applied bituminous mixtures were produced using a CM-150 bituminous product and mixed in a pug mill. One bituminous mixture used 15 mm crushed limestone aggregate and the second used a 9.5 mm crushed limestone aggregate. The bituminous mixtures were independently brought to a spray paver for application. A bituminous bonding layer was applied at about 0.17 L/m² by the spray paver. The bituminous mixture followed approximately one (1) second after the application of the emulsion. The bituminous mixtures were successfully applied, but had to be applied at about 100 kg/m² or about 5.5 cm to 6 cm thick.

Example 2

Another test trial was conducted utilizing the destabilization technique on Enke Road between Highway 94 and Augusta Bottoms Road in Missouri. The bituminous emulsion bonding layer was an RS-2P emulsion as per MoDOT specifications and was applied between 1.08 L/m² and 1.26 L/m² by a spray paver. The RS-2P was produced utilizing a surfactant system comprising tall oil fatty acids salted with sodium hydroxide. A precipitation method was chosen to destabilize the anionic emulsion. A destabilizing agent was produced by mixing calcium chloride in water to create a solution that was about 1.15% anhydrous Calcium Chloride based on the weight of the total solution. This destabilization solution was applied within 1 second of the RS-2P to destabilize the anionic bituminous emulsion at a rate of approximately 0.660 L of destabilization solution per liter of bituminous emulsion or about 6.0% destabilization solution by weight of the anionic emulsion. Two cold-applied bituminous mixtures were produced by mixing a cationic emulsion CMS-150 with aggregates as seen in Table 1. These mixtures were brought to a spray paver for application on the road. The mixtures were applied to the destabilized RS-2 within about one (1) second after the bituminous emulsion application. Both mixtures were applied successfully at about 35.4 kg/m² to 45.0 kg/m² or about 1.58 cm to 2.01 cm thick. The applications were successfully applied without either mixture sliding on the destabilized bituminous emulsion. Also, post-placement compaction with a rubber tire roller did not experience sliding or pushing of the mixtures.

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<thead>
<tr>
<th>Aggregate Gradations</th>
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<tr>
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</table>

All in percent passing

[0061] From the above description, it is clear that the present invention is well adapted to carry out the objects and to attain the advantages mentioned herein, as well as those inherent in the invention. While the devices, compositions, and methods have been described for purposes of this disclosure, it will be understood that other and further modifications, apart from those shown or suggested herein, may be made which are accomplished within the spirit and scope of the invention disclosed and claimed.

What is claimed is:

1. A method of applying a new surface to an existing surface, the method comprising:
   - applying a bituminous emulsion bonding layer to the existing surface;
   - destabilizing the bituminous emulsion bonding layer, and
   - applying a bituminous mixture to the bituminous emulsion bonding layer.

2. The method of claim 1 where the step of destabilizing the bituminous emulsion bonding layer occurs within 15 seconds of applying the bituminous emulsion bonding layer to the existing surface.

3. The method of claim 1 where the step of destabilizing the bituminous emulsion bonding layer occurs within 5 seconds of applying the bituminous emulsion bonding layer to the existing surface.

4. The method of claim 1 where the bituminous mixture is a cold-applied bituminous mixture.

5. The method of claim 4 where the bituminous mixture is applied with a thickness of less than 4.5 cm.

6. The method of claim 4 where the bituminous mixture is applied with a thickness of less than 2.5 cm.

7. The method of claim 1 where the bituminous emulsion bonding layer and the bituminous mixture are applied with a sprayer.

8. The method of claim 1 where the step of applying the bituminous mixture to the bituminous emulsion bonding layer occurs within 5 seconds of the step of applying the bituminous emulsion bonding layer to the existing surface.

9. The method of claim 1 where the bituminous emulsion bonding layer is destabilized with a destabilization agent and the destabilization agent is selected based on the bituminous emulsion bonding layer.

10. The method of claim 1 where the step of destabilizing the bituminous emulsion bonding layer is achieved by counter ion attack, destabilization chemicals, pH change, temperature change, precipitation of a surfactant system, driers, chemical or physical dehydration, or HLB imbalance causing phase inversion.

11. The method of claim 1 where the bituminous emulsion bonding layer is a cationic emulsion and where the step of destabilizing the bituminous emulsion bonding layer comprises applying an anionic surfactant solution to the cationic emulsion.

12. The method of claim 11 where the anionic surfactant solution has a concentration and the concentration is increased to accelerate the step of destabilizing the bituminous emulsion bonding layer.

13. The method of claim 11 where the anionic surfactant solution is a sulfonate mixed with water.

14. The method of claim 13 where the anionic surfactant solution has a concentration of at least about 0.05% of a sulfonate by weight of the water.

15. The method of claim 1 where the bituminous emulsion bonding layer is a cationic emulsion with a pH and where the step of destabilizing the bituminous emulsion bonding layer comprises changing the pH of the cationic emulsion.

16. The method of claim 15 where changing the pH of the cationic emulsion comprises creating a destabilization solution by mixing an alkali in water.

17. The method of claim 16 where the alkali is sodium hydroxide at a concentration of at least about 0.01% by weight of the water.

18. The method of claim 1 where the bituminous emulsion bonding layer is an anionic emulsion and where the step of destabilizing the bituminous emulsion bonding layer comprises applying a cationic surfactant solution to the anionic emulsion.

19. The method of claim 18 where the cationic surfactant solution has a concentration and the concentration is increased to accelerate the step of destabilizing the bituminous emulsion bonding layer.

20. The method of claim 18 where the cationic surfactant solution is fatty acid imidazoline mixed with water.

21. The method of claim 20 where the cationic surfactant solution has a concentration of at least about 0.05% of fatty acid imidazoline by weight of the water.

22. The method of claim 1 where the bituminous emulsion bonding layer is an anionic emulsion with a pH and where the step of destabilizing the bituminous emulsion bonding layer comprises changing the pH of the anionic emulsion.

23. The method of claim 22 where changing the pH of the anionic emulsion comprises creating a destabilization solution by mixing an acid in water.

24. The method of claim 23 where the acid is acetic acid at a concentration of at least about 0.01% by weight of the water.

25. The method of claim 1 where the bituminous emulsion bonding layer is an anionic emulsion with an anionic fatty acid salt and where the step of destabilizing the bituminous emulsion bonding layer comprises precipitating the anionic fatty acid salt with a divalent metal ion in water solution.

26. The method of claim 25 where the divalent metal ion in water solution is at least about 0.01% Calcium Chloride by weight.

27. The method of claim 1 where the bituminous emulsion bonding layer comprises water and the step of destabilizing the bituminous emulsion bonding layer comprises sequestering the water in the bituminous emulsion bonding layer, rendering the bituminous emulsion bonding layer unstable.

28. The method of claim 27 where sequestering the water in the bituminous emulsion bonding layer comprises applying sequestering agents to the bituminous emulsion bonding layer.
29. The method of claim 28 where the sequestering agents comprise silica gels, chalk, clay-based desiccant, Portland cement, fly ash, or combinations thereof.

30. The method of claim 28 where the sequestering agents are applied to the bituminous emulsion bonding layer before, during, or immediately after the application of the bituminous emulsion to the existing surface.

31. The method of claim 1 where the step of destabilizing the bituminous emulsion bonding layer comprises engineering a destabilization component into the bituminous emulsion bonding layer.

32. The method of claim 31 where the destabilization component is a surfactant that has a high cloud point, turbidity point, phase inversion temperature, or combination thereof.

33. The method of claim 31 where the destabilization component is a nonionic surfactant that becomes insoluble in water under normal road surface temperatures.

34. The method of claim 33 where the destabilization component comprises a polyoxyethylene group.

35. The method of claim 1 where the bituminous emulsion bonding layer is a cationic emulsion and the step of destabilizing the bituminous emulsion bonding layer comprises applying an anionic bituminous emulsion to the bituminous emulsion bonding layer.

36. The method of claim 1 where the bituminous emulsion bonding layer is a cationic emulsion and the step of destabilizing the bituminous emulsion bonding layer comprises applying anionic SBR latex to the bituminous emulsion bonding layer.

37. The method of claim 1 where the step of destabilizing the bituminous emulsion bonding layer occurs before, during, or after the step of applying the bituminous emulsion bonding layer to the existing surface, or a combination thereof.

38. A surface layer comprising:
   an existing surface;
   a destabilized bituminous emulsion bonding layer applied to the existing surface; and
   a bituminous mixture applied to the destabilized bituminous emulsion bonding layer.

39. The surface layer of claim 38 where the bituminous mixture is cold-applied bituminous mixture.

40. The surface layer of claim 38 where the bituminous mixture has a thickness of less than 4.5 cm.

41. The surface layer of claim 38 where the bituminous mixture has a thickness of less than 2.5 cm.

42. The surface layer of claim 38 where the destabilized bituminous emulsion bonding layer comprises a bituminous emulsion and a destabilization agent.

43. The surface layer of claim 42 where the destabilization agent was applied to the bituminous emulsion within 15 seconds after the bituminous emulsion was applied to the existing surface.

44. The surface layer of claim 42 where the destabilization agent was applied to the bituminous emulsion within 5 seconds after the bituminous emulsion was applied to the existing surface.

45. The surface layer of claim 42 where the bituminous emulsion is a cationic emulsion and the destabilization agent is an anionic surfactant solution or an alkali solution.

46. The surface layer of claim 42 where the anionic surfactant solution is a sulfonate mixed with water.

47. The surface layer of claim 46 where the anionic surfactant solution has a concentration of at least about 0.05% of a sulfonate by weight of the water.

48. The surface layer of claim 45 where the alkali solution is sodium hydroxide mixed with water at a concentration of at least about 0.01% by weight of the water.

49. The surface layer of claim 42 where the bituminous emulsion is an anionic emulsion and the destabilization agent is a cationic surfactant solution or an acidic solution.

50. The surface layer of claim 49 where the cationic surfactant solution is fatty acid imidazoline mixed with water.

51. The surface layer of claim 50 where the cationic surfactant solution has a concentration of at least 0.05% of fatty acid imidazoline by weight of the water.

52. The surface layer of claim 48 where the acidic solution is acetic acid mixed with water at a concentration of at least about 0.01% by weight of the water.

53. The surface layer of claim 42 where the destabilization agent is a sequestering agent.

54. The surface layer of claim 53 where the sequestering agent is silica gel, chalk, clay-based desiccant, Portland cement, fly ash, or combinations thereof.

55. The surface layer of claim 42 where the destabilization agent is a surfactant that has a high cloud point, turbidity point, phase inversion temperature, or combination thereof.

56. The surface layer of claim 42 where the destabilization agent is a nonionic surfactant that becomes insoluble in water under normal road surface temperatures.

57. The surface layer of claim 42 where the destabilization agent comprises a polyoxyethylene group.

58. The surface layer of claim 42 where the bituminous emulsion is a cationic emulsion and the destabilization agent is an anionic bituminous emulsion utilizing a sodium salt of a fatty acid.

59. The surface layer of claim 42 where the bituminous emulsion is a cationic emulsion and the destabilization agent is anionic SBR latex.

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