A system and method for repairing potholes in a road surface by securing a securing device within a pothole, affixing a reinforcing material to the securing device in the pothole, and adding a polyurethane and/or polyisocyanurate foam material to encapsulate the securing device and reinforcing material.
METHOD AND SYSTEM FOR REPAIRING POTHOLES IN ROADS

CROSS REFERENCE TO RELATED APPLICATIONS

[0001] This application claims the benefit of U.S. Provisional Application No. 60/995,526, filed on Sep. 27, 2007, the contents of which are incorporated by reference herein.

BACKGROUND

[0002] 1. Field of the Disclosure

[0003] The disclosure generally relates to a unique method and system for repairing potholes. In particular, the disclosure pertains to a lightweight portable polyurethane and/or polyisocyanurate foam used in combination with a ground anchoring and reinforcement system.

[0004] 2. Description of Related Art

[0005] Due to many environmental, usage and sabotage factors significant damage to road surfaces can occur which create large holes or craters which make movement of vehicular traffic and the like extremely difficult or dangerous. Unfortunately, current techniques for repairing such potholes or craters is very time consuming, labor intensive, costly, material intensive and requires a substantial transportation investment. Accordingly, in remote areas or areas of high traffic flow, it is not always practical or financially feasible to wait for the delivery and slow repairs to such potholes, as the current technology provides.

[0006] Such current technology typically involves the use of either asphalt or concrete. As an example, a concrete repair requires delivery of the concrete mix and water directly to the repair site, which may, in many instances, not be practical or expeditious. Such concrete systems require the delivery of, in some instances, twelve 60 lb. bags of concrete mix and 20 gallons of water. Another disadvantage is that it typically takes at least one day to cure, requiring monitoring during the cure period to avoid damage if used prior to curing.

[0007] The present disclosure provides numerous advantages over the asphalt and concrete system of the prior art. In particular, this disclosure is portable (i.e., lightweight and can be carried by the user without the need for special transportation equipment used to deliver to the repair site), inexpensive, and cures in a fraction of the time required by conventional repair systems.

[0008] The present disclosure also provides many additional advantages, which shall become apparent as described below.

SUMMARY OF THE DISCLOSURE

[0009] A system and method for repairing potholes which comprises: placing a securing mechanism within the existing pothole bottom or sidewalls, securing a reinforcing material to the securing mechanism to ensure its retention within the pothole, and filling or injecting a foam material to fill the pothole such that it encapsulates the securing mechanism and reinforcing material so that it is securely retained within the potholes and substantially level to the surface of the roadway.

[0010] A preferred foam material is polyurethane and/or polyisocyanurate closed-cell foam prepared with a blowing agent comprising a hydrofluorocarbon selected from the group consisting of 1,1,1,3,3-pentafluoropropane, 1,1,1,2,2-tetrafluoroethane, 1,1,1,3,3-pentafluorobutane, 1,1,1,2,3,3,3-heptafluoropropane, and mixtures thereof.

[0011] The present disclosure includes a unique foam-based pothole repair method and kit, wherein the preferred foam is formed by a method of preparing polyurethane and polyisocyanurate foam compositions comprising the step of reacting and foaming a mixture of ingredients which react to form polyurethane or polyisocyanurate foams in the presence of a blowing agent comprising one or more of the following: water, carbon dioxide, methyl formate, a hydrocarbon, and/or a hydrofluorocarbon; and an effective amount of a blowing agent additive. The foam can be a closed cell foam.

[0012] The additive is present in the amount of from about 0.02 to about 10 weight percent, based on the amount of blowing agent. Preferably, the additive includes α-methyl styrene. The α-methyl styrene is present in an amount of from about 0.02 to about 5 weight percent, based on the amount of blowing agent.

[0013] The blowing agent preferably comprises 1,1,1,3,3-pentafluoropropane and an effective amount of α-methyl styrene. The α-methyl styrene is present in the amount of from about 0.02 to about 5 weight percent, based on the amount of blowing agent. More preferably, the α-methyl styrene is present in the amount of from about 0.02 to about 2 weight percent, based on the amount of blowing agent.

[0014] Optionally, the closed cell foam comprises a blowing agent as defined above.

[0015] Further objects, features and advantages of the present disclosure will be understood by reference to the following drawings and detailed description.

BRIEF DESCRIPTION OF THE DRAWINGS

[0016] FIG. 1 is an example of a pothole in a road surface;

[0017] FIG. 2 depicts a pair of securing members disposed within the pothole according to the present disclosure;

[0018] FIG. 3 depicts a reinforcing mesh disposed within the pothole and secured thereto by the pair of securing members according to the present disclosure;

[0019] FIG. 4 is an example of a two component polyurethane foam system which can be used according to the present disclosure;

[0020] FIG. 5 demonstrates the portability of the two component polyurethane foam system of FIG. 4;

[0021] FIG. 6 demonstrates the application of the foam of the present disclosure to the secured reinforcing mesh of FIG. 3;

[0022] FIG. 7 depicts the finished foam pothole repair system according to the present disclosure; and

[0023] FIG. 8 demonstrates a vehicle pothole repair system according to the present disclosure.

DETAILED DESCRIPTION OF THE DISCLOSURE

[0024] The present disclosure can best be described by referring to the figures, wherein FIG. 1 depicts a standard pothole or crater 1 disposed within a surface or roadway 3. FIG. 2 depicts the initial preparation of the repair system according to the present disclosure, wherein a securing mechanism, such as a pair of securing rods or stakes 5 are disposed or embedded within the bottom or sidewalls of a
pothole 1 for the purpose of securing a reinforcing material 7, e.g., mesh or wire, within pothole 1.

[0025] Securing rods or stakes 5 can be made from any suitable material, such as metal, wood, plastic, etc., wherein the length will be dependent upon the size of the pothole being repaired.

[0026] Reinforcing material 7 can be any material which provides suitable reinforcement and/or strength to the foam material of the present disclosure. For example, reinforcing material 7 can be any mesh or wire configuration and can be made out of metal, synthetic material, rope, fabric, or plastic wood. One preferred reinforcing material 7 is a wire made into a grid, preferably a metal wire. Optionally, reinforcing material 7 can be a rope made into the form of a grid.

[0027] FIGS. 4 and 5 depict an optional canister based system having two canisters 9 and 11, a pair of hoses 13 and 15, and a spray nozzle 17, wherein hoses (13,15) are connected to canisters (9,11), respectively, at one end thereof, and connected to spray nozzle 17, at the other end. FIG. 6 demonstrates the use of the canister based system of FIGS. 4 and 5 to inject a foam product 19 of the present disclosure into pothole 1 of roadway 3. FIG. 7 demonstrates a completed repair, wherein the reinforced foam 19 is substantially level to the surface of roadway 3. Finally, FIG. 8 demonstrates the strength of reinforced foam 19, as a vehicle 21 traverses thereover.

[0028] It is critical to the present disclosure that a foam material 19 be used that provides the quick set, strength and durability for roadways and the like. One preferred foam is recited in U.S. Pat. No. 6,545,063, “Hydrofluorocarbon blown foam and method for preparation thereof,” which is incorporated herein in its entirety.

[0029] The preferred foam material is a polyurethane and/or polyisocyanurate closed-cell foam. More particularly, this foam material includes the addition of α-methyl styrene, isobutanol and/or isopropanol to reduce vapor pressure, improve k-factor, enhance the solubility of the blowing agent in the premix and/or improve the processing characteristics of polyurethane and polyisocyanurate closed-cell foams prepared with a blowing agent. The blowing agent can be, but is not limited to, water, carbon dioxide, methyl formate, a hydrocarbon, and/or a hydrofluorocarbon selected from the group consisting of HFC, HFC, low GWP HFC, e.g., 1,1,1,3,3-pentafluoropropane (HFC-245fa), 1,1,2,2-tetrafluoroethane (HFC-134a), 1,1,2,2-tetrafluoroethane (HFC-134a), 1,1,3,3-pentafluorobutane (HFC-365mfc), 1,1,2,3,3,3-heptafluoropropane (HFC-227ea), and mixtures thereof.

[0030] The preferred foam of the present disclosure includes the addition of one or more of α-methyl styrene, isobutanol and/or isopropanol to the B-side of a polyurethane or polyisocyanurate foam formulation comprising a blowing agent consisting of a hydrofluorocarbon selected from the group consisting of 1,1,1,3,3-pentafluoropropane, 1,1,2,2-tetrafluoroethane, 1,1,2,2-tetrafluoroethane, 1,1,3,3-pentafluorobutane, 1,1,2,3,3,3-heptafluoropropane, and mixtures thereof, resulting in reduced vapor pressure, improved k-factor, enhanced solubility of the blowing agent and/or improved processing characteristics of the foams. The addition of α-methyl styrene to the foam formulation results in improved thermal conductivity (k-factor) and thermal aging characteristics. With respect to thermal conductivity, the term “improved” refers to a decrease in the k-factor of the foam.

[0031] The polyurethane and polyisocyanurate foam compositions are preferably prepared by: reacting and foaming a mixture of ingredients which react to form polyurethane or polyisocyanurate foams in the presence of a blowing agent comprising a hydrofluorocarbon selected from the group consisting of 1,1,1,3,3-pentafluoropropane, 1,1,2,2-tetrafluoroethane, 1,1,2,2-tetrafluoroethane, 1,1,3,3-pentafluorobutane, 1,1,2,3,3,3-heptafluoropropane, and mixtures thereof, and an effective amount of a blowing agent additive ("additive") selected from the group consisting of α-methyl styrene, isobutanol, isopropanol, and mixtures thereof, preferably from about 0.02 to about 10 weight percent of said additive, based on the amount of blowing agent. In another embodiment, the method of preparing polyurethane and polyisocyanurate foam compositions comprises the step of reacting and foaming a mixture of ingredients which react to form polyurethane or polyisocyanurate foams in the presence of a blowing agent comprising 1,1,1,3,3-pentafluoropropane and α-methyl styrene, preferably from about 0.02 to about 5 weight percent α-methyl styrene, based on the amount of blowing agent.

[0032] In one embodiment, the closed cell foam is prepared from a polymer foam formulation containing a blowing agent comprising 1,1,1,3,3-pentafluoropropane and α-methyl styrene, preferably from about 0.02 to about 5 weight percent α-methyl styrene, based on the amount of blowing agent.

[0033] In another embodiment, the closed cell foam contains a cell gas comprising a blowing agent comprising a hydrofluorocarbon selected from the group consisting of 1,1,1,3,3-pentafluoropropane, 1,1,2,2-tetrafluoroethane, 1,1,2,2-tetrafluoroethane, 1,1,3,3-pentafluorobutane, 1,1,2,3,3,3-heptafluoropropane, and mixtures thereof, and an additive selected from the group consisting of α-methyl styrene, isobutanol, isopropanol, and mixtures thereof, preferably from about 0.02 to about 10 weight percent of said additive, based on the amount of blowing agent. In one embodiment, the closed cell foam contains a cell gas comprising a blowing agent comprising 1,1,1,3,3-pentafluoropropane and α-methyl styrene, preferably from about 0.02 to about 5 weight percent α-methyl styrene, based on the amount of blowing agent.

[0034] As used herein, an effective amount of additive means an amount, based on the amount of blowing agent, which reduces the vapor pressure of a foam formulation B-side to below the vapor pressure of the corresponding foam prepared in the absence of additive. Generally, an effective amount is from about 0.02 to about 10 weight percent, based on the amount of blowing agent. For example, the α-methyl styrene is preferably added in an amount of from about 0.5 to about 2 weight percent, based on the amount of blowing agent.

[0035] As used herein, blowing agent composition refers to HFC-245fa or HFC-134a singly or in combination with other non-ozone depleting blowing agents, such as, for example, other hydrofluorocarbons, e.g., difluoromethane (HFC-32), difluoroethane (HFC-152), trifluoroethane (HFC-143), tetrafluoroethane (HFC-134a), pentafluoropropane (HFC-245), pentafluorobutane (HFC-365mfc), hexafluoropropane (HFC-236), and heptafluoropropane (HFC-227ea); C₂CF₄ hydrocarbons, including, but not limited to, butane, isobutane, n-pentane, isopentane, cyclopentane, hexane and isohexane; inert gases, e.g., air, nitrogen, carbon dioxide; and water, in an amount of from about 0.5 to about 2 parts per 100 parts of polyol. Where isomerism is possible for the hydrofluorocarbons mentioned above, the respective isomers may be used either singly or in the form of a mixture.
[0036] HFC-245fa is a known material and can be prepared by methods known in the art such as those disclosed inWO 94/14736, WO 94/29251, WO 94/29252 and U.S. Pat. No. 5,574,192. Difluoroethane, trifluoroethane, tetrafluoroethane, heptfluoropropane and hexafluoropropane are available for purchase from Honeywell, Inc. of Morristown, N.J., USA. The α-methyl styrene, isobutanol and isopropanol components of the disclosure are also commercially available.

[0037] With respect to the preparation of rigid or flexible polyurethane or polysiocyanurate foams using a blowing agent comprising 1,1,1,3,3-pentamethylopropane or 1,1,1,2-tetrafluoroethane, any of the methods well known in the art can be employed. See Saunders and Frisch, Volumes I and II Polyurethanes Chemistry and Technology (1962). In general, polyurethane or polysiocyanurate foams are prepared by combining under suitable conditions an isocyanate (or isocyanurate), a polyol or mixture of polyols, a blowing agent or mixture of blowing agents, and other materials such as catalysts, surfactants, and optionally, flame retardants, colorants, or other additives.

[0038] It is convenient in many applications to provide the components for polyurethane or polysiocyanurate foams in pre-blended foam formulations. Most typically, the foam formulation is pre-blended into two components. The isocyanate or polysiocyanate composition comprises the first component, commonly referred to as the “A” component or “A-side.” The polyol or polyol mixture, surfactant, catalysts, blowing agents, flame retardant, water and other isocyanate reactive components comprise the second component, commonly referred to as the “B” component or “B-side.” While the surfactant and fluorocarbon blowing agent are usually placed on the polyol side, they may be placed on either side, or partly on one side and partly on the other side. Accordingly, polyurethane or polysiocyanurate foams are readily prepared by bringing together the A and B side components either by hand mix, for small preparations, or preferably machine mix techniques to form blocks, slabs, laminates, pour-in-place panels and other items, spray applied foams, froths, and the like. Optionally, other ingredients such as fire retardants, colorants, auxiliary blowing agents, water and even other polyols can be added as a third stream to the mix head or reaction site. Most conveniently, however, they are all incorporated into one B component.

[0039] The a-methyl styrene, isobutanol and/or isopropanol additive of the present disclosure may be added to the B-side of the foam formulation, or to the blowing agent per se, by any manner well known in the art.

[0040] Any organic polysiocyanate can be employed in polyurethane or polysiocyanurate foam synthesis inclusive of aliphatic and aromatic polysiocyanates. Preferred as a class are the aromatic polysiocyanates. Preferred polysiocyanates for rigid polyurethane or polysiocyanurate foam synthesis are the polymethylene polyphenyl isocyanates, particularly the mixtures containing from about 30 to about 85 percent by weight of methylenebis(phenylisocyanate) with the remainder of the mixture comprising the polymethylene polyphenyl polysiocyanates of functionality higher than 2. Preferred polysiocyanates for flexible polyurethane foam synthesis are toluene disocyanates including, without limitation, 2,4-toluene disocyanate, 2,6-toluene diisocyanate, and mixtures thereof.

[0041] Typical polyols used in the manufacture of rigid polyurethane foams include, but are not limited to, aromatic aminopoly-based polyether polyols such as those based on mixtures of 2,4- and 2,6-toluenediamine condensed with ethylene oxide and/or propylene oxide. These polyols find utility in pour-in-place molded foams. Another example is aromatic alkylaminobased polyether polyols such as those based on ethoxylated and/or propoxylated aminoethylated monophenol derivatives. These polyols generally find utility in spray applied polyurethane foams. Another example is sucrose-based polyols such as those based on sucrose derivatives and/or mixtures of sucrose and glucose derivatives condensed with ethylene oxide and/or propylene oxide. These polyols generally find utility in pour-in-place molded foams.

[0042] Typical polyols used in the manufacture of flexible polyurethane foams include, but are not limited to, those based on glycerol, ethylene glycol, trimethylolpropane, ethylene diamine, pentaerythritol, and the like condensed with ethylene oxide, propylene oxide, butylene oxide, and the like. These are generally referred to as “polyether polyols.” Another example is the graft copolymer polyols which include, but are not limited to, conventional polyether polyols with vinyl polymer grafted the polyether polyol chain. Yet another example is polyurea modified polyols which consist of conventional polyether polyols with polyurea particles dispersed in the polyol.

[0043] Examples of polyols used in polyurethane modified polysiocyanurate foams include, but are not limited to, aromatic polyester polyols such as those based on complex mixtures of phthalate-type or terephthalate-type esters formed from polyols such as ethylene glycol, diethylene glycol, or propylene glycol. These polyols are used in rigid laminated boardstock, and may be blended with other types of polyols such as sucrose based polyols, and used in polyurethane foam applications.

[0044] Catalysts used in the manufacture of polyurethane foams are typically tertiary amines including, but not limited to, N-alkylmorpholines, N-alkylalkanolamines, N,N-dialkylcyclohexylamines, and alkylamines where the alkyl groups are methyl, ethyl, propyl, butyl and the like and isomeric forms thereof, as well as heterocyclic amines. Typical, but not limiting, examples are triethylenediamine, tetramethylethylenediamine, bis[2-dimethylaminoethy]l ether, triethylamine, tripolyamine, tributylamine, triamylamine, pyridine, quinoline, dimethylpropazine, piperazine, N,N-dimethylethylcyclohexylamine, N-ethylmorpholine, 2-methylpiperazine, N,N-dimethylthanolamine, tetramethylenediamine, and mixtures thereof.

[0045] Optionally, non-amine polyurethane catalysts are used. Typical of such catalysts are organometallic compounds of lead, tin, titanium, antimony, cobalt, aluminum, mercury, zinc, nickel, copper, manganese, zirconium, and mixtures thereof. Exemplary catalysts include, without limitation, lead 2-ethylhexoate, lead benzoate, ferric chloride, antimony trichloride, and antimony glycolate. A preferred organo-tin class includes the stannous salts of carboxylic acids such as stannous octoate, stannous 2-ethylhexoate, stannous laurate, and the like, as well as dialkyl tin salts of carboxylic acids such as dibutyl tin dicacetate, dibutyl tin dilaurate, dioctyl tin dicacetate, and the like.

[0046] In the preparation of polysiocyanurate foams, trimierization catalysts are used for the purpose of converting the blends in conjunction with excess A component to polyisocyanurate-polyurethane foams. The trimierization catalysts employed can be any catalyst known to one skilled in the art including, but not limited to, glycine salts and tertiary amine...
Also included in the mixture are blowing agents or blowing agent blends. Generally speaking, the amount of blowing agent present in the blended mixture is dictated by the desired foam densities of the final polyurethane or polyisocyanurate foams products. The polyurethane foams produced can vary in density, for example, from about 0.5 pound per cubic foot to about 40 pounds per cubic foot, preferably from about 1 to about 20 pounds per cubic foot, and most preferably from about 1 to about 6 pounds per cubic foot. The density obtained is a function of how much of the blowing agent, or blowing agent mixture, is present in the A and/or B components, or that is added at the time the foam is prepared. The proportions in parts by weight of the total blowing agent or blowing agent blend can fall within the range of from 1 to about 60 parts of blowing agent per 100 parts of polyol. Preferably from about 10 to about 35 parts by weight of blowing agent per 100 parts by weight of polyol are used.

Other optional additives for the blowing agent mixture may include flame retardants such as tris(2-chloroethyl) phosphate, tris(2-chloropropyl)phosphate, tris(2,3-dibromopropyl)phosphate, tris(1,3-dichloropropyl)phosphate, dimethionine phosphate, various halogenated aromatic compounds, antimony oxide, aluminum trihydride, polyvinyl chloride, and the like.

The foam kit includes the polyurethane foam system with disposable spray nozzle or dispensing apparatus or non-disposable dispensing apparatus. Surfacing compounds are optional, e.g., dirt, paint, asphalt or other coating disposed on top of the installed foam material.

While I have shown and described several embodiments in accordance with my disclosure, it is to be clearly understood that the same may be susceptible to numerous changes apparent to one skilled in the art. Therefore, I do not wish to be limited to the details shown and described but intend to show all changes and modifications that come within the scope of the appended claims.

What is claimed is:

1. A method for repairing a pothole in a road surface, comprising:
   securing a sealing device in said pothole;
   affixing a reinforcing material to said securing device within said pothole; and
   adding a foam material to said pothole, wherein said foam material encapsulates said securing device and said reinforcing device within said pothole.

2. The method according to claim 1, wherein said securing device comprises one or more securing rods, one or more securing stakes, and/or combinations thereof.

3. The method according to claim 1, wherein said securing device is disposed about the bottom of the pothole and/or in the sidewalls of the pothole.

4. The method according to claim 1, wherein said securing device comprises a material selected from the group consisting of: metal, wood, plastic, and any combinations thereof.

5. The method according to claim 1, wherein said reinforcing material comprises a material selected from the group consisting of: metal, prefabricated metal, plastic, wood, synthetic material, rope, fabric, and any combinations thereof.

6. The method according to claim 5, wherein said reinforcing material is formed in a mesh and/or grid configuration.

7. The method according to claim 1, wherein said foam material is lightweight.

8. The method according to claim 1, wherein said foam material comprises a closed-cell foam.

9. The method according to claim 1, wherein said foam material is selected from the group consisting of polyurethane foam, polyisocyanurate foam, and combinations thereof.

10. The method according to claim 9, wherein said foam material further comprises:

   a blowing agent selected from the group consisting of: water, carbon dioxide, methyl formate, hydrocarbon, hydrochlorofluorocarbon (HCFC), hydrofluorocarbon (HFC), low Global Warming Potential hydrofluorocarbon (low GWP HFC), and any combinations thereof; and
   a blowing agent additive selected from the group consisting of: α-methyl styrene, isobutanol, isopropanol, and any combinations thereof.

wherein said blowing agent and said blowing agent additive contact a mixture of ingredients which react to form said polyurethane foam and/or polyisocyanurate foam.

11. The method according to claim 10, wherein said hydrofluorocarbon is selected from the group consisting of: 1,1,1,3,3-pentafluoropropane (HFC-245fa), 1,1,1,2-tetrafluoroethane (HFC-134a), 1,1,2,2-tetrafluoroethane (HFC-134a), 1,1,3,3,3-pentafluorobutane (HFC-365mfc), 1,1,2,3,3-heptafluoropropene (HFC-227ea), and any combinations thereof.

12. The method according to claim 10, wherein said blowing agent additive is present in an amount of from about 0.02 to about 10 weight percent, based on a total amount of said blowing agent.

13. The method according to claim 10, wherein said blowing agent comprises 1,1,3,3,3-pentafluoropropane (HFC-245fa), and said blowing agent additive comprises α-methyl styrene; and

wherein said α-methyl styrene is present in an amount of from about 0.02 to about 10 weight percent, based on a total amount of said 1,1,3,3,3-pentafluoropropane (HFC-245fa).

14. The method according to claim 10, wherein said polyurethane foam and/or polyisocyanurate foam comprises a pre-blended foam formulation, wherein said pre-blended foam formulation comprises:

   a first component that is an “A-side” component; and
   a second component that is a “B-side” component, wherein said blowing agent is incorporated in said first component (“A-side”) and/or said second component (“B-side”), and

wherein said polyurethane foam and/or polyisocyanurate foam are prepared by mixing said first component (“A-side”) and said second component (“B-side”), and placed in the pothole.
15. The method according to claim 1, further comprising: placing a surfacing compound on said foam material, said surfacing compound selected from the group consisting of: dirt, paint, asphalt, coating, and any combinations thereof.

16. A kit for repairing a pothole in a road surface, comprising:
   a securing device;
   a reinforcing material; and
   a two-container foam dispensing system comprising a first container that contains a first composition, and a second container that contains a second composition, and a dispensing apparatus for each of said first container and said second container, wherein said first composition and said second composition can be mixed to form a foam material to repair a pothole.

17. The kit according to claim 16, wherein said foam material is selected from the group consisting of: polyurethane foam, polyisocyanurate foam, and combinations thereof.

18. The kit according to claim 16, wherein the dispensing apparatus is a spray nozzle.

19. The kit according to claim 16, further comprising: a surfacing compound selected from the group consisting of: dirt, paint, asphalt, coating, and any combinations thereof.

* * * * *