A barrier fortification structure includes a sidewall having an interior surface and an exterior surface opposite the interior surface, the interior surface surrounding an interior volume, a filling material within the interior volume, thereby forming a barrier, and a foam disposed on at least a portion of the exterior surface of the sidewall.
BARRIER FORTIFICATION ENHANCEMENT AND BUILDING STRUCTURAL UNITS

CROSS-REFERENCED APPLICATION

[0001] This application claims priority to U.S. Provisional Application No. 61/122,444, filed on Dec. 12, 2008. U.S. Provisional Application No. 61/122,444, filed on Dec. 12, 2008, is incorporated herein by reference in its entirety.

BACKGROUND

[0002] 1. Field of the Disclosure
[0003] The present disclosure relates generally to building unit structures and methods therefore. More particularly, the present disclosure relates to a structure including a sidewall enclosing an interior volume filled with a filling material and having a foam on a side of the sidewall opposite the interior volume.

[0004] 2. Description of Related Art
[0005] Barrier fortification enhancement and building structural units that have been referred to as gabions, include a box-shaped fencing or cage that is filled with aggregate material such as sand or stones to form a wall or block. Many of the building structures include a layer of material between the fencing and aggregate to prevent the aggregate from leaking. These building structures may be erected quickly by erecting the cage and filling it with aggregate on site. These building structures are used as barriers by, for example, the military, to stabilize shorelines against erosion, form retaining walls, floodwalls, dams, barrier protection from bullets and ammunition, and analogous structural uses.

[0006] Presently, these barrier fortification enhancement and building structural units that are in use are deteriorating. The layer of material between the fencing and aggregate may develop holes or tears over time leaking the aggregate material such as sand. Portions of the cage or fencing may also corrode or break over time causing instability of the building structure. Currently, the predominant solution to the deterioration of the building structures is replacement, which results in substantial labor and cost.

[0007] Accordingly, there is a need for a building unit structure that resists deterioration. There is a further need for a method and apparatus that reinforces the building structure or repairs and prevents further deterioration of a building structure in use that has begun to deteriorate.

SUMMARY OF THE DISCLOSURE

[0008] A barrier fortification structure is provided that includes a sidewall having an interior surface and an exterior surface opposite the interior surface, the interior surface surrounding an interior volume, a filling material within the interior volume, thereby forming a barrier, and a foam disposed on at least a portion of the exterior surface of the sidewall.

[0009] A method for forming a barrier fortification structure is also provided that includes erecting the structure comprising a sidewall surrounding an interior volume, the interior volume being filled with a filling material forming a barrier, insulating and/or strengthening the sidewall by applying a foam on at least a portion of a side of the sidewall opposite the interior volume.

[0010] The above-described and other advantages and features of the present disclosure will be appreciated and understood by those skilled in the art from the following detailed description, drawings, and appended claims.

BRIEF DESCRIPTION OF THE DRAWINGS

[0011] FIG. 1 is a front perspective view of an exemplary embodiment of a structure according to the present disclosure without foam;
[0012] FIG. 2 is a perspective view of an exemplary embodiment of a sidewall according to the present disclosure in a flattened or collapsed condition;
[0013] FIG. 3 is a perspective view of an exemplary embodiment of the sidewall according to the present disclosure in a partially erected condition;
[0014] FIG. 4 is a perspective view of an exemplary embodiment of the sidewall according to the present disclosure in an erected condition;
[0015] FIG. 5 is a perspective view of an exemplary embodiment of the sidewall according to the present disclosure with foam on a portion of the sidewall;
[0016] FIG. 6 is a perspective view of an exemplary embodiment of a sidewall according to the present disclosure in an erected condition with foam on a portion of the sidewall;
[0017] FIG. 7 is a perspective view of an exemplary embodiment of a sidewall according to the present disclosure in a partially an flattened condition;
[0018] FIG. 8 is a perspective view of an exemplary embodiment of the sidewall according to the present disclosure in the flattened condition;
[0019] FIG. 9 is a top view of an exemplary embodiment of the side wall according to the present disclosure in the flattened condition; and
[0020] FIG. 10 is a perspective view of an exemplary embodiment of a structure according to the present disclosure with foam on a portion of the sidewall having a component connected to the sidewall.

DETAILED DESCRIPTION OF THE PREFERRED EMBODIMENT

[0021] Referring to the drawings and in particular to FIG. 1, an exemplary embodiment of a structure according to the present disclosure is generally referred to by reference numeral 10. Structure 10 has a sidewall 20. Sidewall 20 forms a sidewalk that surrounds an interior volume 23 in an erected condition. As shown in FIGS. 3 through 6, sidewall 20 may be connected to a bottom 38 as shown in FIG. 3 and/or a lid 28 as shown in FIG. 5. Sidewall 20 may have one or more holes 21. One or more holes 21 may be formed by mesh panels, such as, for example, a wire mesh cage.

[0022] Sidewall 20 is filled with filling material 26 to form a building unit, such as, a barrier, wall, block, or other building unit. Filling material 26 may be a filling material 26, such as, for example, stones, sand, concrete, soil, ash, brick, broken concrete, granite, limestone, sandstone, shingle, slag, stone, or any combinations thereof. Sidewall 20 may be filled with filling material 26 on site by any suitable method such as hand shovels, augers, pumps, earth movers of various types, or any combination thereof. Filling material 26 may be sized so that it will not pass through one or more holes 21.

[0023] Sidewall 20 may have a layer of material 24 connected on a side of sidewalk 20 within interior volume 23. Layer of material 24 may be flexible. Layer of material 24 covers one or more holes 21. Covering one or more holes 21 by layer of material 24 prevents filling material 26 having a
size smaller than one or more holes 21 from leaking out of one or more holes 21. Layer of material 24 may be between filling material 26 and lid 28, filling material 26 and bottom 38, and/or filling material 26 and sidewall 20. Layer of material 24 may be, for example, burlap or bonded felts of synthetic fibers which are of considerable tensile strength, but are porous so as to allow liquid to pass therethrough.

As shown in FIGS. 2 through 4, sidewall 20 may be in a collapsed or flattened condition and folded to the erected condition. The flattened condition allows for easier transportation of sidewall 10 by reducing size of structure 10 providing a flat shape. A weight of sidewall 20 is reduced without filling material 26 therein allowing easier transportation of sidewall 20. Adjacent edges of panels of sidewall 20 are clipped together with connectors, such as, for example, stainless steel clips, galvanized spring steel ring clips, helical binders, a helical spring binder clip, or any combination thereof. Wire mesh panels 30, 32, 34, and 36 may make up sidewall 20 and sidewall 20 may be connected to bottom 38 in the flattened condition. Wire mesh panels 30, 32, 34, and 36 and bottom 38 are suitably secured together so as to be relatively hingeable. Sidewall 20 and bottom 38 in the flattened condition may be covered by a sheet of flexible material 24, which is secured to wire mesh panels 30, 32, 34, and 36 and bottom 38. To erect the cage and the sheet material 40, initially panels 34 and 30 are folded to the position shown in FIG. 3, following which the excess portions of the material 40 at the corners are tucked inwardly as indicated by arrows 42, and then the end panels 32 and 36 are turned upwardly until the position shown in FIG. 4 is reached, the extra portions of the material 40 forming flat fillets 44. Sidewall 20 may be filled with the filling material 26. Panels 30 and 34 may have tie hooks 51 and 52. Tie hooks 51 and 52 link with each other as shown in FIG. 3 when the panels 30 and 34 are erected, in order to keep the panels connected whilst the material 40 is tucked at the corner and then the panels 32 and 36 are folded to the upright position.

Referring now to FIGS. 6 through 9, sidewall 20 may have sides 90 and 92, ends 94 and 96 that may be connected to cage partition panels 98 and 100, each of these components being of a wire mesh construction. Sides 90 and 92, ends 94 and 96, cage partition panels 98 and 100 may be hinged together by clip hinge rings 102 which enable respective portions to be relatively hinged so that the inter-connected portions can be relatively hinged to the flattened condition, as shown in FIGS. 8 and 9. Lid 28 can be hinged relative to side 90, as bottom 38 can be hinged relative to side 92. The sides 90 and 92 can be displaced relative to each other as indicated by arrows 112 and 114 in FIG. 7, so that the sides 90, 92, the end panels 94 and 96 and the partition panels 98 and 100 move to a flattened condition as indicated by FIGS. 8 and 9. When these panels and walls are so moved to the flattened condition lid 28 and bottom 38 can be swung onto the outsides of sides 90 and 92 to provide the flattened assembly.

Sidewall 20 may be readily manufactured under factory conditions and transported to site where it is filled with filling material 26. Inner surfaces of sides 90 and 92 and inner surfaces of ends 94 and 96 may be lined with layer of material 24 in order to contain filling material that is smaller than one or more holes 21. Inner surfaces of lid 28 and/or bottom 38 may also be lined layer of material 24.

As shown in FIG. 5, foam 50 is applied to sidewall 10. Foam 50 may be applied to structure 10 after structure 10 is erected to the erected condition. Foam 50 may be applied to structures that are in use with or without foam 50 and can deteriorate, and foam 50 is applied to deteriorated areas of structure 10 or all of sidewall 20 to reinforce structure 10. Alternatively, foam 50 is applied to structure 10 upon erection of structure 10 to resist deterioration and extend a period of time structure is in use without deterioration. Deterioration includes tears in layer of material 24 allowing filling material to leak, corrosion or breakage of a portion of sidewall 20, and/or any other structural failures.

It has been found by the present disclosure that the application of foam 50 to structure 10 prevents deterioration, or, in a structure 10 that is already in the erected condition and in use without foam 50, repairs and resists further deterioration to structure 10. Applying foam 50 to surfaces of layer of material 24 and/or sidewall 20 protects the surfaces from wear caused by, such as, for example, corrosion, impact from projectiles, weather, and/or other environmental conditions. Layer of material 24 can tear forming an aperture allowing filling material 26 to leak out of structure 10. Foam 50 may be applied to the tear to shore or repair layer of material 24 to eliminate the leak and maintain filling material 26 within structure 10. Foam can be used to repair holes and damaged areas to structure 10 by injecting the foam into the area in need of repair to seal and repair the damaged area. The foam can also be used to repair the surface area of the foamed structure 10. Application of foam 50 eliminates or reduces the need to replace structures 10 that are deteriorated and extends the lifetime of use of structure 10. Foam 50 may be applied to structure 10 on site and without the need to disassemble structure 10. Foam 50 may be used on other building structures, deteriorating structures, or temporary structures to resist deterioration or prevent further deterioration.

Foam 50 is a foamed synthetic composition, such as, for example, spray polyurethane foams. It has been found by the present disclosure that a foamed polymer is more tolerant to physical abuse than other materials such as a non-foamed resin that are more rigid. Foams generally can be struck, punched, hit, and gouged and will only dent. Structural integrity will usually be maintained by foam. In contrast, other materials, such as non-foamed resins, may be more prone to cracking when subject to physical abuse. It has also been found by the present disclosure that foams are more energy absorbing than other material, such as, solid plastics, since energy is absorbed when the cells are crushed. Layer of material 24 is better protected from projectiles and debris from explosions by foam than other material such as a solid plastic resin. Foam 50 may insulate structure 10, strengthen structure 10, and resist impact while absorbing energy from bullets and other ammunition that may impact structure 10. Foam 50 is less solid than a non-foamed resin.

The Rigid Closed Cell Foam

Closed cell spray polyurethane and polyisocyanurate foams, including their formulation and application in housing insulation applications are well known in the art. In general, polyurethane or polyisocyanurate foams are prepared by combining an (1) isocyanate, (2) a polyol, (3) a blowing agent, and optionally (4)—other additives. Each of these components and their processing to make polyurethane and polyisocyanurate foam formulations for building insulation applications is described below. Foam 50 may have a
density of about 1.0 to about 10.0 pounds per cubic foot, and preferably about 3.0 pounds per cubic foot.

1—The Isocyanate Component

[0031] Any organic polyisocyanate can be employed in polyurethane or polyisocyanurate foam synthesis inclusive of aliphatic and aromatic polyisocyanates. Preferred as a class are the aromatic polyisocyanates. Preferred aromatic polyisocyanates for rigid polyurethane or polyisocyanurate foam synthesis include the polymethylene polyphenyl isocyanates, particularly the mixtures containing from about 30 to about 85 percent by weight of methylenbis(phenyl isocyanate) with the remainder of the mixture comprising the polymethylene polyphenyl polyisocyanates of functionality higher than 2. These polyisocyanates can be used alone or in any combination. Suitable commercially available isocyanates include: Lupinate® M208 from BASF, PAPI 27 from Dow, Rubinate® M from Huntsman, and Monchur® MR from Bayer.

[0032] The amount of isocyanate in polyurethane or polyisocyanurate foam formulations is generally in the range of about 40 to about 60 weight percent of the total foam formulation.

2—The Polyl Component

[0033] Typical polyls used in the manufacture of rigid polyurethane or isocyanurate foams include, but are not limited to, (i) aromatic amino-based polymer polyls such as those based on mixtures of 2,4- and 2,6-toluenediamine condensed with ethylen oxide and/or propylene oxide, (ii) aromatic allylamine-based polymer polyls such as those based on ethoxylated and/or propoxylated aminomethyl nonylphenol derivatives, (iii) sucrose or sorbitol-based polyls such as those based on sucrose derivatives and/or mixtures of sucrose and glycine derivatives condensed with ethylene oxide and/or propylene oxide, (iv) polyls derived from natural products including without limitation soy and linseed oil, (v) aromatic polyester polyls such as those based on complex mixtures of phthalate-type or terephthalate-type esters formed from polyls such as ethylene glycol, diethylene glycol, or propylene glycol. These polyls may be used alone or in any combination.

[0034] Suitable commercially available polyls include: Voranol® 470x from Dow, Jefferol® A630 from Huntsman, Terate® 4020 from Kosa, Voranol® 370 from Dow.

[0035] The amount of polyl in the polyurethane or polyisocyanurate foam formulations is generally in the range of about 20 to about 40 weight percent of the total foam formulation.

3—The Blowing Agent Component

[0036] The blowing agent component can be any blowing agent known to be useful in the manufacture of polyurethane or polyisocyanurate foam. Generally these materials include: fluorocarbons (including chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFcs), hydrofluorocarbons (HFCs), hydrocarbons (HCs), water, CO₂, fluorosteres, fluoroethers, fluoroethanes, fluoroethanes (HFOs), chlorofluoroethanes (HFCos) organic acids, esters, ethers, alcohols, and trans-1,2-dichlorohydrogen.

[0037] Preferred blowing agents are those that have some or all of the following are non-flammable, liquid, have a low molecular weight, no or low (<about 0.01) ozone depletion potential (ODP) and have a low global warming potential (GWP) (that is a GWP of less than about 1500, more preferably about 1000 or less, still more preferably less than about 500, and most preferably less than about 150):

[0038] Suitable physical blowing agents include but are not limited to:

[0039] HCFCs and HFCs of from about 1-4 carbon atoms, and HCIs of from about 4-6 carbon atoms.

[0040] In certain embodiments, pentaffluoropropenes are preferred, including particularly those pentaffluoropropenes in which there is a hydrogen substituent on the terminal unsaturated carbon, such as CF₃CF=CFH(HFO-1225yeZ), particularly since applicants have discovered that such compounds have a relatively low degree of toxicity in comparison to at least the compound CF₂=CH—CF₂ (HFO-1225ye).

[0041] The term “HFO-1234” is used herein to refer to all tetrafluoropropenes. Among the tetrafluoropropenes are included 1,1,1,2-tetrafluoropropene (HFO-1234yf) and both cis- and trans-1,1,3-tetrafluoropropene (HFO-1234ze). The term HFO-1234e is used herein generally to refer to 1,1,1,3-tetrafluoropropene, independent of whether is the cis- or trans-form. The terms “cisHFO-1234ze” and “transHFO-1234ze” are used herein to describe the cis- and trans-forms of 1,1,1,3-tetrafluoropropene respectively. The term “HFO-1234e” therefore includes within its scope cisHFO-1234ze, transHFO-1234ze, and all combinations and mixtures of these.

[0042] The term “HFO-123” is used herein to refer to all trifluoro monochloropropenes. Among the trifluoro monochloropropenes are included 1,1,1,3-trifluoro-2-chloropropene (HFO-1233xf) and both cis- and trans-1,1,3-trifluoro-3-chloropropene (HFO-1233zd). The term HFO-1233zd is used herein generally to refer to 1,1,1,3-trifluoro-3-chloropropene, independent of whether is the cis- or trans-form. The terms “cisHFO-1233zd” and “transHFO-1233zd” are used herein to describe the cis- and trans-forms of 1,1,1,3-trifluoro-3-chloropropene, respectively. The term “HFO-1233zd” therefore includes within its scope cisHFO-1233zd, transHFO-1233zd, and all combinations and mixtures of these.

[0043] The term “HFO-1225” is used herein to refer to all pentaffluoropropenes. Among such molecules are included 1,1,1,2,3-pentaffluoropropene (HFO-1225yeZ), both cis- and trans-forms thereof. The term HFO-1225yeZ is thus used herein generally to refer to 1,1,1,2,3-pentaffluoropropene, independent of whether it is the cis- or trans-form. The term “HFO-1225yeZ” therefore includes within its scope cisHFO-1225yeZ, transHFO-1225yeZ, and all combinations and mixtures of these.

[0044] HFOs derived from 365mc including without limitation HFO-1354 and HFO-1345 may also be used as blowing agents in this application.

[0045] Preferred physical blowing agents include but are not limited to: 1,1-dichloro-1-fluoroethane (HFC-141b), 1,1,1,2-tetrafluoroethane (HFC-134a), 1,1,1,2-tetrafluoroethane (HFC-134), 1-chloro-1,1-difluoroethane, 1,1,3,3-pentafluoroethane (HFC-142b), 1,1,1,2,3,3,3-heptaffluoropropene (HFC-227ea), difluoroethane, 1,1,3,3-pentafluoroethane (HFC-245fa), 1,1,1,3,3-pentafluoroethane (HFC-365mc), 1,1,1,2-tetrafluoroethane (HFC-1234yr), 1,2,3,3,3-pentafluoroethane (HFC-1225ye), 1-chloro-3,3,3-trifluoroethane (HFO-1233zd, trans and/or cis isomers), 1,1,1,3-tetrafluoroethane (HFO-1234ze, trans and/or cis isomers) and combina-
tions of any of the foregoing or combinations of any of the foregoing with other suitable blowing agents.

[0046] Suitable commercially available physical blowing agents include ENOVATE® 245fa from Honeywell and SOL-KANE® 365mc available from Solvay. When used alone these materials are present in an amount of about 3 to about 15 weight percent of the total foam formulation. When 245fa and 365mc are used in combination they may be used in any combination however physical blowing agent compositions which are 245fa rich (i.e., >50 weight percent of the physical blowing agent composition is composed of HFC-245fa).

[0047] Chemical blowing agents include but are not limited to compounds that react with the isocyanate to liberate a gas. Preferred chemical blowing agents include water and organic acids like formic acid.

[0048] Generally speaking, the amount of blowing agent present in the foam formulation is dictated by the desired foam densities of the final polyurethane or polyisocyanurate foams products. The polyurethane and polyisocyanurate foams produced can vary in density from about 1.0 to about 6.0 pounds per cubic foot, more preferably from about 1.5 to about 4.0 pounds per cubic foot and most preferably 1.8 to 4 pound 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.

[0049] The amount of physical blowing in the polyurethane or polyisocyanurate foam formulations is generally in the range of about 3 to about 15 weight percent of the total foam formulation while the amount of chemical blowing agent in such formulations is generally in the range of about 0 to about 3 weight percent of the total foam formulation.

4—Catalysts:

[0050] Any catalyst useful in the manufacture of polyurethane and/or polyisocyanurate foam may be used in the invention. 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-dimethylaminoethyl)ether, triethylenamine, tripropylamine, tributylamine, trimethylamine, pyridine, quinoline, dimethylpiperazine, piperazine, N,N-dimethylcyclohexylamine, N-ethylmorpholine, 2-methylpiperazine, N,N-dimethylethanolamine, tetramethylpropylenediamine, methyltriethylenediamine, and mixtures thereof.

[0051] The amount of amine catalyst in the polyurethane foam formulation is generally in the range of about 0 to about 5 weight percent of the total foam formulation.

[0052] Optionally, non-amine polyurethane catalysts may be used in the polyurethane foam formulation. 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 dioctoate, dibutyl tin dilaurate, dioctyl tin diacetate, and the like.

[0053] The amount of non-amine catalyst in the polyurethane foam formulations is generally in the range of about 0 to about less than 1 weight percent of the total foam formulation.

[0054] In the preparation of polyisocyanurate foams, trimerization catalysts are used for the purpose of converting excess (i.e., greater than the amount required to react with the polyl and other isocyanate-reactive components in the foam formulation). Any trimerization catalyst known to be useful in the manufacture of polyisocyanurate foam may be employed in the present invention. These catalysts include, but are not limited to, glycine salts and tertiary amine trimerization catalysts, alkali metal carboxylic acid salts, and mixtures thereof. Preferred species within these classes are potassium acetate, potassium octoate, and N-(2-hydroxy-5-nonylphenol)methyl-N-methylglycinate.

[0055] The amount of trimerization catalyst in the polyisocyanurate foam formulation is generally in the range of about 0 to about less than 5 weight percent of the total foam formulation.

5—Other Additives:

[0056] There are numerous additives that may be added to the foam formulation to optimize properties of the formulation. They include without limitation: surfactants, cell stabilizers, flame retardants, viscosity modifiers, crosslinking agents, solubilizers, dispersing agents, colorants, adhesion promoters, vapor pressure suppressants and stabilizers. These are all well known in the art. Generally additives are present in the foam formulation in an amount of 0 to about 15 weight percent of the total foam formulation.

[0057] Closed-cell spray foam suitable for this application preferably have the following nominal properties:

<table>
<thead>
<tr>
<th>Property</th>
<th>ASTM Test</th>
<th>Unit</th>
<th>Value</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nominal Density</td>
<td>D-1622</td>
<td>lbs/ft³</td>
<td>1.5-4.0</td>
</tr>
<tr>
<td>Sprayed-in-Place</td>
<td>C-518</td>
<td>R/¹⁰¹CF</td>
<td>5.0-8.0</td>
</tr>
<tr>
<td>R Value at 75°F R/¹⁰¹ mean temp. measured 6 months after foam manufacture</td>
<td>D-1621</td>
<td>psi</td>
<td>20-60</td>
</tr>
<tr>
<td>Panel to Rise Compressive Strength</td>
<td>D-1623</td>
<td>psi</td>
<td>30-100</td>
</tr>
<tr>
<td>Tensile Strength</td>
<td>D-2856</td>
<td>%</td>
<td>&gt;80</td>
</tr>
</tbody>
</table>

[0058] Useful closed-cell spray foams are disclosed in U.S. Pat. Nos. 6,414,046; 7,214,294; 6,843,934, 6,806,247, 6,790, 820; 6,784,150, among others which are incorporated herein by reference.

[0059] Useful closed-cell spray foams include Comfort Foam® FE178, FE158, CF178, CF158 commercially available from BASF Polyurethanes—Foam Enterprises (a division of BASF) of Florham Park, N.J.; BaySeal™ 2.0 commercially available from BaySystems (a division of Bayer) of Spring, Tex.; Corbond® commercially available from Corbond of Bozeman, Mont.; Heatlok Soy 0240 commercially available from Demilec USA of Arlington, Tex.; Styrofoam™ 2.0 commercially available from Dow Chemical Company of Midland, Mich.; PF-173, PF-193 commercially

6—Preparation and Application of the Rigid Closed Cell Foam

[0060] The preparation of polyurethane and polyisocyanurate foam is well known in the art. It is convenient in many applications to provide the components for polyurethane or polyisocyanurate foams in pre-blended foam formulations. Most typically, the foam formulation is pre-blended into two components. The isocyanate or polyisocyanurate composition comprises the first component, commonly referred to as the “A” component. The polyol or polyol mixture, surfactant, catalyst(s), blowing agent(s), flame retardant, and other isocyanate reactive components comprise the second component, commonly referred to as the “B” component. While the surfactant, catalyst(s) and blowing agent are usually placed in the “B” component, they also may be added to the “A” side, or added to both the “A” and “B” sides.

[0061] When spray foam is applied, the A-side chemicals (e.g. polyisocyanate) and B-side chemicals are mixed in appropriate amounts, typically equal amounts by volume, and then atomized into a mist. This mixture is then sprayed by a spray gun.

The polyurethane or polyisocyanurate foam is created as the two chemicals mix and are deposited on structure 10. Alternatively, fire retardant, colorant, auxiliary blowing agents, water, and even other polyols can be added as a third stream to the mix head of the spray gun.

[0062] Structure 10 having foam 50 thereon can be used for barriers, walls, blocks,王者荣耀 walls, barricades, coastal supports, stabilize shorelines against erosion, form retaining walls, floodwalls, dams, barrier protection from bullets and ammunition, and analogous uses. Structure 10 effectively combats erosion and is particularly suitable for stabilizing and strengthening embankments. Structure 10 having foam 50 thereon has some flexibility to allow some movement and change in shape should local ground subsidence occur. Strength and integrity of structure 10 are retained. Structure 10 may be porous and it is not therefore normally necessary to incorporate drainage systems.

[0063] Foam 50 may be coated with a UV resistant material. The UV resistant material may be silicone, polyurea, acrylic, urethane, asphalt coatings, membrane roof waterproofing sheets, pavers, aggregate, poured in-place concrete protection surfacing, or any combination thereof.

[0064] Foam 50 may be coated with an insect and/or pest (e.g., ants, moths, roaches, ants, spiders, etc.), resistant material. Coating foam 50 with insect and/or pest resistant material on structure 10 repels, reduces or eliminates pests such as insects, rodents, and other unwanted pests, in and around structure 10.

[0065] Filling material 26 may expand and/or contract due to environmental conditions such as temperature and humidity. It has been found by the present disclosure that foam 50 maintains a connection to sideward 20 during environmental conditions such as freeze and thaw of filling material 26 and is able to permit movement due to freeze and thaw of filling material in contrast to a non-foamable resin that will flake off due to expansion and/or contraction due to freezing and thawing. Foam 50 may insulate structure 10. Insulating structure 10 reduces freeze and thaw of filling material 26 that can lead to instability or erosion of filling material 26.

[0066] Structure 10 may collect liquid within filling material 26 and/or interior volume 23. One or more holes 21 drain liquid out of interior volume 23. Foam 50 may reduce water entry into the structure 10. Foam 50 may be formed to have openings or ports to drain liquid from interior volume 23. Foam 50 may be waterproof and/or permeable allowing liquid to drain from interior volume 23. The collection of liquid in interior volume 23 may cause filling material 26 to swell by applying force to sideward 10 and foam 50. Similar to freezing and thawing described herein, foam 50 is able to permit movement due to freezing and thawing as well as collection of liquid within interior volume 23. Foam can be used to flash drainage opening and penetrations.

[0067] Foam 50 may be a blast mitigation material and/or an energy absorption material. Foam 50 that is a blast mitigation material and/or an energy absorption material maintains the structural integrity of structure 10 to resist structural failure due to impact from a projectile or blast. As discussed herein, it has been found by the present disclosure that a foamed polymer is more tolerant to physical abuse than other materials such as non-foamed resin. Foams generally can be struck, punched, hit, and gouged and will only dent. Structural integrity will usually be maintained. In contrast, other materials, such as non-foamed resins, may be more prone to cracking when subjected to physical abuse. It has also been found by the present disclosure that foams are also more energy absorbing than other material, such as, solid plastics since energy is absorbed when the cells are crushed. A layer of material 24 is better protected from projectiles and debris from explosions than other material such as a solid plastic resin.

[0068] Foam 50 may have a color. Color may be added to foam 50 by dyes. For example, foam 50 may have a color that camouflages structure with the surrounding environment. Such camouflage patterns and colors include shades of green similar to plant life, white to camouflage with snow, tan similar to desert sand, and analogous camouflage colors and patterns.

[0069] As shown in FIG. 6, sideward 20 may include a first sideward 27 connected to a second sideward 29 having a connection area 25 there between. Foam 50 may be applied to connection area 25. Foam 50 on connection area 25 may adhere first sideward 27 to second sideward 29. Foam 50 may be applied to connection area 25 so that a continuous surface that is substantially smooth and/or in the same plane is formed.

[0070] Structure 10 may be stacked or placed side-by-side to form larger structures. Structure 10 may be erected to the erected condition and an additional structure may be erected to the erected condition adjacent to structure 10 or stacked upon structure 10. Structure 10 and the additional structure form a connection area similar to connection area 25. Foam 50 is applied to the connection area between structure 10 and the additional structure so that a continuous surface that is a substantially smooth surface and/or within the same plane is formed. Foam 50 may adhere structure 10 to the additional structure stacked thereon or adjacent thereto. Foam 50 may be applied to layer of material 24 of structure 10 and a layer of material of the additional structure either on a side opposite
filling material 26 of structure 10 and filling material of the additional structure or within interior volume 23 of structure 10 and an interior volume of the additional structure.

[0071] Referring to FIG. 10, sidewall 10 may have a component 60 adhered thereto by foam 50. Component 60 may be placed on sidewall 10 and foam 50 is applied to sidewall 10 and component 60 to adhere component 60 to sidewall 10. Foam 50 may be an adhesive. Foam 50 may be applied to an interior side within interior volume 23 to connect component 60 to sidewall 10. Foam 50 may be applied to a side of sidewall opposite interior volume 23 to connect component 60 to sidewall 10. Component 60 may be a barrier deterrent such as, for example, razor wire, barbed wire, concertina wire, and the like or lighting and/or wiring.

[0072] It should also be noted that the terms “first”, “second”, “third”, “upper”, “lower”, “above”, “below”, and the like may be used herein to modify various elements. These modifiers do not imply a spatial, sequential, or hierarchical order to the modified elements unless specifically stated.

[0073] While the present disclosure has been described with reference to one or more exemplary embodiments, it will be understood by those skilled in the art that various changes may be made and equivalents may be substituted for elements thereof without departing from the scope of the present disclosure. In addition, many modifications may be made to adapt a particular situation or material to the teachings of the disclosure without departing from the scope thereof. Therefore, it is intended that the present disclosure not be limited to the particular embodiment(s) disclosed as the best mode contemplated, but that the disclosure will include all embodiments falling within the scope of the appended claims.

What is claimed is:
1. A barrier fortification structure comprising:
   a sidewall having an interior surface and an exterior surface opposite said interior surface, said interior surface surrounding an interior volume;
   a filling material within said interior volume, thereby forming a barrier; and
   a foam disposed on at least a portion of said exterior surface of said sidewall.
2. The structure of claim 1, wherein said sidewall is transformable between a flattened condition and an erected condition, wherein in said erected condition, said sidewall is filled with said filling material, and in said flattened condition, said sidewall is flattened and collapsed upon itself without said filling material therein.
3. The structure of claim 1, further comprising a layer of material covering said interior surface of said sidewall between said sidewall and said filling material.
4. The structure of claim 1, wherein said sidewall has a plurality of holes or is formed of a mesh-like material.
5. The structure of claim 1, wherein said foam comprises a rigid closed cell foam that comprises (a) a blowing agent, and(b) at least one compound selected from the group consisting of: a polyurethane, a polyisocyanurate polymer and combinations thereof.
6. The structure of claim 5, wherein said blowing agent is at least one selected from the group consisting of: 1,1,1-dichloro-1-fluoroethane (HCFC-141b); 1,1,1,2-tetrafluoroethane (HFC-134a); 1,1,1,2-tetrafluoroethane (HFC-134); 1-chloro-1,1-difluoroethane (HCFC-142b); 1,1,1,3,3-pentfluorobutane (HFC-365mcic); 1,1,2,3,3-heptafluoropropane (HFC-227ea); difluoroethane ([HFC-142b]; 1,1,1,3,3-pentfluoropropane (HFC-245fa); 1,1,2-tetrafluoroprop-1-ene (HFO-1234yf), 1,2,3,3,3-pentafluoroprop-1-ene (HFO-1225ye), 1-chloro-3,3,3-trifluoroprop-1-ene (HFO-1233zd, trans and/or cis isomer), 1,1,1,3-tetrafluoroprop-1-ene (HFO-1234ze, trans and/or cis isomer), water, formic acid, carbon dioxide, esters, chlorocarbons, ethers, fluoroethers and combinations thereof.
7. The structure of claim 5, wherein said blowing agent is selected from the group consisting of: 1,1,1,3,3-pentafluoropropane, 1,1,1,3,3-pentafluorobutane, and mixtures thereof.
8. The structure of claim 7, wherein said blowing agent is 1,1,1,3,3-pentafluoropropane.
9. The structure of claim 8, wherein said foam comprises at least one compound selected from the group consisting of: co-blowing agent, surfactant, polymer modifier, toughening agent, colorant, dye, solubility enhancer, rheology modifier, plasticizing agent, flammability suppressant, antibacterial agent, viscosity reduction modifier, filler, vapor pressure modifier, nucleating agent, catalyst, and a combination thereof.
10. The structure of claim 1, wherein said foam has a density from between about 1.5 to about 10.0 pounds per cubic foot.
11. The structure of claim 1, wherein said foam is coated with a UV resistant material.
12. The structure of claim 1, wherein said foam is coated with an insect and/or pest resistant material.
13. The structure of claim 1, wherein said foam is an insulation material that insulates said interior volume.
14. The structure of claim 1, wherein said foam is a blast mitigation material and/or an energy absorption material.
15. The structure of claim 1, wherein said foam is a color that camouflages the structure with its surrounding environment.
16. The structure of claim 1, wherein said foam is waterproof.
17. The structure of claim 1, wherein said foam maintains a connection to said sidewall during freeze and thaw of said filling material.
18. The structure of claim 1, wherein said foam connects a component selected from the group comprising electrical wiring, lighting to said sidewall, a barrier deterrent, and an additional structure, to said sidewall.
19. The structure of claim 3, wherein said layer of material has a hole therethrough, and wherein said foam is further applied over said hole.
20. The structure of claim 1, wherein said foam is permeable and drains liquid out of said interior volume.

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