ABSTRACT

A boot for reducing injury from a close range explosion includes a sole unit, an upper, and a shin guard. The sole unit includes at least an outer sole, a shank sheet composite, a shank filler and an insole. At least the shank sheet composite includes a plurality of layers having a pyramid shape and is formed of a strong composite fiber. The upper is attached to the sole unit and is formed of a laminated canvas. The shin guard is connectable to the upper and protects an ankle and leg of a user. The shin guard is formed of a strong composite fiber.
BOOTS FOR MINIMIZING INJURY FROM EXPLOSIVES

CROSS-REFERENCE TO RELATED APPLICATION

[0001] This patent application claims priority to Thai Patent Application No. 0701005013, filed on Oct. 3, 2007, the entire content of which are hereby expressly incorporated by reference.

TECHNICAL FIELD

[0002] The present invention relates generally to the field of protective footwear. In particular, the present invention relates to Explosive Ordnance Disposal (EOD) footwear.

BACKGROUND

[0003] There are a number of live explosives buried beneath the surface, especially in conflict areas such as war zones. During combat, soldiers typically wear combat boots designed to protect their feet from rugged terrain and environments. While combat boots have traditionally been made of hardened leather, newer fabrics have recently been incorporated into combat boots to increase ventilation and comfort. Although combat boots are effective for protecting the feet of the user from natural elements, they are not as effective for preventing injury to the feet and lower appendages of the user from explosives.

[0004] Explosive Ordnance Disposal (EOD) boots are designed to prevent or reduce injuries to the lower appendages of a person that may be in direct contact with an explosive, such as a M14 anti-personnel mine (plastic mine). EOD boots are designed specifically to counteract an explosive force acting against the bottom of a user's foot. While effective, conventional EOD boots are heavy and bulky, making them uncomfortable to walk around in and difficult to quickly maneuver around in when traversing steep or rough terrain.

SUMMARY

[0005] In one embodiment, the present invention is a boot for reducing injury from a close range explosion and includes a sole unit, an upper, and a shank guard. The sole unit includes at least an outer sole, a shank sheet composite, a shank filler and an insole. At least the shank sheet composite includes a plurality of layers having a pyramid shape and is formed of a strong composite fiber. The upper is attached to the sole unit and is formed of a laminated canvas. The shank guard is connectable to the upper and protects an ankle and leg of a user. The shank guard is formed of a strong composite fiber.

[0006] In another embodiment, the present invention is a boot for protecting a lower appendage of a user. The boot includes a shoe and a shank guard. The shoe includes an upper and a sole unit attached to the upper. The sole unit includes a plurality of layers angled along a longitudinal axis extending from the toe portion to the heel portion of the sole unit at between about 102 degrees and about 112 degrees. At least one of the layers is formed of a strong composite fiber. The shank guard is positionable adjacent the upper.

[0007] In yet another embodiment, the present invention is an explosion ordnance device boot. The boot includes a shoe and a shank guard attached to the shoe. The shoe includes an upper, an insole, a shank sheet composite, a filler, and an outer sole. The insole is bonded to the upper. The shank sheet composite includes at least eight angled layers, a top surface, a bottom surface, and a cavity formed at the top surface. The filler is formed within the cavity of the shank sheet composite. The outer sole is connected to the bottom surface of the shank sheet composite.

[0008] While multiple embodiments are disclosed, still other embodiments of the present invention will become apparent to those skilled in the art from the following detailed description, which shows and describes illustrative embodiments of the invention. Accordingly, the drawings and detailed description are to be regarded as illustrative in nature and not restrictive.

BRIEF DESCRIPTION OF THE DRAWINGS

[0009] FIG. 1 is a schematic view of an EOD boot, according to one embodiment of the present invention.

[0010] FIG. 2 is a schematic view of a shoe of the EOD boot, according to one embodiment of the present invention.

[0011] FIG. 3 is an exploded view of a sole unit of the EOD boot, according to one embodiment of the present invention.

[0012] FIG. 4 is a schematic view of an insole of the EOD boot, according to one embodiment of the present invention.

[0013] FIG. 5 is a schematic view of a shank filler of the EOD boot, according to one embodiment of the present invention.

[0014] FIG. 6A is a schematic view of a shank sheet composite of the EOD boot, according to one embodiment of the present invention.

[0015] FIG. 6B is a cross-sectional view of the shank sheet composite of the EOD boot, according to one embodiment of the present invention.

[0016] FIG. 6C is a top view of the shank sheet composite of the EOD boot, according to one embodiment of the present invention.

[0017] FIG. 7A is a schematic view of an outer sole of the EOD boot, according to one embodiment of the present invention.

[0018] FIG. 7B is a top view of the outer sole of the EOD boot, according to one embodiment of the present invention.

[0019] FIG. 8 is an exploded cross-sectional view of the sole unit, according to one embodiment of the present invention.

[0020] FIG. 9A is a cross-sectional view of the sole unit and dispersive forces of an explosion, according to one embodiment of the present invention.

[0021] FIG. 9B is an enlarged, partial cross-sectional view of the sole unit and the dispersive forces of an explosion, according to one embodiment of the present invention.

[0022] FIG. 10 is a schematic view of an inner side of a shank guard of the EOD boot, according to one embodiment of the present invention.

[0023] FIG. 11 is a schematic view of an outer side of the shank guard of the EOD boot, according to one embodiment of the present invention.

DETAILED DESCRIPTION

[0024] FIG. 1 shows a schematic view of an Explosive Ordnance Disposal (EOD) boot 10 of the present invention. The EOD boot 10, or personal protective boot, includes a shoe 12 and a shank guard 14 positionable at least partially over the shoe 12. The EOD boot 10 is designed to be used in areas where there is a high likelihood of explosions, such as from land mines, and in environments with critically high pressures, heat, flames, toxic gases, and sharp fragments. The
EOD boot 10 is designed to protect the user's foot and leg below the knee from injury from an explosion, to increase comfortability, and to provide support around the user's ankle in order to prevent injury to the user when walking through rough slopes or terrain. The lower appendages are protected by the EOD boot 10 and help keep the user's appendages intact in the event that the EOD boot 10 comes into direct contact with an explosive, heat or fragments of a bomb. The EOD boot 10 controls the extent or degree of any injury such that the patient can be sent to emergency medics and/or physicians in time to receive medical treatment and avoid amputation of the foot or leg.

**[0025]** FIG. 2 shows a schematic view of the shoe 12, which includes an upper 16 and a sole unit 18. The shoe 12 has the appearance and comfortability of an athletic shoe, but is formed of a material capable of providing protection to soldiers on the battlefield or to EOD specialists. The combination of the upper 16 and the sole unit 18 provides flexibility of an athletic shoe such that the shoe 12 is lightweight and comfortable to wear in substantially any environment. In one embodiment, the shoe 12 has a weight of between about 1.0 kilogram (2.2 pounds) and about 1.5 kilogram (3.3 pounds) and particularly between about 1.0 kilogram and 1.3 kilogram (2.0 pounds).

**[0026]** The upper 16 covers the top contour of the foot and is designed to cover the foot up to the ankle. When the EOD boot 10 (FIG. 1) is being used on surfaces with steep angles, such as on rough terrains with different slopes, the upper 16 provides firmness around the ankle to prevent foot, ankle and leg injuries while walking. For example, the risk of the user twisting an ankle is substantially reduced. In one embodiment, the upper 16 is made from a plurality of sponge layers on an inner side of the upper 16 and canvas laminated with strong multi-layer composite polymer fabrics on an outer side of the upper 16. The sponge layers are positioned to contact the user's foot when the user is wearing the shoe 12 to provide comfort to the user. The composite polymer fabrics support the user's foot from injury and are positioned opposite the sponge layers to protect the user's foot against the elements.

**[0027]** The upper 16 and the sole unit 18 are attached to each other with a high enough bond strength that in the event of an explosion, the EOD boot 10 does not completely break apart. At the same time, the bond between the upper 16 and the sole unit 18 is designed such that parts of the sole unit 18 can absorb part of the explosion by tearing or splitting, while still protecting the foot. For example, the EOD boot 10 is capable of withstanding a blast pressure of about 60-65 bars/110 msc and preventing gases produced from the explosion from contacting the skin. In one embodiment, the upper 16 and the sole unit 18 are attached at a bond strength of at least about 3 kg/cm square. In another embodiment, the upper 16 and the sole unit 18 are attached at a bond strength of less than about 6 kg/cm. The sole unit 18 may be bonded to the upper 16 by pressing and curing. Alternatively, the sole unit 18 may be bonded to the upper 16, for example, by an adhesive system that is a mixture of phenol formaldehyde and vinyl resins dissolved in polar solvents. The sole unit 18 may be also bonded to the upper 16 by boning and sewing.

**[0028]** FIG. 3 shows an exploded view of the components of the sole unit 18 of the EOD boot 10 (FIG. 1). The sole unit 18 works as a combined, molded structure to take the impact of an explosion and prevent injury to the user's foot by quickly reducing and distributing blast forces, toxic gases and heat away from the shoe 12. The sole unit 18 also protects the user's foot from blast fragments and sharp objects.

**[0029]** The sole unit 18 is formed of four primary layers: an insole 20 (FIG. 4), a shank filler 22 (FIG. 5), a shank sheet composite 24 (FIG. 6) and an outer sole 26 (FIG. 7). The insole 20, the shank filler 22, and the shank sheet composite 24 are molded as a composite system designed to capture forces from a blast. In one embodiment, a sock liner 29 may also be positioned between the sole unit 18 and the user's foot. The sock liner 29 functions as a padding between the more stiff components of the sole unit 18 and the user's foot. In order to increase the comfort level of the user wearing the EOD boot 10, the sock liner 29 is formed of a softer material to provide cushion and support to the user's foot. In one embodiment, the sock liner 29 is formed of ethylene vinyl acetate and is laminated with canvas.

**[0030]** FIG. 4 shows a schematic view of the insole 20. The insole 20 has a top surface 28, a bottom surface 30, a toe portion 32, a mid-portion 34 and a heel portion 36. As mentioned above, when a user is wearing the EOD boot 10 (FIG. 1), the user's foot is in contact with the sock liner 29, which is positioned on top of the insole 20 of the sole unit 18. The insole 20 attaches the upper 16 and the sole unit 18 together to provide support to the user's foot. In one embodiment, the insole 20 has a thickness of about 4 millimeters. In one embodiment, the insole 20 is formed from a combination of a strong composite fabric, polyurethane and a binding agent. In another embodiment, the insole 20 is formed of a strong composite fabric and canvas. The insole 20 can have a slip lasted or a board lasted construction.

**[0031]** FIG. 5 shows a schematic view of the shank filler 22. FIGS. 6A, 6B and 6C show a schematic view, a cross-sectional view and a top view, respectively, of the shank sheet composite 24. FIGS. 5 and 6A-6C will be discussed in conjunction with each other. The shank filler 22 is formed of a porous material and is poured into the shank sheet composite 24. In one embodiment, the shank filler 22 is a porous polyurethane. When formed, the shank filler 22 has a top surface 38, a bottom surface 40 having a pyramid shape, a toe portion 42, a mid-portion 44 and a heel portion 46. The shank filler 22 is designed to absorb and scatter the energy created by an explosion by quickly breaking into small pieces or fragments when exposed to a blast.

**[0032]** The shank sheet composite 24 works as a fireproof and explosive barrier and has a top surface 50, a bottom surface 52, a toe portion 54, a mid-portion 56 and a heel portion 58. As can be seen in FIG. 6B, the shank sheet composite 24 is formed of a plurality of layers molded together. In one embodiment, the shank sheet composite 24 is formed of about eight layers. However, the shank sheet composite 24 may be formed of any number of layers without departing from the intended scope of the present invention.

**[0033]** Each of the layers of the shank sheet composite 24 has a pyramid shape that is closed at both the toe and heel portions 52, 56. The pyramid shape forms an angle along a longitudinal axis LA of the shank sheet composite 24 which extends from the toe portion 52 to the heel portion 56. The angle formed by each of the layers creates a channel 58 (FIG. 6C) that functions as a leak way for high pressure gases released by an explosion. The angle also functions to deflect the force of an explosion away from the user's foot. The shank sheet composite 24 is capable of deflecting explosive forces in part due to a cavity 60 (FIGS. 6B and 6C) formed at the top surface 48 of the shank sheet composite 24 by the pyramid
shape of each of the layers. In one embodiment, each of the pyramid shapes of the layers has a proper apex angle $\Theta$ of between about 102 degrees and about 112 degrees in order to optimize dispersion of the forces from a blast. The angle is set at an optimum value to branch off the vector direction represented from the separated total force.

[0034] As mentioned above, the cavity 60 is filled with the shank filler 22, which allows the explosion forces to be absorbed before reaching the insole 20 (FIG. 4). In addition, because the top surface 49 of the shank sheet composite 24 becomes flat once the shank filler 22 is poured into the cavity 60, the shank sheet composite 24 can more easily be attached to the insole 20.

[0035] The shank sheet composite 24 is composed of strong composite polymer fabrics that are lightweight and molded as shoe soles containing physical and mechanical properties that diminish scattered explosive forces. The combination of the strong composite polymer fabric and the apex shape of the shank sheet composite 24 dissipate some of the energy that may have broken into the surface of the shank sheet composite 24 from the outer sole 26 in the event of an explosion. While each of the layers of the shank sheet composite 24 are formed of the same material, each layer can be formed having a different thickness or a different density or tensile strength. In one embodiment, the outer layers have a higher density and greater tensile strength than the inner layers. Each of the layers has a thickness, for example, of about 0.5 millimeters.

[0036] The strong composite polymer fabric has the physical and mechanical properties to reduce vector forces, distribute blasting powers and effectively prevent fragments. In one embodiment, the strong composite polymer fabric is substantially as strong as a standard Level II small arm bullet proof material. In one embodiment, the strong composite polymer fabric has an embrittlement transition temperature of about $-46$ degrees Celsius, a weight of between about 9 and about 10.7 kg/m$^2$, a modulus of about 27.5 KPa and includes about 57% to about 60% fiber. In one embodiment, the strong composite polymer fabric is a para aramid synthetic fiber. An example of a suitable para-aramid synthetic fiber includes Kevlar, available from DuPont. Examples of suitable aramids include Nomex, available from DuPont, Wilmington, Del.; Teijinconex, available from Teijin Japan; New Star, available from Yantai, China; and Kermel, available from Kermel, France.

[0037] FIGS. 7A and 7B show a schematic view and a top view, respectively, of the outer sole 26. The outer sole 26 is the outermost part of the sole unit 18 and is designed to absorb the majority of the energy created by an explosion and to perform as a leak way for pressure, forces and heat to travel to the sides of the sole unit 18. The outer sole 26 includes a top surface 62, a bottom surface 64, a toe portion 66, a mid-portion 68, a heel portion 70, a cavity 71, a middle apex 72 along the bottom surface 64 and a plurality of treads 74 along the bottom surface 64. The cavity 71 is located at the top surface 62 of the outer sole 26 and maintains the components of the sole unit 18 together. The outer sole 26 is sized slightly larger than the other layers 20, 22, 24 of the sole unit 18 such that the insole 20, shank filler 22 and shank sheet composite 24 are positionable within the cavity 71 at the top surface 62 of the outer sole 26.

[0038] The outer sole 26 includes multiple rails at the middle apex 72 of the bottom surface 64 to provide toe flex at the toe portion 66 of the outer sole 26. In one embodiment, the toe portion 66 has a thickness of about 4 millimeters in order to allow flexibility, while the heel portion 70 has a thickness of between about 1.8 inches and about 2.5 inches to provide stability and support to the user.

[0039] The treads 74 provide friction between the shoe 12 and the surface the user is traversing to help the user navigate through rough terrains without slipping.

[0040] A blast directed at the sole unit 18 is reduced very quickly by the outer sole 26 breaking into small pieces or fragments at the same time. By allowing the outer sole 26 to easily break into small pieces, energy is scattered from the sole unit 18. The high abrasion resistance properties of the outer sole 26 is capable of quickly distributing blast forces, toxic gases and heat away from the sole unit 18. In one embodiment, the outer sole 26 is made of rubbers or polymers such as polyurethane.

[0041] FIG. 8 shows an exploded cross-sectional view of the sole unit 18 and the upper 16. As can be seen in FIG. 8, the insole 20, shank filler 22, shank sheet composite 24 are positioned within the outer sole 26 and the sock liner 29 is positioned within the upper 16. The outer sole 26 holds the layers of the sole unit 18 together. The insole 20, shank filler 22 and shank sheet composite 24 of the sole unit 18 are formed, cut or molded having substantially the same outline such that when positioned on top of each other, the toe portions 32, 42, 52, mid-portions 34, 44, 54 and heel portions 36, 46, 56 of the components 20, 22, 24 are all aligned with each other, respectively. Also referring back to FIG. 3, it can be seen that when positioned in the cavity 71 of the outer sole 26, the bottom surface 30 of the insole 20 engages the top surface 38 of the shank filler 22, the bottom surface 40 of the shank filler 22 engages the top surface 48 of the shank sheet composite 24, and the bottom surface 50 of the shank sheet composite 24 engages the top surface 62 of the outer sole 26. The insole 20, shank filler 22, shank sheet composite 24 and outer sole 26 are then pressed together to form the sole unit 18.

[0042] When the shoe 12 includes a sock liner 29, the sock liner 29 is also formed, cut, or molded having substantially the same outline as the other components of the sole unit 18. The sock liner 29 is positioned within the upper 16 and adhered to the insole 20 by an adhesive. For example, the sock liner 9 is attached to the insole 20 using a glue.

[0043] FIG. 9A shows a cross-sectional view of the sole unit 18 and its dispersion capabilities when the EOD boot 10 is exposed to an explosion and FIG. 9B shows an enlarged, partial cross-sectional view of the sole unit 18 and its dispersion capabilities. In the event of an explosion, the outer sole 26 and shank sheet composite 24 function to disperse the explosive forces extremely quickly, causing the outer sole 26 to substantially completely fragment and the shank filler 22 within the cavity 60 of the shank sheet composite 24 to also fragment. Because the outer sole 26 is formed of polyurethane and the shank filler 22 is formed of a porous, sponge-like polyurethane, the outer sole 26 and the shank filler 23 can easily fragment and disperse the forces from the explosion. While the shank filler 22 also fragments, it generally does not fragment to the same extent as the outer sole 26, as the outer sole 26 is in more direct contact with the explosion forces. As the outer sole 26 and the shank filler 22 fragment, the action force of the explosion is reduced and delays the explosive wave traveling through the EOD boot 10.

[0044] The total blast or scattering energy dispersion on the shank sheet composite 24 is equal to the amount of energy lost at the outer sole 26, or $R_s + R_b + R_f = R_e$. $R_s$ is equal to the energy lost at the outer sole 26 and is the amount of energy
remaining after the leaks that caused the outer sole 26 to break or split apart. \( R_s \) is equal to the scattering energy dispersed on the shank sheet composite 24, or the amount of energy remaining after the force has passed through the outer sole 26 and the shank sheet composite 24. \( R_s \) is equal to the energy absorbed by the shank sheet composite 24. After the shank sheet composite 24 collapses, air bubbles break in the body mass of the outer sole 26 and some of the energy is lost in \( R_s \). The \( R_s \) force is not normal to the plane of the insole 20 breaking into \( R_s \), which is perpendicular to the insole 20. \( R_s \) is equal to the amount of energy absorbed by the insole 20. \( R_s \) is equal to the trauma energy (i.e., remaining energy impact on the foot), or the vector force that results from the force which was reduced to force encounter to the sock liner 29. The decreased force that actually impacts the foot of the user of the EOD boot 10 allows the user to be taken to medics in time to save the limb.

[0045] FIGS. 10 and 11 show schematic views of an inner side 74 and an outer side 76, respectively, of the shin guard 14 of the EOD boot 10 (FIG. 1) designed to protect the user’s ankle and lower leg from blast fragments. The shin guard 14 includes a top portion 78, a bottom portion 80, a first edge 82 and a second edge 84. The first and second edges 82, 84 extend between the top portion 78 and the bottom portion 80. The shin guard 14 is designed to act as a soft armor and is sized to wrap around the leg of the user. In one embodiment, the total area of the shin guard 14 is about one square foot.

[0046] The shin guard 14 is designed as a separate component from the shoe 12 (FIG. 2) so that the user has increased flexibility at the ankle joint. Because the bottom portion 80 of the shin guard 14 is not permanently attached or stitched to the shoe 12, the user has increased range of motion and is not restricted by a rigid structure around the ankle area. Also, when the user is not in a location where an EOD is likely to be located, the user can remove the shin guard 14 and wear only the shoe 12, decreasing the overall weight of the EOD boot 10. The user can then move around with increased agility, especially when traversing rough terrain. While the shin guard 14 is designed separately from the shoe 12, the shin guard 14 can be positioned such that a projection 85 at the bottom portion 80 of the shin guard 14 either completely or partially covers the upper 16 of the shoe 12 to ensure that the foot or ankle is either not exposed at all or only minimally exposed.

[0047] To secure and remove the shin guard 14 to and from the user’s leg, the shin guard 14 is positionable in an open position and a closed position. A securing mechanism 86 is located at the first edge 82 and correspondingly at the second edge 84 of the shin guard 14 and maintains the shin guard 14 in the closed position, wrapped around the user’s leg. The securing mechanism 86 is also located at the bottom portion 80 of the inner side 74 of the shin guard 14 and correspondingly at the upper 16 of the shoe 12 to secure the shin guard 14 to the shoe 12. The securing mechanism 86 may be any connection means known in the art. For example, the shin guard 14 may be maintained in the closed position and to the shoe 12 using a hook & loop mechanism, commercially available under the tradenam VELCRO®. The shin guard 14 is formed of about 1 to about 2 layers of polyurethane fabrics. The polyurethane fabric is also optionally laminated with a strong composite fabric, such as para aramid. In one embodiment, the inner side 74 and the bottom portion 80 of the shin guard 14 are laminated with the strong composite fabric.

**EXAMPLES**

[0048] The present invention is more particularly described in the following examples that are intended as illustrations only, since numerous modifications and variations within the scope of the present invention will be apparent to those skilled in the art. Unless otherwise noted, all parts, percentages, and ratios reported in the following examples are on a weight basis, and all reagents used in the examples were obtained, or are available, from the chemical suppliers described below, or may be synthesized by conventional techniques.

[0049] Various studies were performed associated with boot engineering, physiology, anatomy, ergonomics and personal safety to develop a boot that reduces injuries from personnel explosives. Sample boots were tested in the field using simulated legs and M14 anti-personnel mines. The simulated legs represent the anatomy of a leg, ankle and foot with proper chemicals, nylon felts, gelatin and polymer materials according to the Aberdeen Ordnance Division, USA.

[0050] The EOD boot tested was formed at least in part of Kevlar. The M14 anti-personnel plastic mine was positioned at a toe portion, a mid portion and a heel portion of the EOD boot of the present invention and at a toe portion, a mid portion and a heel portion of a comparative combat boot. Each of the explosions were set off separately. Table 1 compares the condition of the EOD boot of the present invention and the condition of the combat boot after being directly exposed to each of the explosions.

<table>
<thead>
<tr>
<th>TABLE 1</th>
</tr>
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<tbody>
<tr>
<td>Condition of Boot/Leg</td>
</tr>
<tr>
<td>Outer Sole</td>
</tr>
<tr>
<td>Middle Sole</td>
</tr>
<tr>
<td>Insole</td>
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<tr>
<td>Simulated Leg</td>
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[0051] As illustrated in Table 1, the EOD boot was able to withstand explosions at all three portions of the boot better than the comparative combat boot. While the combat boot was damaged after being exposed to explosions at the toe portion, the mid-portion and the heel portion of the EOD boot, the EOD boot remained substantially intact after being exposed to explosions at the same locations. In particular, the outer sole and the shank filler of the EOD boot broke into pieces to deflect some of the forces from the explosions. The eight layers of the shank sheet composite, or middle sole, peeled off and left about four layers under the foot. The insole remained completely intact. This indicated that while the bone of the foot might be cracked, it was not severed from the ankle or cut and could be treated as a single unit.

[0052] At locations proximate where the explosions took place, the EOD boot had a buckle, or dent. The mid-portion of the EOD boot had a higher degree of buckling because the surface area of the mid-portion was greater than the surface areas of either the toe portion or the heel portion. In addition, the simulated leg wearing the EOD boot exposed to the explosions only split a little bit and generally looked intact. On the
other hand, the simulated leg wearing the comparative combat boot was damaged below the knee.

[0053] The results in Table 1 show the ability of the EOD boot to reduce injury to a user, i.e., the ability to protect a foot wearing the EOD boot and the area of the leg under the knee covered by the shin guard when exposed to a blast, heat or fragments. The foot and leg were not badly injured other than a few cuts and splits. This satisfies the main purpose of the EOD boot, which is to provide the user with enough protection to be able to send patients to be treated by a physician so that the physician can save the user’s foot and/or leg.

[0054] The EOD boot reduces injury from personnel explosives and is used as part of personal safety equipment to reduce injuries to the leg and foot for bomb squads and for people living in dangerous areas. Conventional EOD boots were not constructed for comfortability. They were bulky, heavy, rigid and less flexible, possibly causing knees to twist while walking, especially when the EOD boot is worn for a long time period of time or worn while traversing rough, steep terrains.

[0055] Various modifications and additions can be made to the exemplary embodiments discussed without departing from the scope of the present invention. For example, while the embodiments above refer to particular features, the scope of this invention also includes embodiments having different combinations of features and embodiments that do not include all of the features. Accordingly, the scope of the present invention is intended to embrace all such alternatives, modifications, and variations as fall within the scope of the claims, together with all equivalents thereof.

The following is claimed:

1. A boot for reducing injury from a close range explosion comprising:
   a sole unit including at least an outer sole, a shank sheet composite, a shank filler and an insole, wherein at least the shank sheet composite includes a plurality of layers having a pyramid shape and comprises a strong composite fiber;
   an upper attached to the sole unit, wherein the upper comprises a laminated canvas; and
   a shin guard connectable to the upper for protecting an ankle and leg of a user, wherein the shin guard comprises a strong composite fiber.

2. The boot of claim 1, wherein the strong composite fiber is fire retardant, reduces vector forces, distributes explosive powers and prevents fragments.

3. The boot of claim 1, wherein the strong composite fiber comprises para arimid synthetic fiber.

4. The boot of claim 1, wherein the upper is attached to the sole unit at a bond strength of at least about 3 kg/cm² standard.

5. The boot of claim 1, wherein the pyramid shape of the shank sheet composite is angled at between about 102 degrees and about 112 degrees along a longitudinal axis extending between a toe portion and a heel portion of the shank sheet composite.

6. The boot of claim 1, wherein the sole unit and upper have a weight of between about 1 kilogram and about 1.5 kilograms.

7. The boot of claim 1, wherein the outer sole is designed to break apart upon contact with a force of at least about 60-65 bars/110 msec.

8. A boot for protecting a lower appendage of a user, the boot comprising:
   a shoe comprising:
   an upper; and
   a sole unit attached to the upper and including a toe portion, a heel portion and a plurality of layers, wherein at least one of the layers comprises a strong composite fiber; and
   a shin guard positionable adjacent the upper;
   wherein at least a portion of the sole unit is angled along a longitudinal axis extending from the toe portion to the heel portion of the sole unit at between about 102 degrees and about 112 degrees.

9. The boot of claim 8, wherein the strong composite fiber comprises para arimid synthetic fiber.

10. The boot of claim 8, wherein the upper and the sole unit are bonded at a bond strength of at least about 3 kg/cm² standard.

11. The boot of claim 8, wherein the shin guard comprises a strong composite fiber.

12. The boot of claim 8, wherein the sole unit comprises:
   an insole;
   an outer sole;
   a shank sheet composite positioned between the insole and the outer sole; and
   a shank filler formed within a cavity of the shank sheet composite.

13. The boot of claim 8, wherein the outer sole is designed to break apart upon contact with a force of at least about 60-65 bars/110 msec.

14. An explosion ordnance device boot comprising:
   a shoe comprising:
   an upper;
   an insole attached to the upper;
   a shank sheet composite including at least eight angled layers bonded to the insole, wherein the shank sheet composite includes a top surface, a bottom surface, and a cavity formed at the top surface;
   a filler formed within the cavity of the shank sheet composite;
   and
   an outer sole connected to the bottom surface of the shank sheet composite; and
   a shin guard attachable to the shoe.

15. The boot of claim 14, wherein each of the angled layers of the shank sheet composite are angled along a longitudinal axis extending between a toe portion and a heel portion of the shank sheet composite at between 102 degrees and about 112 degrees.

16. The boot of claim 14, wherein the shank sheet composite comprises a strong composite fiber.

17. The boot of claim 16, wherein the strong composite fiber comprises para arimid synthetic fiber.

18. The boot of claim 14, further comprising a sock liner engaging the insole.

19. The boot of claim 18, wherein the upper is bonded to the insole at a bond strength of at least about 3 kg/cm².

20. The boot of claim 19, wherein the outer sole comprises polyurethane.

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