

WORLDFOOTWEAR

Protecting against landmines

Andy Bingham, safety footwear specialist at SATRA, looks at how footwear manufacturers can help minimise the risk to those living and working in theatres of war.



Anti-personnel landmines are defined as mines designed to be exploded by the presence, proximity or contact of a person and will incapacitate, injure or kill one or more persons irrespective of any foot and leg protection.

There are estimated to be around 70 million anti-personnel landmines still to be cleared in war-ravaged areas of the world. It has been claimed that they kill an estimated 800 innocent individuals per month and injure a further 1,200—that amounts to an annual toll of 24,000 victims.

Basic types

Although anti-personnel mines come in a range of shapes, sizes and modes of action, most fall into two broad categories: fragmentation and blast mines.

Fragmentation mines are usually laid on or under the ground and are often activated by a tripwire. When the mine is detonated, hundreds of high velocity fragments are fired over a large area. These mines are capable of killing individuals many metres away by driving metal fragments into their bodies, ripping through tissue, organs and bone.

Blast mines are usually hand-laid on or under the ground or scattered from the air. They are pressure sensitive and are typically detonated by someone stepping on them. The explosive force of the mine causes foot, leg, and groin injuries. Secondary infections add further complications. Clothing, grass and injured body parts become secondary missiles and amputation of the lower leg is common.

Protection

Providing foot protection against these types of risk for those who have to venture into minefields presents a major challenge to which several footwear manufacturers around the world have responded. Protection for the foot can be of two types, depending on the type of mine.

Protection against a fragmentation mine is simpler than against blast types. Protective fabrics or composites incorporated into the footwear over the top of the foot are typical solutions.

Protection against the effects of standing on, and detonating, a blast mine is far more complex. Large cushions have been used

to spread the weight load over a greater surface area with the intention of preventing activation of the mine in the first place. Platforms have also been used to elevate the primary footwear. In some cases the platform is supported on legs that extend outside the platform to displace the detonation point away from the underside of the foot.

Strategies

Mine protective footwear strategies currently fall into three broad categories:

Blast deflection relies on directing the blast away from the victim's foot. Perhaps the most obvious way is to incorporate a highly rigid angled plate within the bottom of the footwear. Metal and composite materials have been tried using a composite material in the forepart area of the sole and a metallic deflector in the heel. Angled sole designs have also been used in an attempt to build in blast deflection characteristics.

Stand-off exploits the fact that the level of blast energy transmitted to the foot falls rapidly as the distance between the foot and the exploding device increases (in air the energy transmittance decays in proportion to the cube root of the distance). One simple and obvious approach is to use thick soles. However, there are limitations, as boots with extremely thick soles tend to be more clumsy—a real disadvantage in a minefield.

Another method is to attach some form of platform to the underside of the footwear. The Spider Boot produced by Med-Eng provides an excellent example (*Figure 1*). The design incorporates legs that extend beyond the platform with the intention of ensuring that if a blast is triggered, it will not be directly beneath the foot.

Blast attenuation relies on reducing the energy transmitted to the foot by absorbing part of the energy within the footwear itself. This may be thought of as creating a situation where the foot is protected at the expense of damage to the footwear. This strategy involves the use of materials in the footwear bottom

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Figure 1: Spider Boot from Med-Eng Systems exploits a unique design to distance the foot from the source of the blast with the aim of allowing blast energy and fragments to be dispersed and deflected away from the foot.

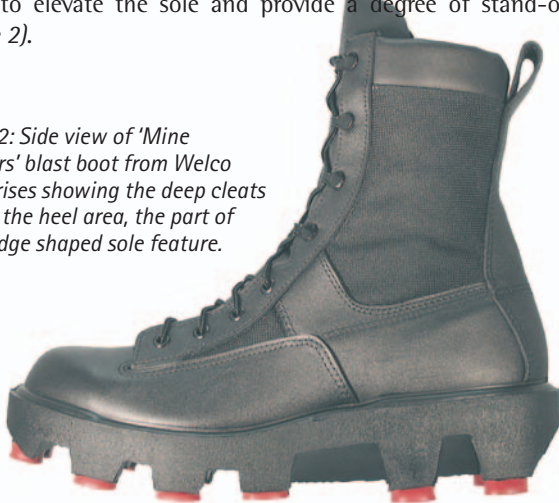
that deform rather than transmit energy, thereby neutralising a significant proportion of the blast energy before it reaches the foot, in much the same way as the crumple zone in a car body.



Combined strategies

In practice, mine protective footwear generally combines more than one strategy. Welco's 'Mine Boggles' boots and over-boots are good examples of a multi-strategy approach. The design of the polyurethane sole of both products is intended to direct much of the blast to the side rather than up into the foot and leg. The sole incorporates a wedge-shaped attenuator, constructed from stainless steel and aluminium honeycomb. This is designed to absorb energy through compression of the honeycomb and thereby reduce energy transmission. Finally, the sole design itself features deep rubber cleats to elevate the sole and provide a degree of stand-off (Figure 2).

Figure 2: Side view of 'Mine Boggles' blast boot from Welco Enterprises showing the deep cleats and, in the heel area, the part of the wedge shaped sole feature.



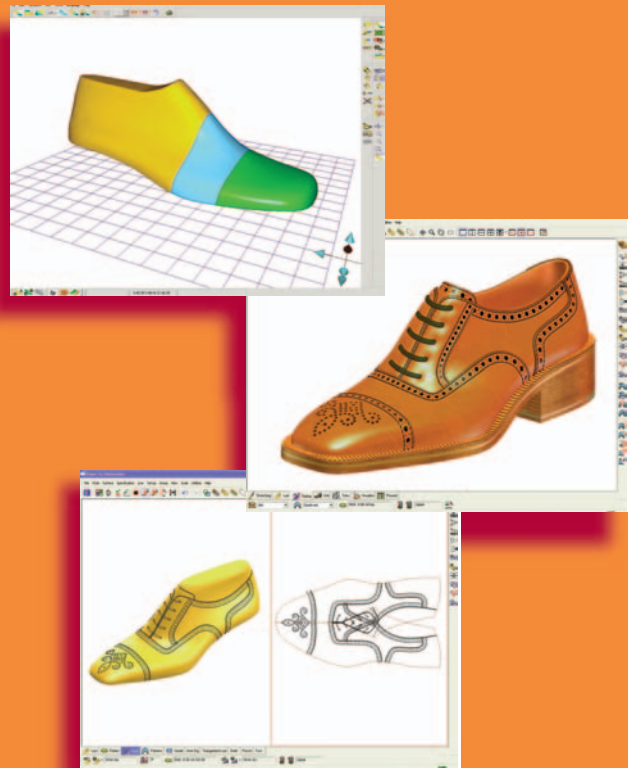
Effectiveness

Protective footwear has not been universally welcomed. Some de-mining operatives prefer not to wear other forms of footwear. However, the US Army clearly sees its value, having been users of Welco products for more than 30 years.

But, does specialist footwear really work? The Indian de-miner who was wearing the Bfr combat boot, shown in the headline photo, when he dropped a mine then trod on it, survived the accident with nothing worse than a broken ankle and leg. So the answer appears to be that mine protective footwear can and does save lives.

Although there are, as yet, no international test standards, SATRA is liaising with the International Test and Evaluation Program for Humanitarian Demining (ITEP) to bring together international experience to develop appropriate test methods and standards. 

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