Ballistic protection for tentage

Karen Horak, Claudia Quigley and **Ryan Devine,** US Army Soldier Systems Center,
herald the new developments in shelter systems…

The US Army Natick Soldier Center's (NSC) Collective Protection Directorate (CPD), located in Natick, Mass., USA, provides shelter systems for today's soldier in environments ranging from the Artic cold to the desert heat. With a mandate to protect our warfighters worldwide, this directorate develops new technologies for both soft walled shelters or tents, and rigid wall shelters. Rapid deployment, ease of installation, reduced weight, and improved logistics are all trademarks of any new military shelter technology. For soft walled shelters, the NSC has developed: inflated textile composites called airbeams – a replacement for a shelter's metal frame; solar covers to protect our soldiers from the heat of the sun; and flexible solar panels to generate electricity. On the horizon lie shelter fabrics with improved chemical and biological protection and better thermal insulation. A future lightweight shelter lighting system aims to improve the interior shelter environment with less power. A new ballistic protection system for soft walled shelters, under development at the NSC, shows great promise as an emerging technology, and is detailed below.

As a result of lessons learned in Operation Iraqi Freedom, a need has been established to provide enhanced protection to warfighters while living and working in soft walled shelters. Traditionally, these dwellings are the first means of living and working facilities seen by troops deployed in theatre; for highly mobile units, tents remain their primary means of shelter. Daily accounts of mortar attacks led to a CPD objective; enhancing the ballistic protection of soft walled shelters. With sufficient time and proper logistical support, tents can be protected by traditional means: sandbags, concrete barriers, and hescobastions; however, these methods of protection typically are very labour or logistically intensive. CPD along with its technical partner, the Advanced Engineering Wood

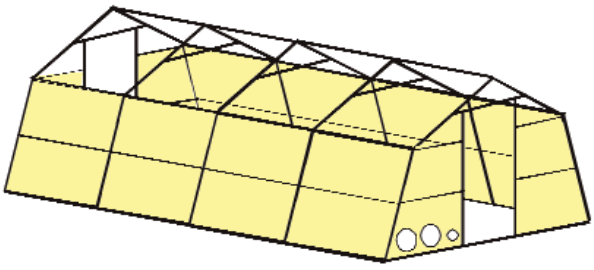

Fig. 1: MBPS overview

Fig. 2: MBPS installed in TEMPER tent

Composites Center at the University of Maine, has developed highly mobile, reusable, lightweight panels that can provide ballistic protection to troops from their first day in theatre and be expeditionary enough to travel with the most highly mobile units. This system of panels is called the Modular Ballistic Protection System (MBPS).

Design

While sleeping and working in tents, soldiers need protection from munitions threats. The world of tentage is one of expediency and relatively low cost, and CPD's goal was to provide the maximum protection feasible while controlling these parameters. Within this realm, engineering analysis and preliminary testing quickly determined that a level of fragmentation protection could be provided similar to Kevlar helmets.

Besides providing ballistic protection, factors of deployment, standardisation, cost, weight, and durability were considered. The MBPS had to integrate quickly and seamlessly into a standard army shelter system. A Tent Expandable Modular PERsonnel (TEMPER) tent was chosen to demonstrate this application, as it is a widely used shelter throughout the Army. The TEMPER is 20ft wide and is modular in 8ft sections. The MBPS is required to be installed in a 32ft TEMPER in one hour and is designed to attach directly to the TEMPER without any modifications to the frame. Panel cost and weight were also driving factors; the intent is to provide the most protection at the lowest weight and cost. As a result, parallel development efforts of competing panel designs are underway with material costs ranging from $10-35 per ft^2

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with respective weights from 4.0-2.6lbs per ft^2. Lastly, methods of panel ruggedisation are under investigation to achieve durability and resistance to UV and moisture degradation. The multifaceted panel development has had to take many factors into consideration in the ultimate design of the MBPS.

Although the design of the MBPS is based around fragmentation protection, the MBPS panels must not compromise the structural integrity of the TEMPER tent frame itself. The system was designed to minimise load transfer to the frame under blast load conditions through a unique high strength strap connection. These straps secure the panels to the frame as the blast wave travels through the tent. The panels, possessing sufficient flexural strength to safely bend through the blast pressure wave, remain in position without damaging the frame of the TEMPER.

Test and analysis

The primary threat associated with mortars is the large amount of fragmentation they project into the area surrounding the detonation. The fragmentation is propelled with an explosive charge which creates a secondary threat through its associated blast wave. In the development of the MBPS panels, the primary design objective has been to mitigate the thousands of fragmentation coming off the mortar, but, at the same time, the panel has been designed to withstand the blast associated with the detonation.

As stated earlier, fragmentation parameters were based on requirements similar to those of a Kevlar helmet. Requirements specify laboratory evaluation of samples through Right Circular Cylinder (RCC) testing in which small stainless steel cylinders of specified mass – 2, 4, 16, and 64 grains – are fired at the test sample repeatedly to derive a set of V50 data points. V50, a widely used ballistic standard, represents the velocity at which there is a 50% probability of penetration of the test sample. Initially a large variety of panel lay-ups were manufactured and subjected to RCC testing. Ultimately, two panel designs proved successful in meeting the RCC requirements: one panel design can be manufactured at a lower cost while the other has a lower weight.

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Fig. 3: MBPS blast tent

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Using compiled V50 data, an engineering modelling and analysis of the low cost panel's effectiveness was performed at NSC, which resulted in panel performance in terms of percentage of fragments defeated. Using a first order approximation empirical model, the V50 data was processed along with munitions data. The results showed the MBPS panel defeated more than 99% of fragments from a mortar detonation at a standoff distance of three metres. These results were encouraging and showed that the MBPS performed exceptionally against low-mass fragments (the majority of fragments produced by mortar detonation are very low-mass). A lethality study is now under development, which will show the effectiveness of the MBPS system installed in tents within a base camp environment.

Concurrent to RCC testing and fragmentation modelling, live blast testing was conducted at Tyndall Air Force Base in February and April 2006. A 16ft x 20ft TEMPER tent was outfitted with MBPS panels of the two top designs. The shelter was submitted to both endwall and sidewall blasts simulating a mortar detonation at standoff distances of 75ft down to 21ft. The MBPS successfully sustained all blasts without damage and panel deflection was minimal, on the order of 0.5 to 2.5 inches.

Future performance testing of the MBPS is planned at the US Army Aberdeen Proving Ground test facility. The complete MBPS system will be evaluated for environmental ruggedness, durability, and response to live fire munitions.

Prototyping

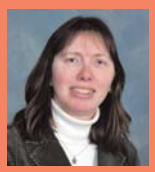
Our first MBPS prototype was fully integrated into a standard force provider basic tent module (20ft x 32ft TEMPER) equipped with HVAC, liners, and lighting. The MBPS design has panels at a height of approximately 7ft on all sides of the shelter. The MBPS panels are put in place underneath the exterior fabric of the TEMPER tent and, therefore, do not provide any visual signature of the improved shelter capabilities, eliminating target identification. The MBPS is designed with a full width sliding door to provide complete protection on all sidewalls.

A first generation MBPS prototype was also shipped in July 2006 to South West Asia. This prototype will be used as a demonstration item to allow field commanders to view the technology and provide valuable input to the design teams. In support of this effort, a comprehensive instruction manual and video were developed to assist troops installing and using the MBPS in the field.

Conclusion

Responding to a critical field need, the CPD developed a means of protecting warfighters living and working in soft walled shelters. The MBPS, a system of ballistic panels integrated into the interior of a tent, has the potential to provide a significant improvement in the protection of our highly mobile combat forces. Preliminary testing and modelling predict a significant threat reduction to troops housed in an MBPS shelter when subjected to the fragmentation threat of mortars.

Ongoing engineering development will mature this ballistic technology. Future work, including live fire testing, durability testing, and field evaluations, will enhance subsequent designs as well as provide validation for more advanced engineering models. Efforts to successfully transition the MBPS into the hands of our soldiers will continue through qualification testing and demonstration. The MBPS promises to provide our warfighters with lightweight, highly mobile protection where it never existed before – their tents.



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