THE UNIVERSITY of NEW MEXICO

ME 591 Graduate Seminar

Department of Mechanical Engineering, and Electrical & Computer Engineering
The University of New Mexico

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Friday, November 9, 2007 at 3:30 p.m. ME Bldg., Room 218

Blast Mitigation Body Armor

Abstract

This presentation describes recent work in which our company developed jacket prototypes to mitigate the hazard of blast-induced, cumulative lung injury for soldiers training with certain weapons. The design process was guided by theories of layered media, which describe the frequency-dependent transmission of an incident wave through the jacket and into the chest. The theory explains why single-layer soft jackets (such as the ballistic armor currently worn by soldiers) can amplify the stress transmitted into the chest wall, and it guided the selection of materials for the jacket. Prototypes were tested using a shock tube, with sensors embedded in a rig that represented the chest. Published injury criteria were considered in evaluating the performance of the prototypes, and we found that they did not seem entirely appropriate for evaluating the risk of cumulative injury from complex waves dominated by low-frequency components. We suggest that jerk or jolt, which relates to spatial and temporal gradients of stress, is a measure that should be included in injury criteria. The results of this project have numerous applications, such as protection of soldiers' lungs and brain from improvised explosive devices in Iraq and Afghanistan.

This work was supported by the U.S. Army Medical Research Acquisition Activity under a Phase II SBIR, Contract DAMD17-01-C-0008. The views, opinions and/or findings are those of the authors and should not be construed as an official Department of the Army position, policy or decision unless so designated by other documentation.

Dr. Winfree received a B.S. degree in mechanical engineering from the University of Michigan in 1984, and M.S. degrees in mechanical engineering and bioengineering from the same university in 1986. She earned her Ph.D. in Applied Mechanics from Caltech in 1999. She is a co-founder of Dominca, LLC and a Principal Engineer. Her expertise includes design and analysis of experiments involving high-pressure shock-compression of materials, with a focus on solid mechanics and material behavior. She has expertise in the continuum modeling of solid-to-solid diffusionless phase-transformations of materials such as shape memory alloys and GeO_2, and she developed a finite-difference code based on a Godunov method for analysis of phase changes.

She developed shock mitigation technology to protect electronic fuze in future penetrating weapons, and a blast mitigation jacket to protect soldier's lungs. Other projects include modeling of shaped-charge jet formation and penetration, development of equation of state models for tributyl phosphate and earth materials, numerical modeling of impact between a metal sphere and a thin metal plate, and analytical modeling of erosion process of penetrator's nose. Dr. Winfree also has experience in evaluating the mechanisms of human injuries in industrial and automotive accidents, in design of artificial knee implants, and with biomedical laboratory instrumentation