EFFECT OF SUB-LAMINATE STACKING SEQUENCE ON THE TRANSVERSE IMPACT AND PERFORATION BEHAVIOR OF MULTI-LAYER SOFT-BODY ARMOR PACK (SBAP)

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Introduction
• SBAPs are components in body armor and are composed of Dyneema SK76, [0/90] soft ballistic sub-laminates (SBSL)
• Orientation of SBSL has an affect on the performance of the SBAP

Objectives
• Compare the minimum perforation velocity of different stacking sequences of an 8-Layer SBAP
• Explore the affect of the stacking sequence on the deformation cone shape of the 8-Layer SBAP

Stacking Sequences
• Model a 360mm x 360mm 8-Layer SBAP with five different stacking sequences (Layups)
• Denoting a single layer [0/90] SBSL as \( \beta^{SBSL} \) (where \( \beta \) is the material angle of [0/90] SBSL with respect to reference material direction 1 or [0])

Perforation Mechanics
• Simulated impact velocities ranging from 100 m/s to 400 m/s under a right circular cylinder impactor with a diameter of 12.7 mm
• Plot final velocity (\( V_F \)) vs impact velocity (\( V_I \)) to determine minimum perforation velocity

Deformation Mechanics
• Deformation cone shape is given by back face deflection
• Back face deflection causes blunt force trauma to the wearer

Summary and Conclusion
• Baseline Layup 1 \( [0]^{SBSL}_1 \) has the highest minimum perforation velocity range
• The effect of the stacking sequence on the shape of the deformation cone is present on the rear/back face

Future Work
• Perform the same study on a 32-Layer SBAP to see if results are consistent at different layer counts
• Perform a similar study looking at the interlaminar stacking sequence of the SBSL

References
• B. Z. Haque, M. A. Ali, and J. W. Gillespie, “Modeling transverse impact on UHMWPE soft ballistic sub-laminate”
• B. Z. Haque and J. W. Gillespie, “Perforation mechanics of UHMWPE soft ballistic sub-laminate and soft ballistic armor pack: A finite element study”

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