COMPARISON OF EXPLOSIVELY DRIVEN SHOCK TUNNEL AND OPEN-AIR BLAST WAVE PROPAGATION AND INTERACTION WITH TARGET MATERIALS

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Abstract: Military personnel who experience blasts, whether during training or combat, face a significant risk of Traumatic Brain Injury (TBI). Explosively driven shock tunnels have emerged as a popular tool for studying TBI, and structural response, in a controlled environment. These shock tunnels generate precise and reproducible shockwaves that can be scaled to full-sized blasts. However, vortex rings that are frequently observed at the end of shock tunnels can have a significant impact on the pressure and impulse measurements. Vortex rings are not present in open-air testing and it is important to understand how the vortex changes the shock interaction with different materials. This study aims to examine the differences in shockwave impacts from open air and shock tunnel testing visually using Schlieren imaging. Incident shockwaves impact materials commonly seen in buildings, vehicles, and body armor of military personnel to compare shock tunnel to open air testing. The incident shock waves are formed from a thin exploding wire for both the shock tunnel and open-air tests with similar incident shock velocities prior to material impact. While both open-air and shock tunnel tests will examine the effect of the shockwave on materials, the shock tunnel produces a vortex ring which can influence the incident shockwave and collide with the test subject after the incident shockwave. Vortex rings colliding with a wall have been found to produce a wall shock along the surface of the wall and this could have major implications for experimental results. The resulting wall shock and the velocity of the vortex ring are measured and compared to determine the effect of the vortex impact. The study provides insight into open-air and shock tunnel testing to determine the effects of vortex rings produced from the end of shock tunnels. The research will contribute to the development of improved experimental design to assist in the development of materials that can better withstand blast and impact. Overall, this study has significant implications for the study of TBI and for the development of materials for blast and impact protection.