HIGH VELOCITY IMPACT OF DYNEEMA OF VARYING SIZE AND THICKNESS

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OVERVIEW OF PROJECT

- A considerable amount of research has been done on the effects of composites under high velocity impact loading.
- Most research does not take into account how the size of the tested material can affect results. Generally it is assumed that the panel size should not have an effect on the ballistic resistance of a material.
- This study specifically looks at Dyneema during high speed impact and to see if damage propagation and ballistic resistance are affected by panel size.

IMPACT DAMAGE MECHANISMS

- During a high velocity impact damage is dissipated through a verity of mechanisms.
- If any mechanism is constrained or fails to occur then the materials ability to dissipate energy from high velocity impacts should be decreased.
- The damage mechanisms that are directly affected by the panel size are Dynamic Cone Formation and Interlaminar Delamination.
  - Dynamic cone formation occurs as the backside of the material deflects during a high velocity impact
  - Interlaminar delamination occurs as differences in stress between lamina creates delaminations between lamina sheets

MATERIAL SELECTION

- The specific material used for this testing was Dyneema HB-26
  - 0/90° unidirectional fiber laminate
  - 1.5psf areal density samples (0.30 inches thick)
  - 2.5psf areal density samples (0.50 inches thick)
- Preliminary testing showed that damage would propagate about 9” away from impact.
- Panel sizes were chosen to allow or prevent different types of delamination.
  - 24”x24” samples which will not allow any damage to propagate to the edge
  - 14”x14” samples which will allow mid-thickness slip delamination to occur at the edge
  - 8”x8” samples which will barely prevent the backside delamination from reaching the edges

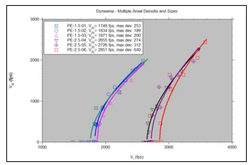
HIGH SPEED TEST SETUP

- The impact devices used in this study are 0.30 caliber fragmentation simulation projectiles made from hardened steel.
- The samples were impacted at varying velocities both above and below the Ballistic Limit (V_{50}) of the material.
- A thin aluminum sheet was placed behind the material to record the shape of the dynamic cone.

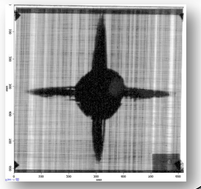
COLLECTED DATA

- The V_{50} for each test was calculated by curve fitting the initial and residual velocity data with the Lambert Equation

$$V_R = \beta * (V_I^{\,p} - V_{BL}^{\,p})^{(1/p)}$$

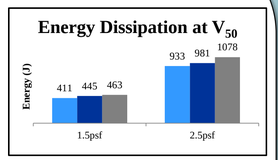


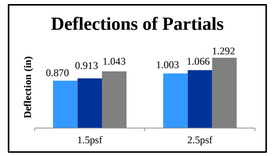
- Maximum deflections from the witness plates
- Delaminated regions from ultrasonic C-scanning

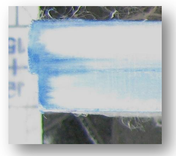


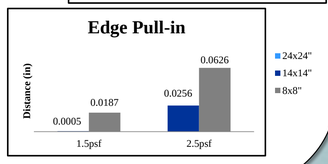
RESULTS

- The energy dissipation that occurred at the V_{50} for each sample was calculated
- The maximum deflections of the witness plate were measured for each sample
- When delamination reached the free edge of the material edge pull-in would occur
  - Measurements were made to quantify the amount of material movement









CONCLUSIONS

- Findings from data
  - Increased energy dissipation as panel size was decreased
  - Dynamic deflections increased as panel size was decreased and panel thickness was increased
  - Wider range of energy dissipation as panel size was decreased and panel thickness was increased
- Conclusions from data
  - When the damage from the impact reached the free edge of the material the material slides thus dissipating additional energy
  - This would explain the correlation between smaller panels, larger dynamic deflection, and increased energy absorption

ACKNOWLEDGEMENTS

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