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OBJECTIVE/APPROACH

◆ **OBJECTIVE:**

1. Characterizing and predicting damage in quasi-static punch-shear tests on plain weave S-2 glass/SC-15 epoxy composite hick laminates.
2. Predict residual velocities of projectiles
3. Determine the ballistic limit

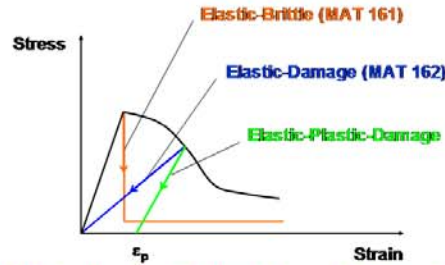
◆ **APPROACH:**

LS-DYNA
MAT 161 & MAT 162

ACKNOWLEDGEMENTS

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MATERIAL MODELING

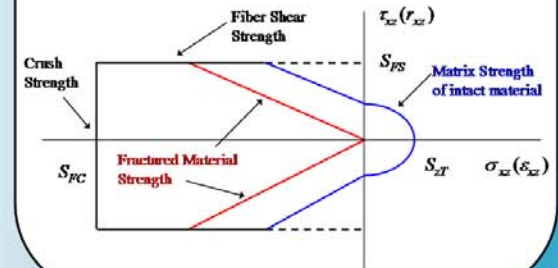


MAT 161 Based on the Hashin's model, gives elastic-brittle material response and no post failure is considered

MAT 162 Damage mechanics is introduced to model the softening region of material response and plastic deformations are not taken into account

FAILURE SURFACE IN MAT 162

Based on the three-dimensional isotropic continuum, the general form of a failure criterion is approximated by a complete quadratic polynomial in terms of the integrity basis in stress space. Failure planes are introduced to split the general failure criterion into four separate criteria



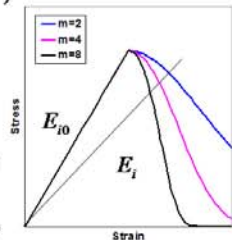
PROPERTY DEGRADATION MODEL IN MAT 162

$$d_i = 1 - e^{-\frac{1}{m}(1-r_j)^m}$$

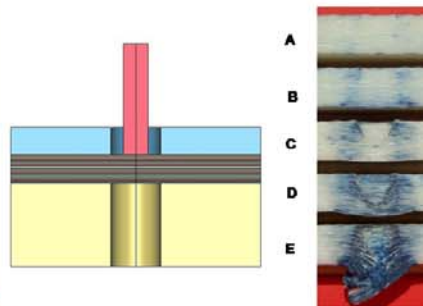
$$r_j \geq 1$$

$$E_i = (1 - d_i)E_{i0}$$

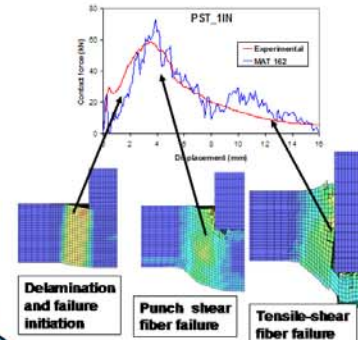
$$G_i = (1 - d_i)G_{i0}$$



SIMULATION OF PUNCH SHEAR TEST (1IN)



SIMULATION OF PUNCH SHEAR TEST (1IN)



CONCLUSIONS AND FUTURE WORK

Damage and delamination of composites under punch shear loading have been investigated using MAT 162. Material properties have been calibrated and modeling parameters have been identified to match the experimental results

Future work

- Tie-break options for delamination
- Ballistic impact
- Implementing/developing plastic-damage model