ROLE OF THE INTERLAYER BETWEEN CERAMIC TILES AND THICK SECTION COMPOSITES SUBJECTED TO IMPULSE LOADING

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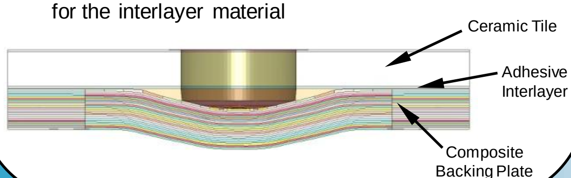
BACKGROUND AND OBJECTIVES

- A tile reinforced thick-section composite structure is a system of multilayer multi-functional materials (including a ceramic tile, composite backing plate and adhesive interlayer) which work together to provide resistance to impact loading.
- Research Objectives
  - To develop a series of experimental and numerical tests which will provide a fundamental understanding of the effect of interlayer properties on the stress wave propagation in the composite and ceramic layers as a structure under impulse loading
  - To realistically quantify the optimal properties needed for the interlayer material

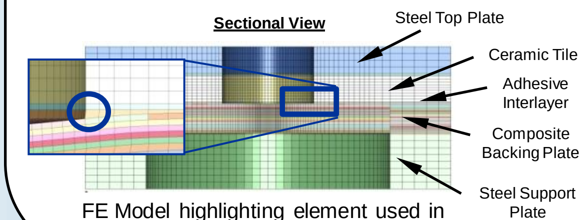


INTERLAYER ANALYSIS APPROACH

- Experimental Testing
  - Quasi-Static Punch Shear Testing (QS-PST)
    - 6-inch x 6-inch Steel Support Fixture
    - Interchangeable Rings for Quick Span Variation
    - Rounded 1-inch Diameter Steel Punch
  - Hopkinson Bar
  - Double Cantilever Beam (DCB) & End Notch Flexure (ENF)
- Finite Element Analysis with LS-DYNA
  - Punch loading which replicates QS-PST to compare and validate FE model
  - Impulse loading pressure which can be customized as a function of time and radial distance
- Parametric Study of Adhesive Material Properties
  - Stiffness, Toughness, Strain-to-Failure, Yield Strength, Rate Effects

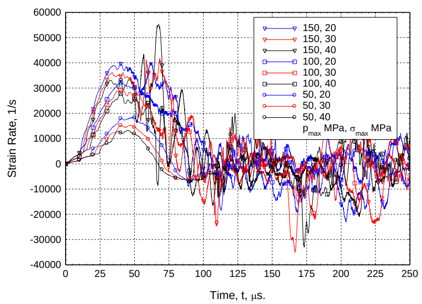
FE MODELING AND ANALYSIS ACCOMPLISHMENT

- Ran single element uni-axial stress and strain tests to efficiently determine that a cohesive material model is needed at interlayer
- Developed model which replicates 6-inch PST fixture and can be subjected to punch or impulse loading (allows pressure to be a function of time and radial distance)
- Began parametric study of the adhesive material properties and understanding how to analyze the results



FE Model highlighting element used in analysis for the following graphs

FEA: STRAIN RATE AS A FUNCTION OF TIME



- Different impulse amplitudes (p_{max}) and different yield stress (s_{max}) of an elastic-perfectly-plastic interlayer

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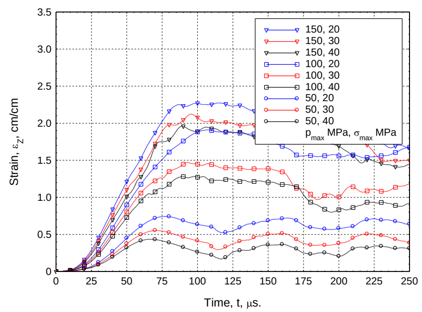

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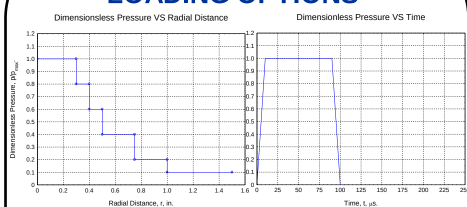
FE MODEL: IMPULSE LOADING OPTIONS



CONCLUSIONS

- Stress rate is a function of impulse amplitude
- Strain rate and strain of the interlayer element depend on the yield strength of the material and can be predicted as a function of time for different impulse loading cases

PATH FORWARD

- Continue FEA with wide range of adhesive material properties
- Experimentally determine rate sensitive properties of adhesive materials
- Validate FE model with QS-PST
- Compare FEA with experimental results
- Develop new experimental test methods

ACKNOWLEDGEMENTS

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