STOCHASTIC CONTINUUM DAMAGE MODELLING OF COMPOSITES AND AUTOMATED DATA PROCESSING

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Introduction

- Rate dependent progressive continuum composite damage model MAT162 in LS-DYNA is the state-of-the-art for ballistic penetration
& perforation modeling
- Properties and parameters are assumed uniform over a PART
- Six/Seven different damage modes can be tracked at different time steps
- Manual data processing takes a significant amount of time

Objectives

- Develop a computational framework to add stochastic capabilities in MAT162
- Develop automated LS-DYNA data processing to reduce all data in a single step
- Develop automated reports in visualizing the processed data

Problem Specification

- Start with modeling the perforation of a thin composite laminate (Fig. 1)
- Generate a stochastic model of the original FE model
- Develop automated data processing

Stochastic Modeling Methodology

- original FE model file is read
- Elements are grouped in the through-thickness direction by their centroids.
- Material properties are randomly generated within a range
- Each group is assigned a material property set.
- Automate process using Python.

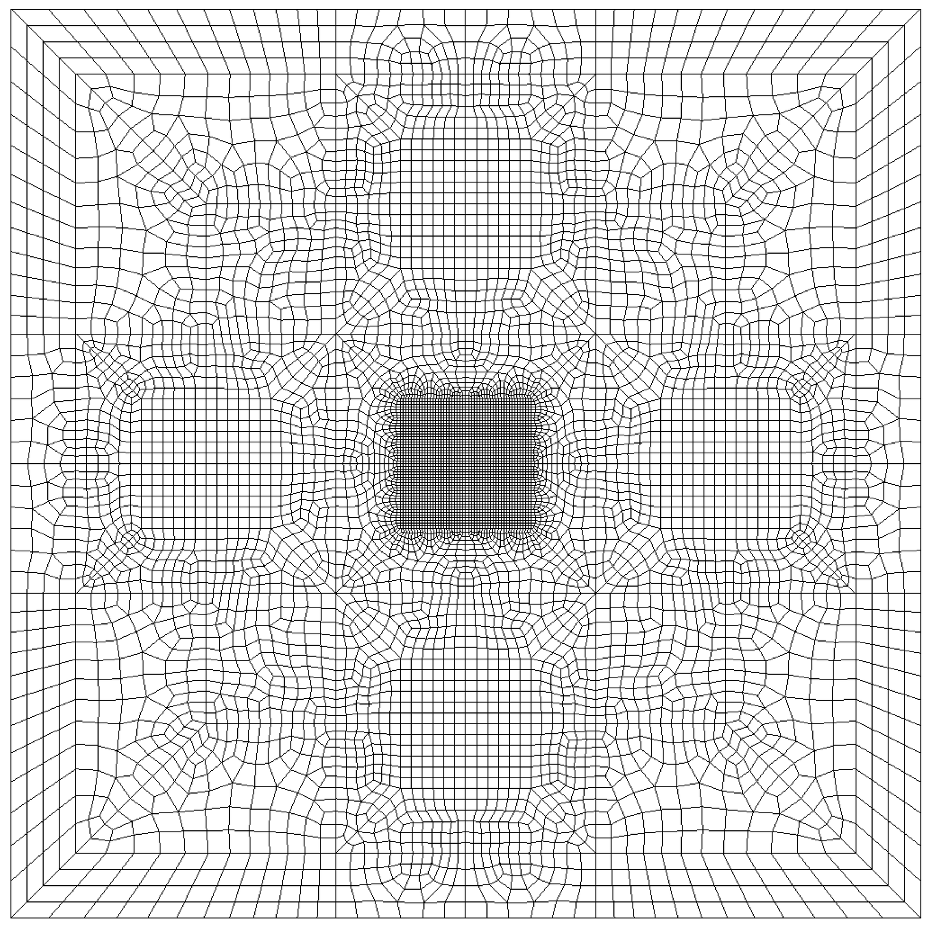
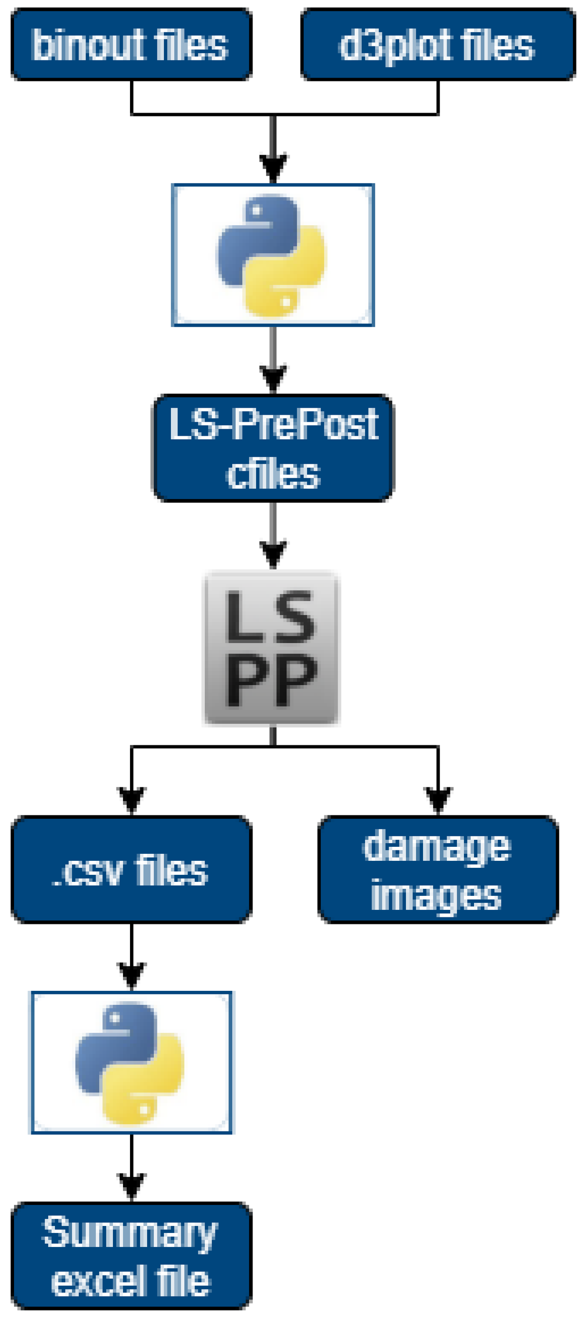


Figure 1.Original FE model of semi-infinite composite plate without stochastic properties.

Data Collection and Analysis Methodology

- Run multiple simulations per MAT162 parameter
  - create binout files and d3plot files for each simulation
- Write command files for LS-PrePost using Python
- Collect and reduce simulation data through an automated Python script
- Visualize summary of results using Python
- Process d3plot images using Python



Results and Discussion

- Stochastic model can be generated for FE model with multiple composite layers
- Elements are grouped in through thickness direction and assigned non-uniform material properties

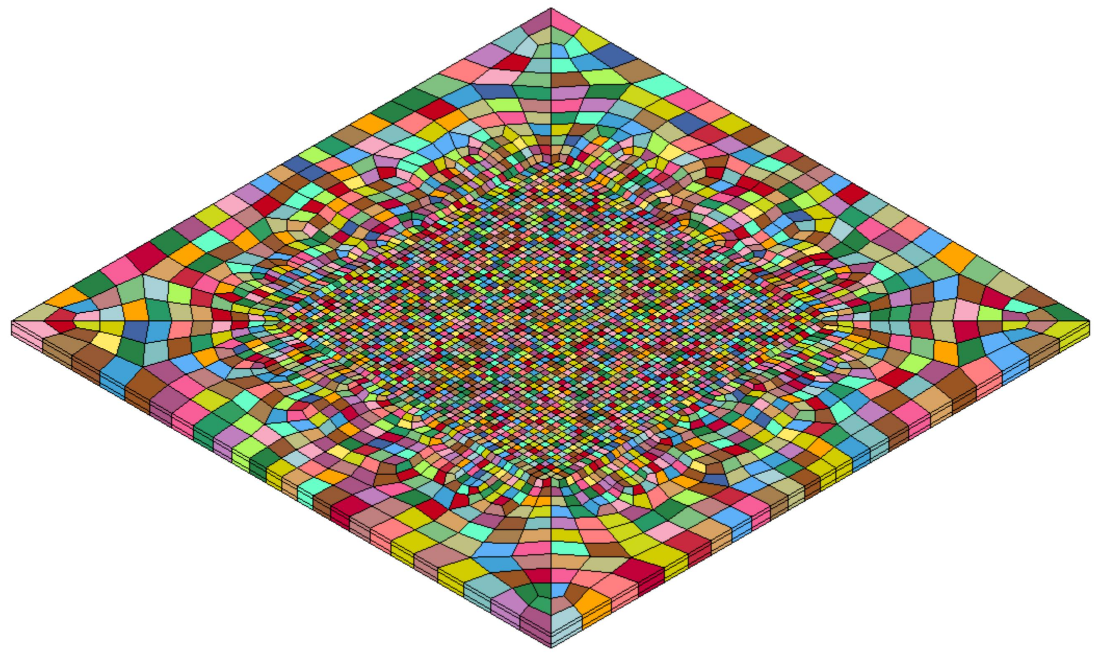


Figure 2. Stochastic model of center impact zone in the FE model. Each elements in the TT direction is a new PART and new MAT162.

- Binout file and d3plot file reading has been automated
- Output data is collected, summarized, and visualized within a few minutes through automated Python scripts
- Damage mode images from LS-PrePost are collected

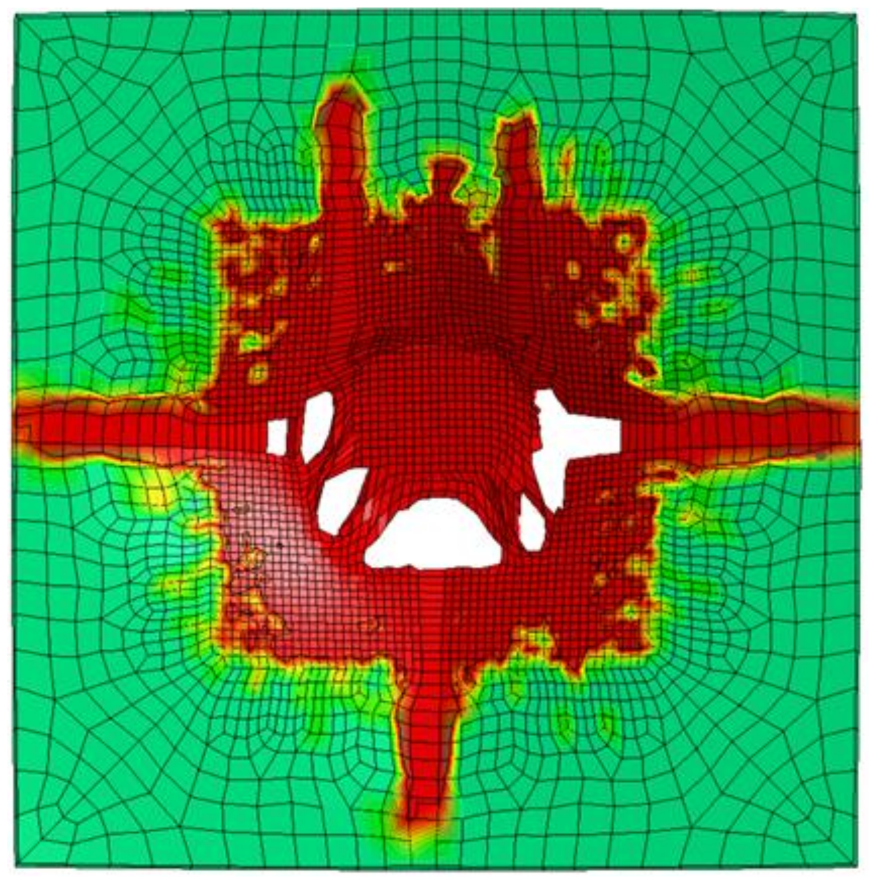


Figure 3. Transverse shear damage HISV11 in the stochastic model.

Summary and Conclusion

- Obtained a more realistic damage response of the composite material using the stochastic FE model
- Applying stochastic distribution has been automated using Python
- Graphical User Interface for applying stochastic distribution has been developed.
- Data is reduced and visualized has been automated to show immediate results
- Multiple simulations can be analyzed at once

Future Work

- Automate method to process d3plot images
- Better visualize damage modes of the composite panel
- Continue calibrating the model

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