# Progressive Damage in $[0/90]_S$ Laminated Plates

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## Introduction

Numerical analysis of progressive damage in fiber-reinforced laminated composite plates is a challenge due to the presence of different, complex failure mechanisms and their mutual interaction.

A meso-scopic progressive failure model is presented to simulate interacting damage mechanisms (matrix cracking and delamination) in laminated composite plates.
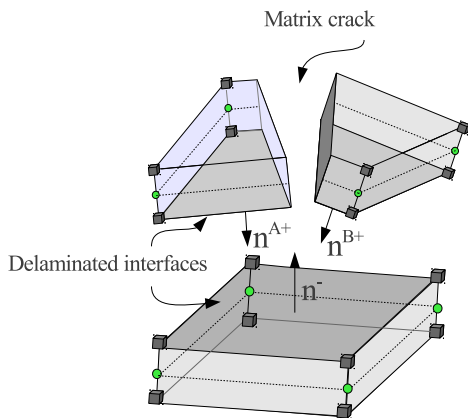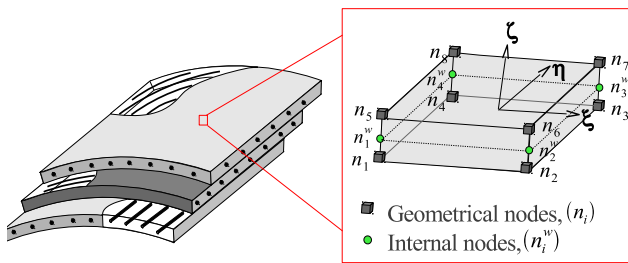
## Model





Figure 1: Solid-like shell element and a meso-scopic progressive failure model

- A solid-like shell element is used to model thin plies of the laminate, figure 1.

- The phantom-node method is used to simulate mesh-independent matrix cracking through shell elements.

- Delamination damage is modeled using a shell interface model.

- Interaction between matrix cracking and delamination is taken into account using an enriched shell interface model.

## Results

Progressive damage analysis of a symmetric, cross-ply laminate is performed. Shear induced matrix cracking and delamination is shown in figures 2,3 and 4.
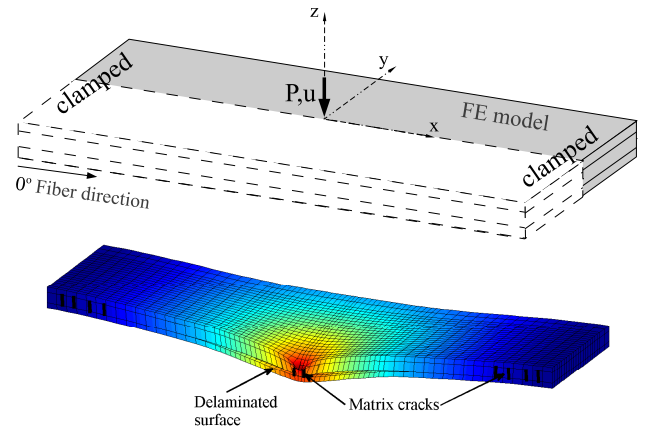
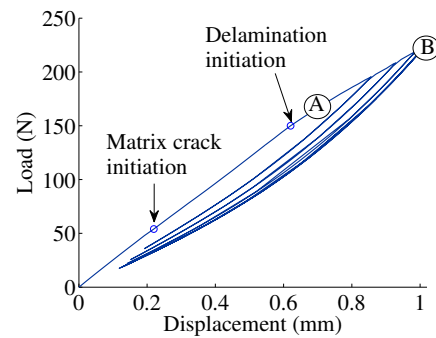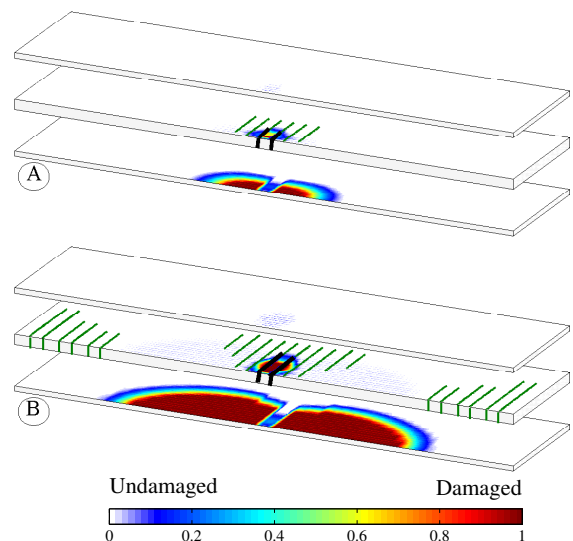

Figure 2: Laminate model and a deformed mesh



Figure 3: Load-displacement curve



Figure 4: Matrix cracking and delamination damage