Computational analysis of Geometric Nonlinear Effects in Adhesively Bonded Single Lap Composite Joints

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Outline of the talk

- **Introduction**
- **Presentation of models**
- **Presentation of main findings**
- **Conclusion**

Applications



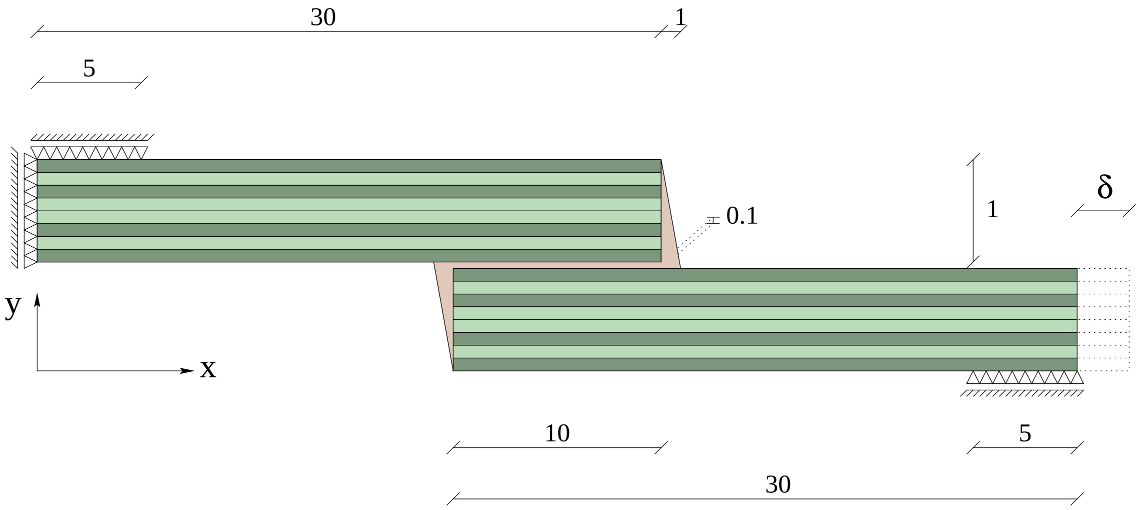

- **Composite materials are applied in numbers of engineering constructions**

Motivation

- **Geometric nonlinear effects are important in strength analysis of non-symmetric composite joints**
- **Investigation**
  - **Due to non-symmetric geometry?**
  - **Due to material properties?**
  - **Only for loads near ultimate strength?**

Models

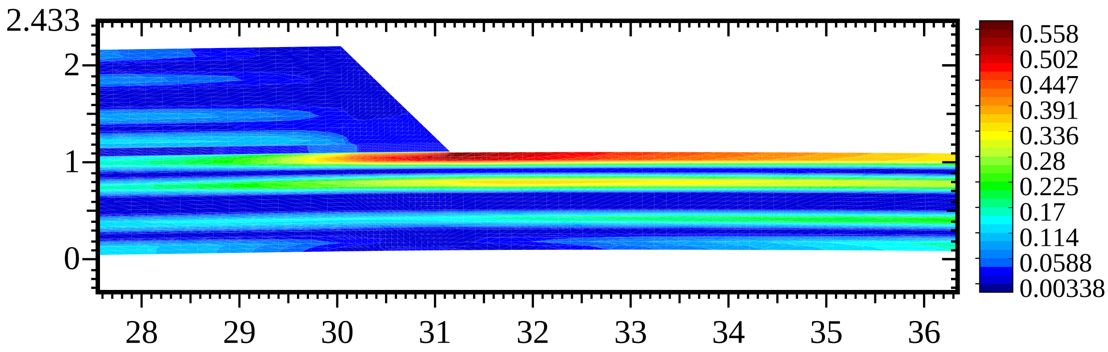
- Adhesively bonded single lap joints



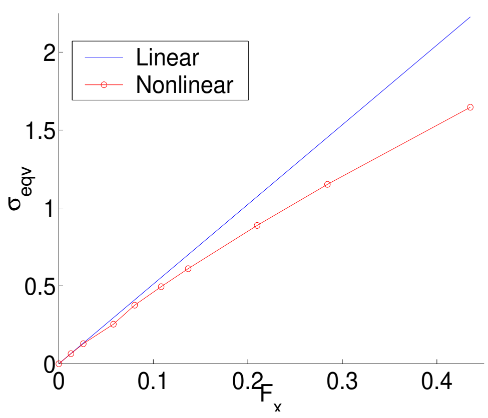
- Linear material properties
  - XAS/914C composite
  - Redux 308A adhesive
- Geometric nonlinear finite element method
  - ANSYS
  - Diffpack
- 2-D plane strain

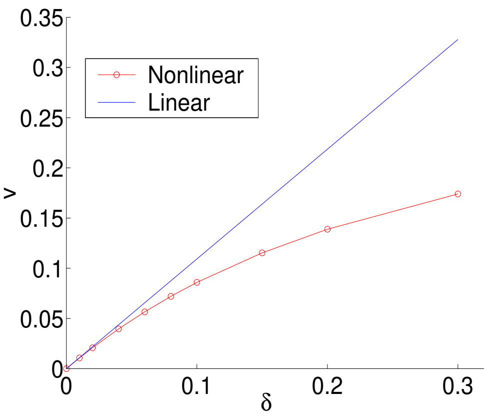
Single lap joint

- **Equivalent stress for $\delta = 0.1$**



- **Fillet tip results as a function of reaction force/end displacement**

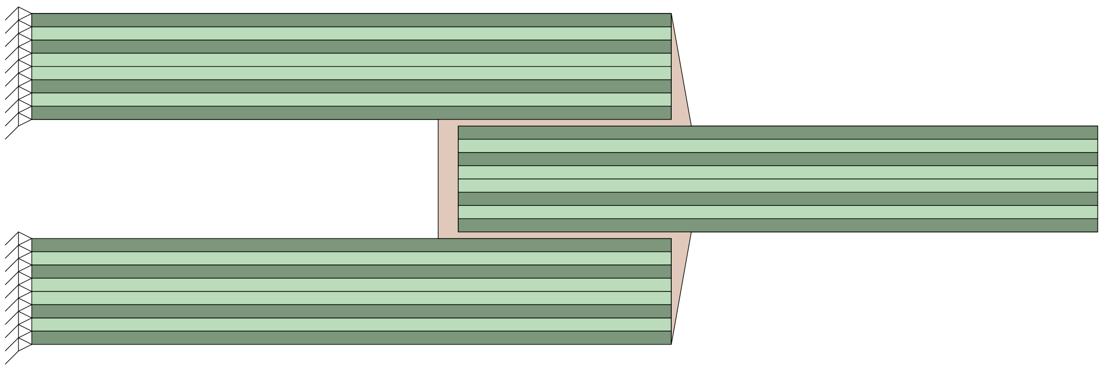




- **Geometric nonlinear effects significant**
- **Due to material properties or non-symmetric geometry?**

Double lap joint

- Symmetric double lap joint investigated



- Linear relations observed
- Preliminary conclusion:
    - Non-symmetric geometry important reason for nonlinear results
    - Other reasons?

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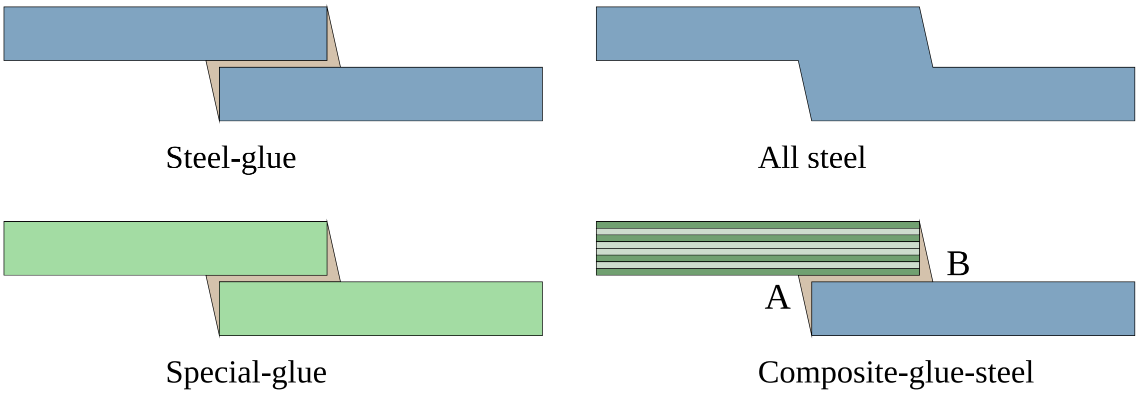
Further investigations

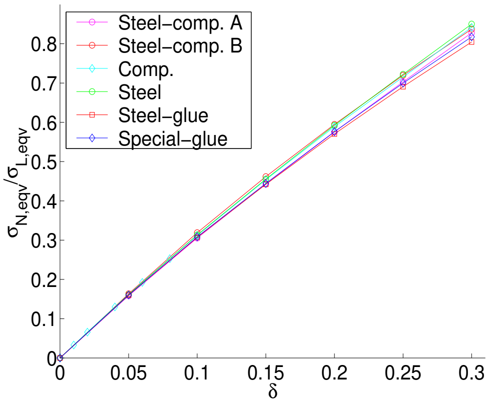
- **Various non-symmetric joints analysed**



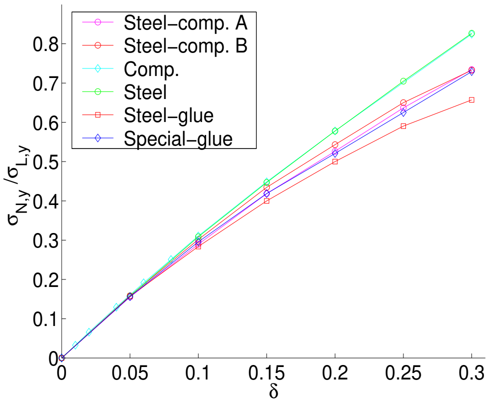
- **Comparison of results from geometric nonlinear and linear models**

Results

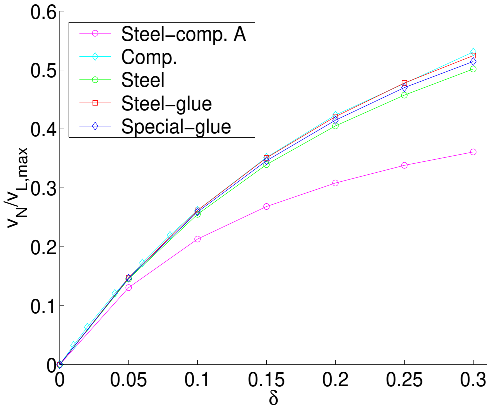
- **von Mises equivalent stress,** σ_{eqv}



- **Vertical stress,** σ_Y

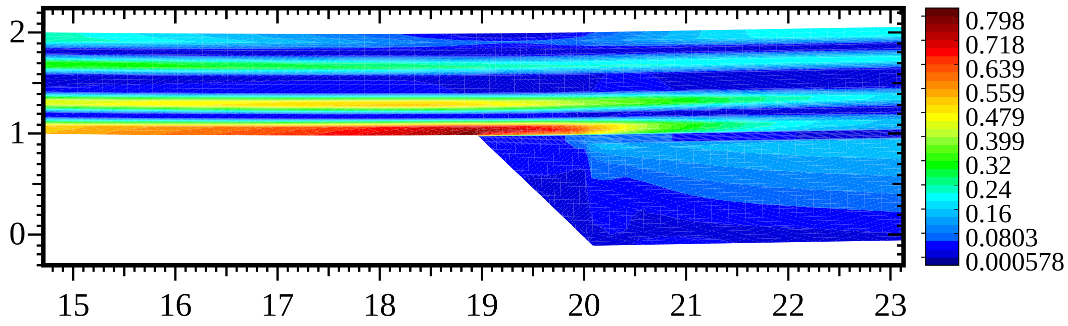


- **Vertical displacement,** v

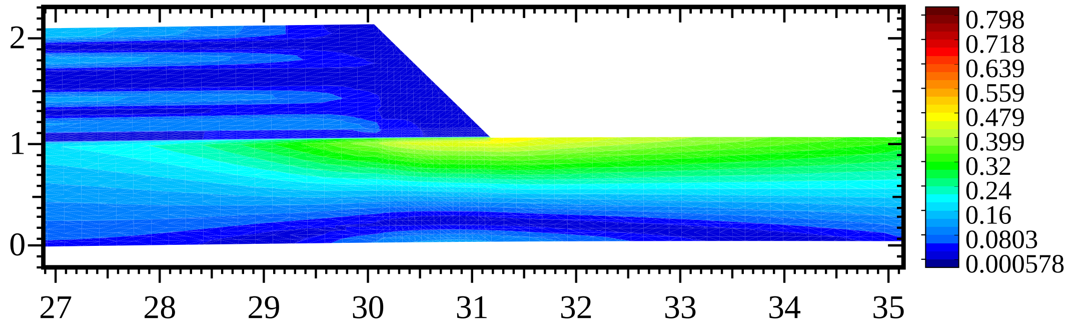


Plots

- **Equivalent stress for the composite-glue-steel model, $\delta = 0.1$**
- **Distribution near the fillet tip A**



- **Distribution near the fillet tip B**



Conclusion

- **Significant nonlinear effects are observed**
  - **due to non-symmetric geometries**
  - **due to non-symmetric distribution of materials**
  - **for almost all levels of external load**