

FEA of the effect of delamination on carbon fibre composites impact failure mode

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8th April 2025



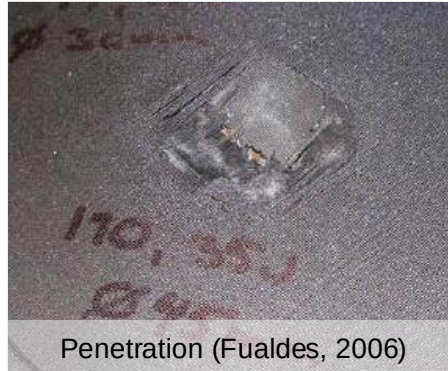
EPSRC Centre for Doctoral
Training in Composites Science,
Engineering and Manufacturing

Motivation

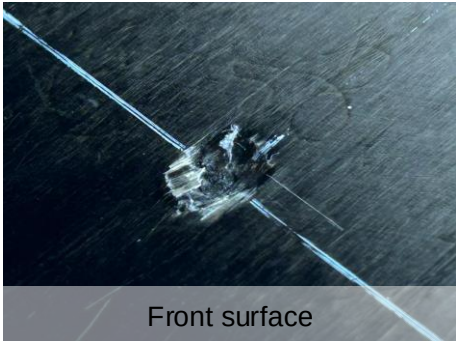
CFRP impact-sensitive



Blade-out (NASA, 2007)



Penetration (Fualdes, 2006)



Front surface



Rear surface

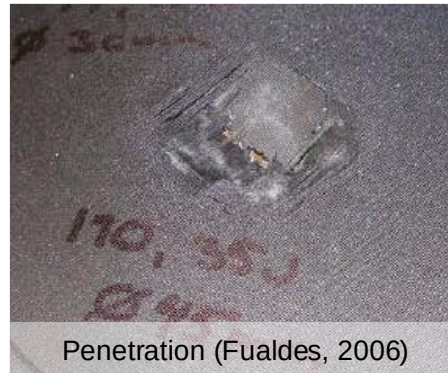


Motivation

CFRP impact-sensitive



Blade-out (NASA, 2007)



Penetration (Fualdes, 2006)

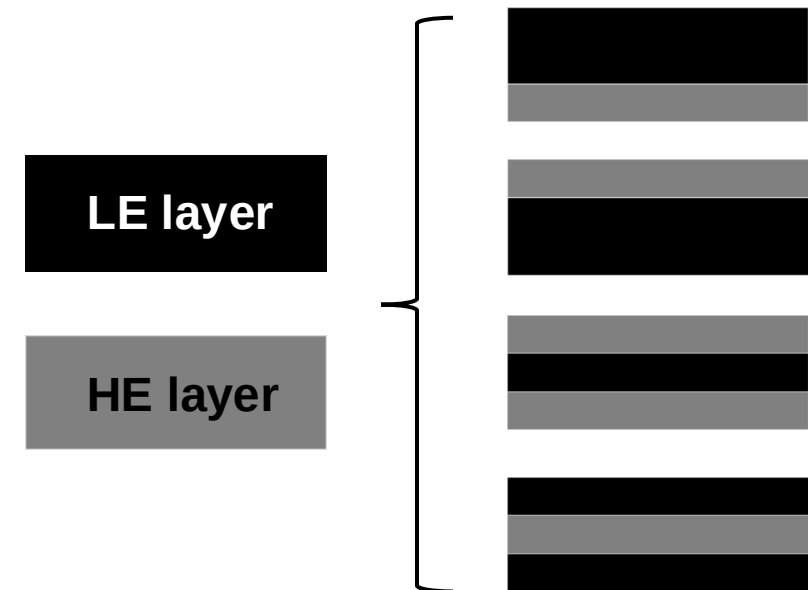


Front surface

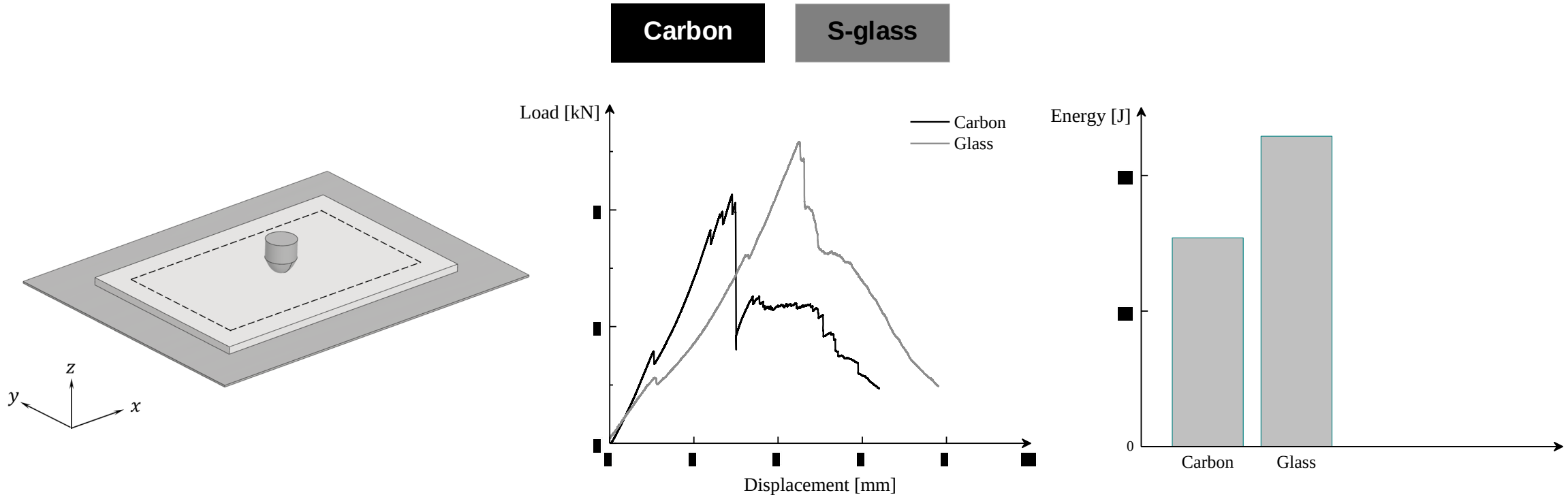


Rear surface

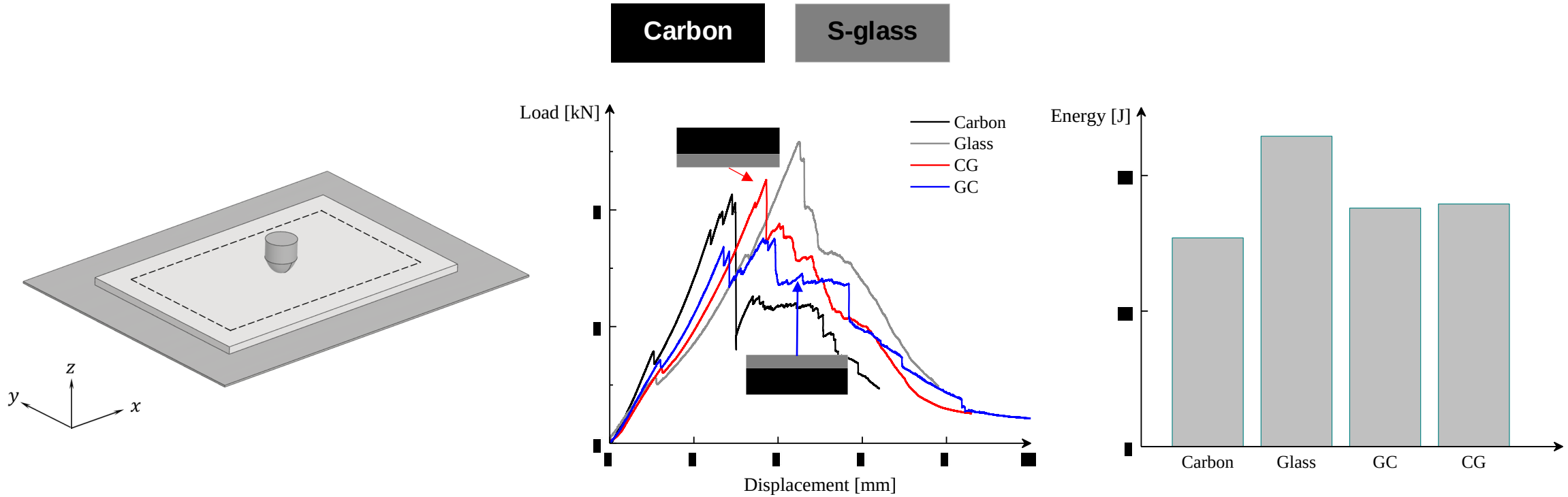
Improve by hybridisation



Quasi-static Indentation: $[0/60/-60]_{3s}$



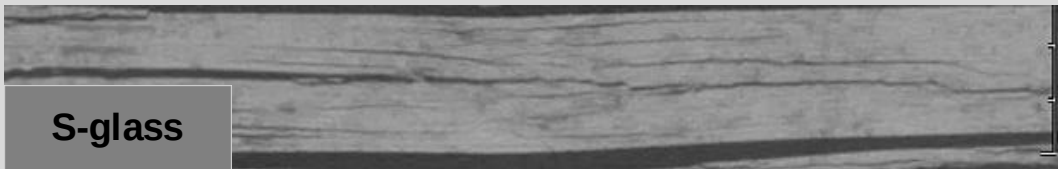
Quasi-static Indentation: $[0/60/-60]_{3s}$



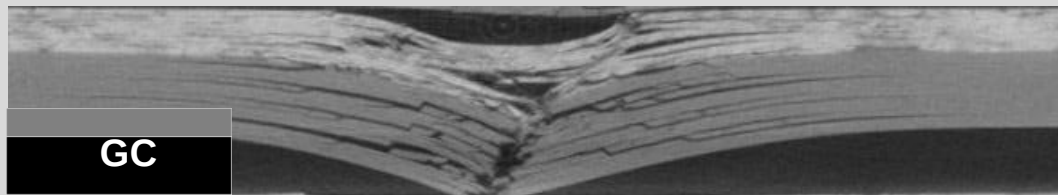
Carbon



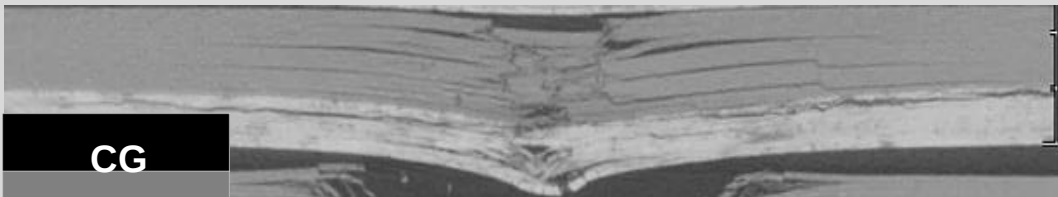
S-glass

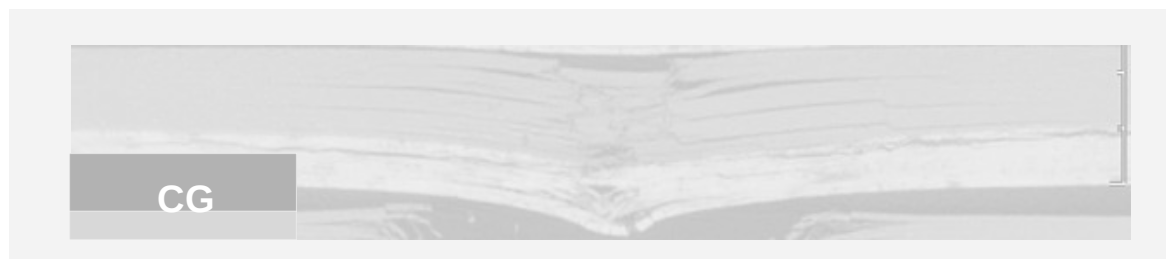
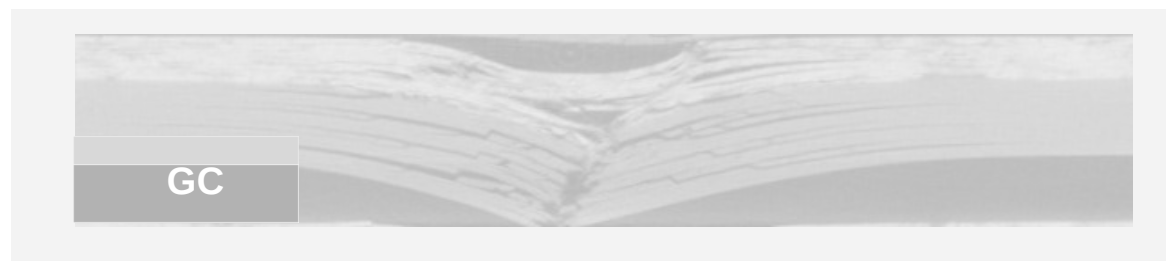
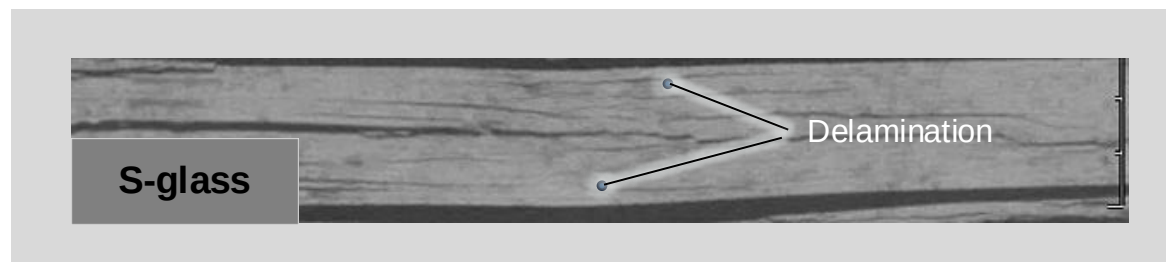
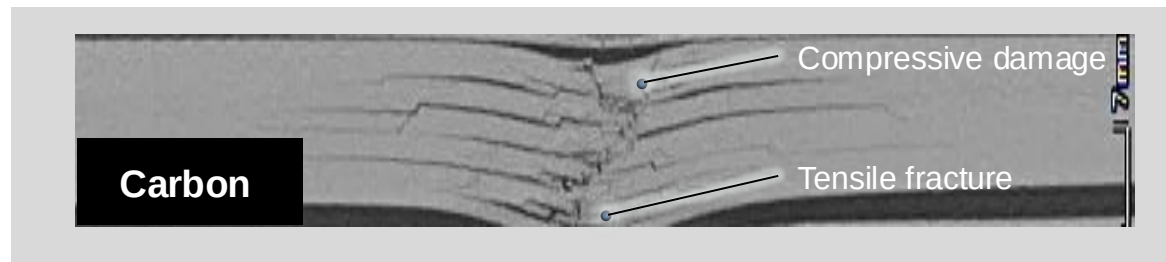


GC



CG





Observation

Delamination is

- extensive in Glass
- limited in Carbon

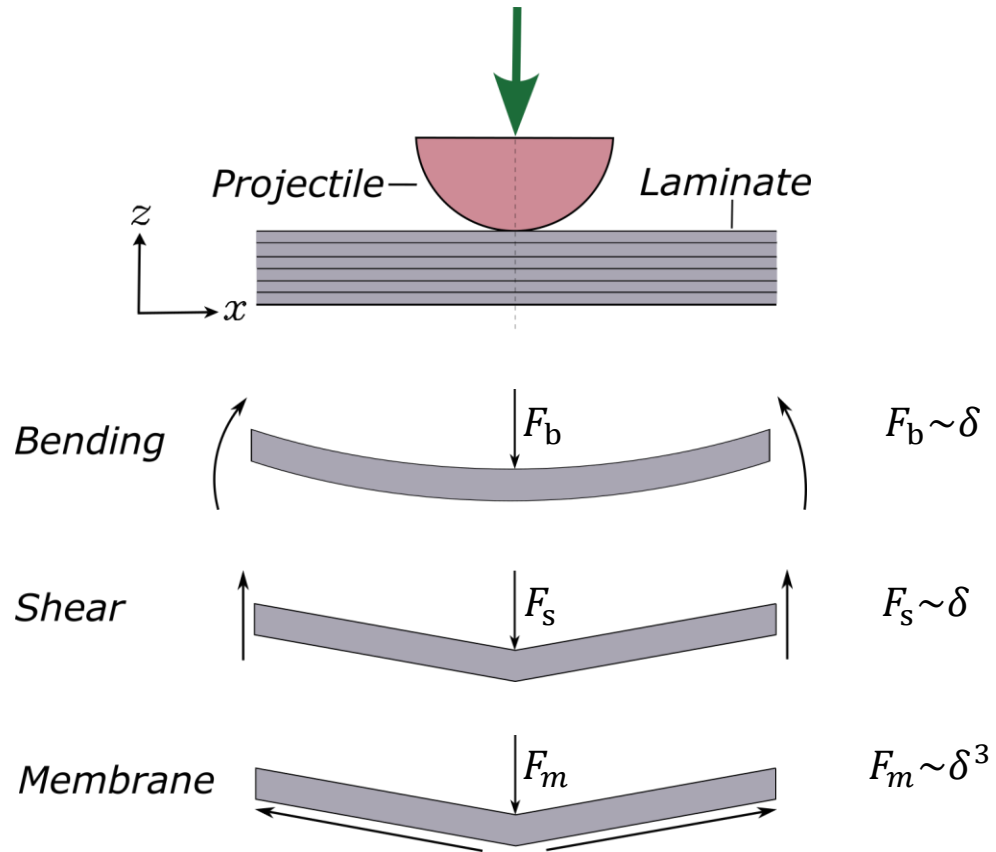
Motivation

What is the effect of delamination on the impact behaviour of composites?

Impact mechanisms

8

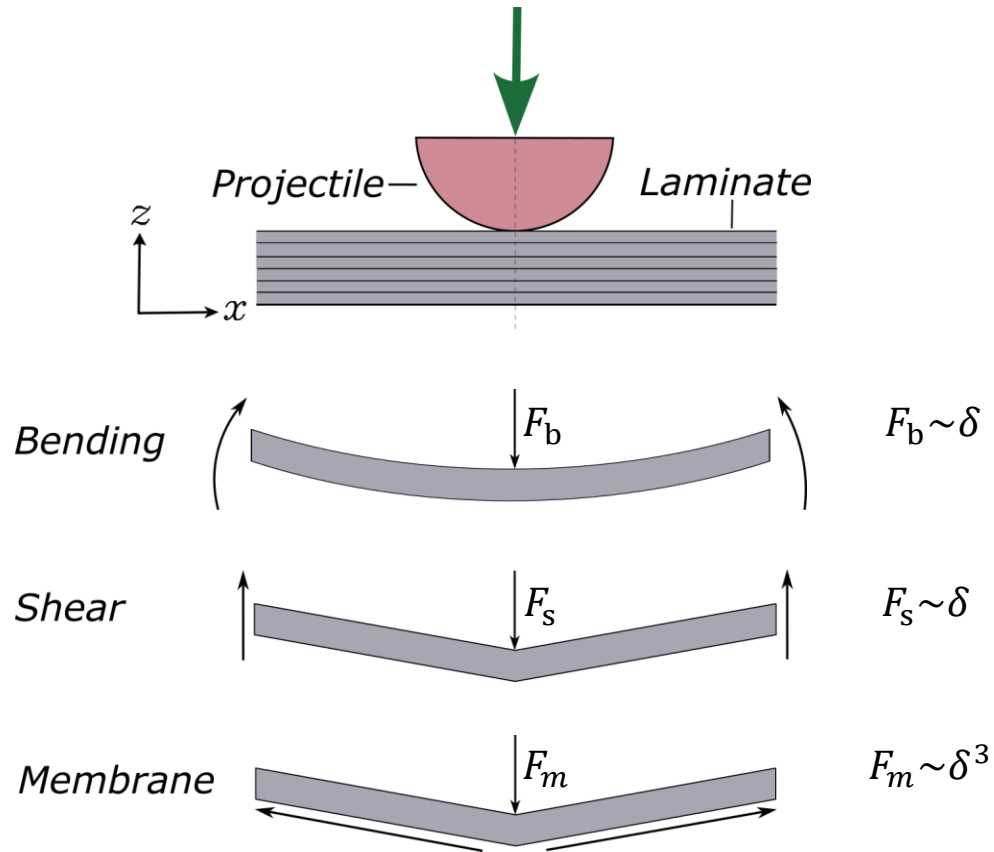
Deformation mechanics



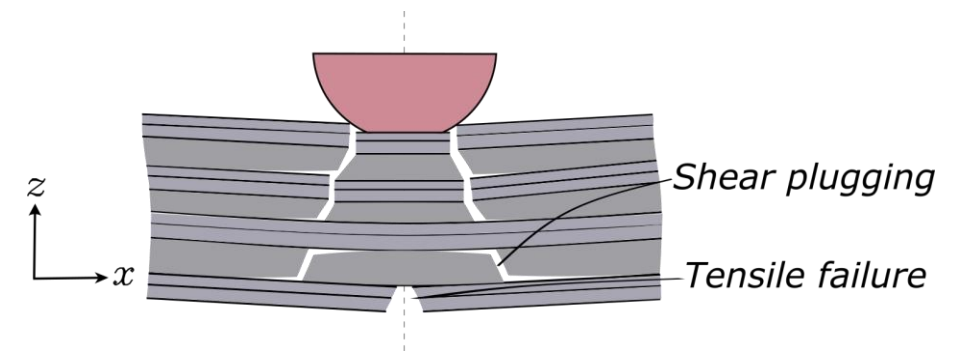
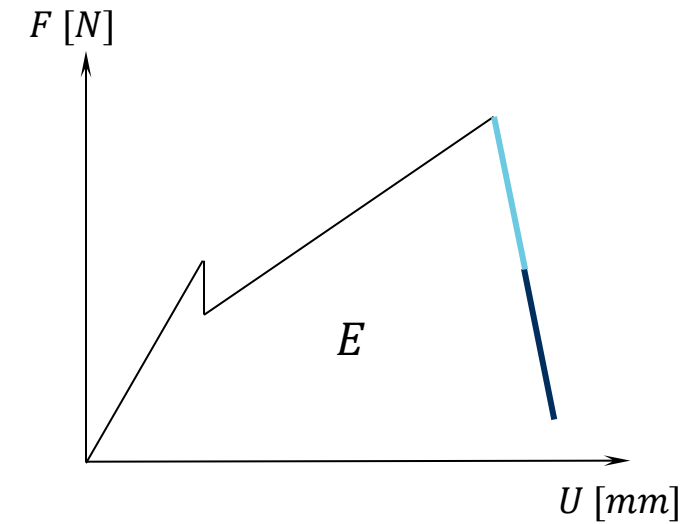
Impact mechanisms

9

Deformation mechanics

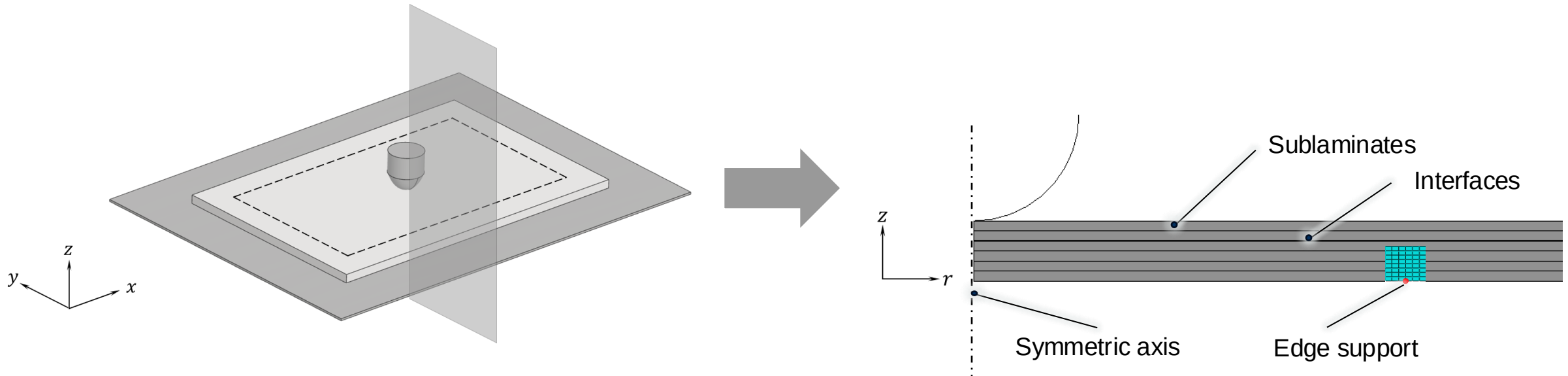


Failure process



2D axisymmetric model

10



Parametric study

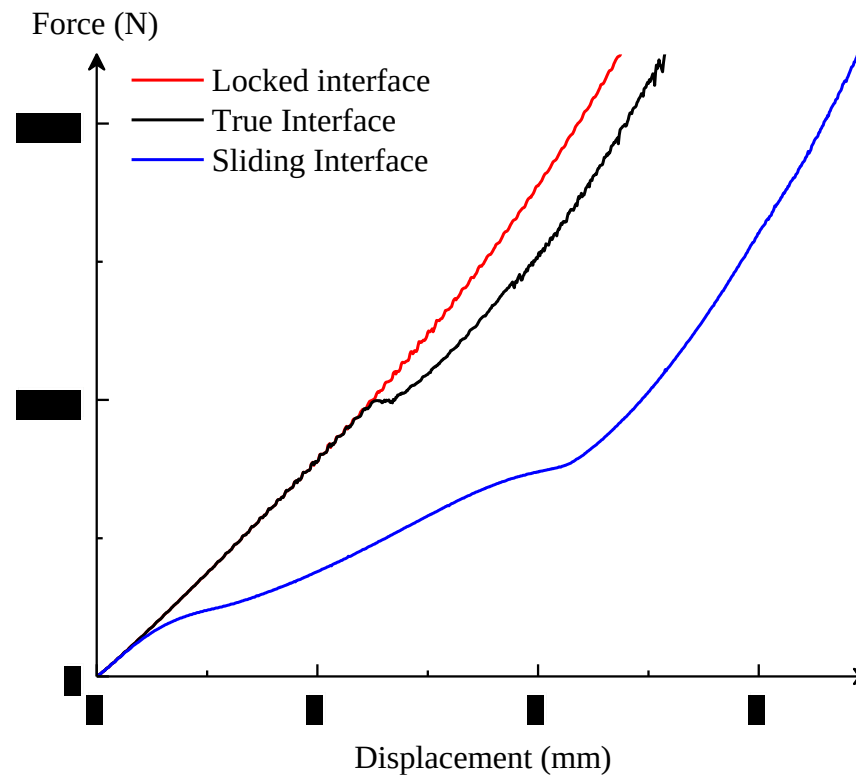
	τ_{II}^* [MPa]	G_{II}^* [N/mm]
True Interface		
Locked interface		
Sliding interface		

Locked interface: No delamination

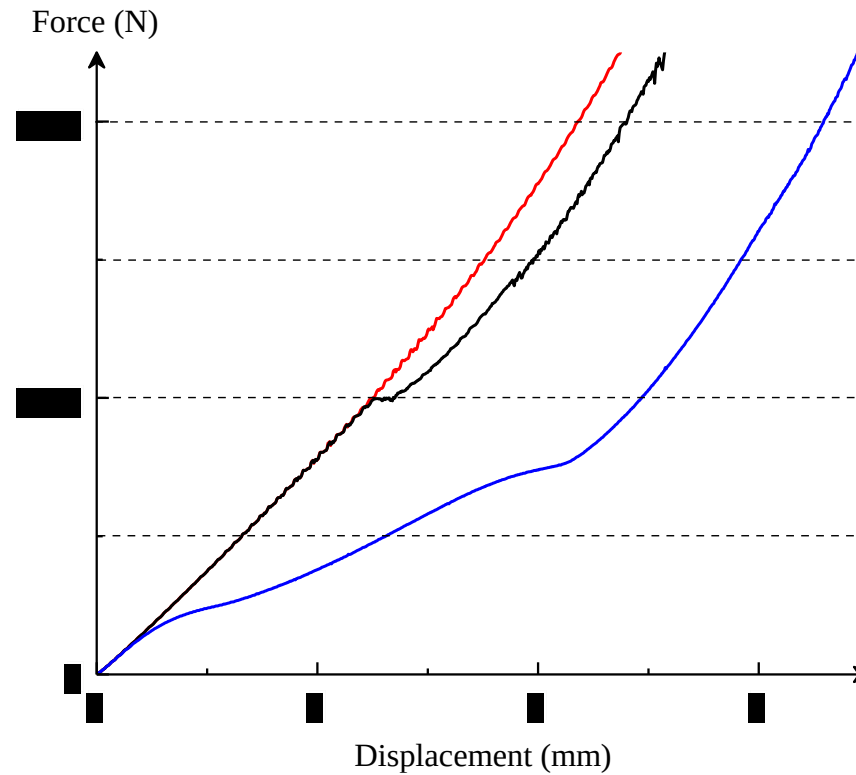
Sliding interface: Extensive delamination



Parametric study

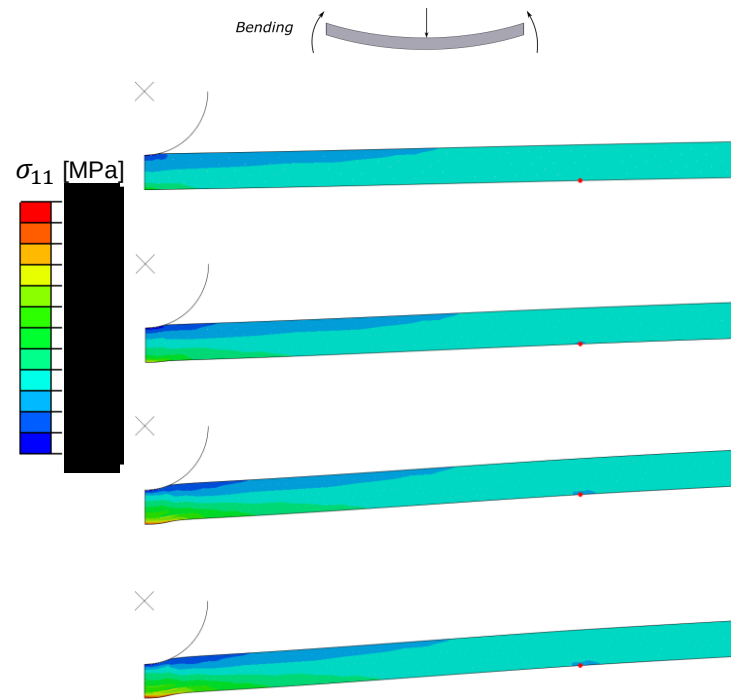


Deformation at the same load

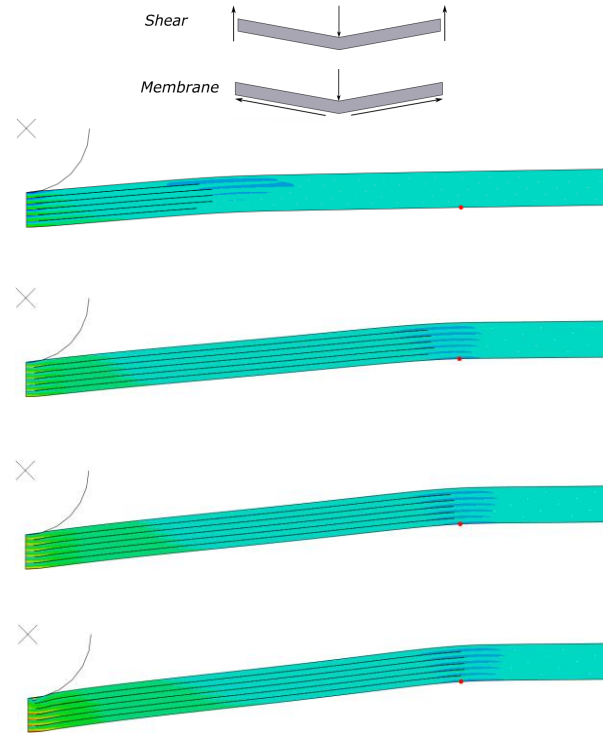




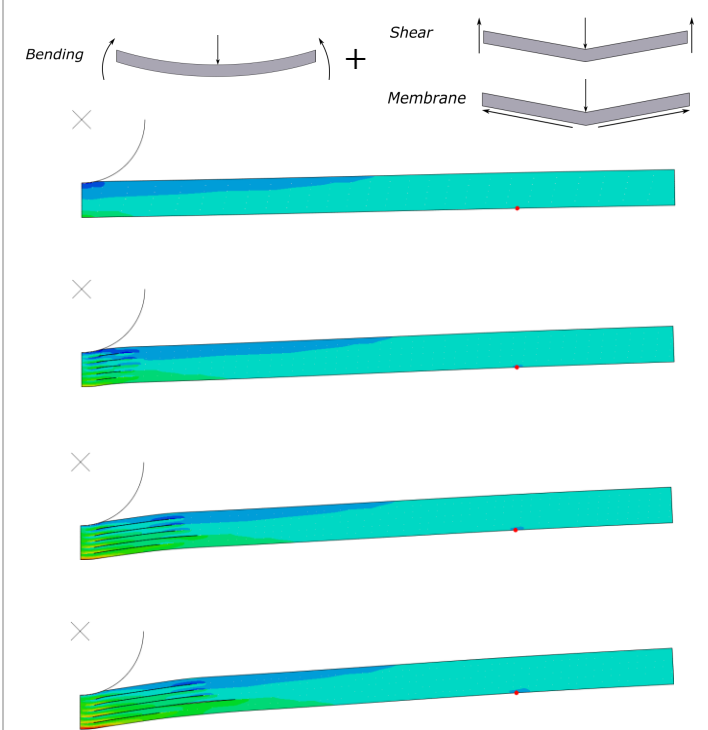
Locked Interface



Sliding Interface

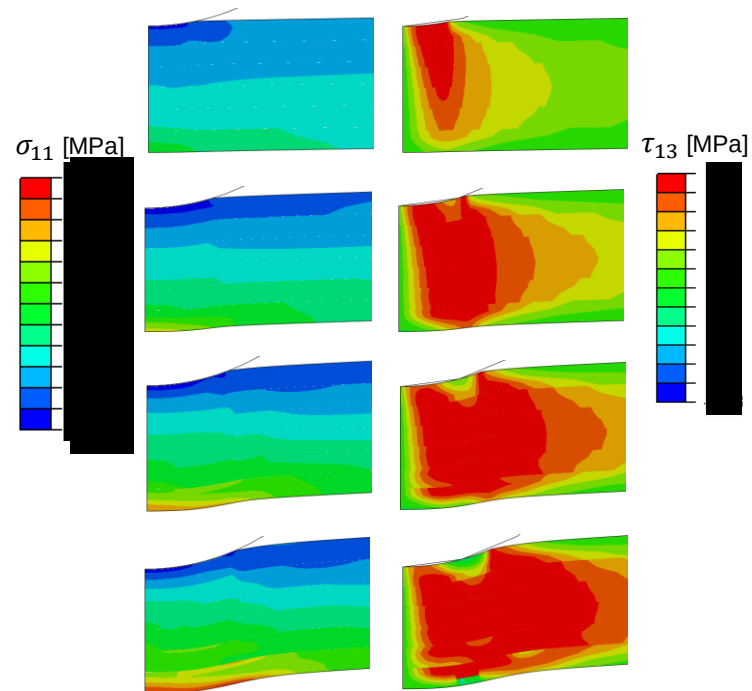


True Interface

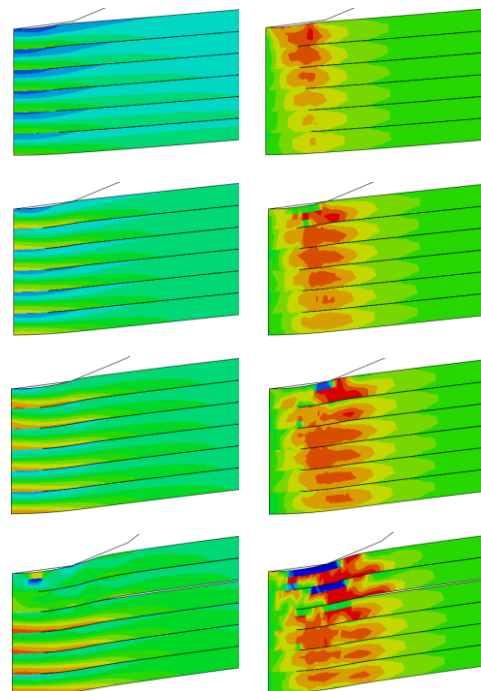




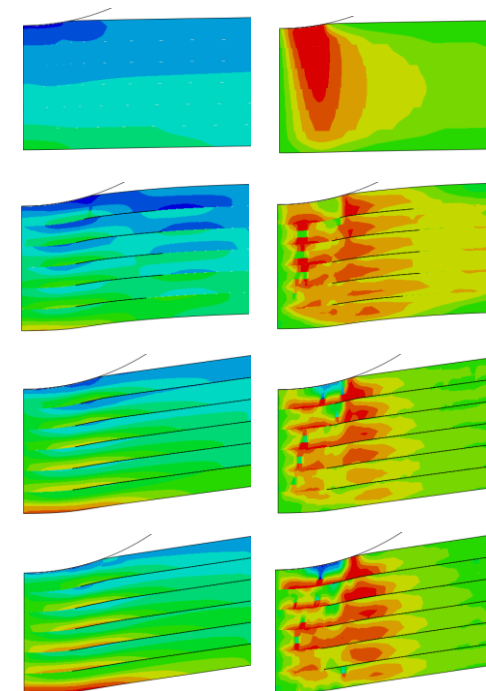
Locked Interface



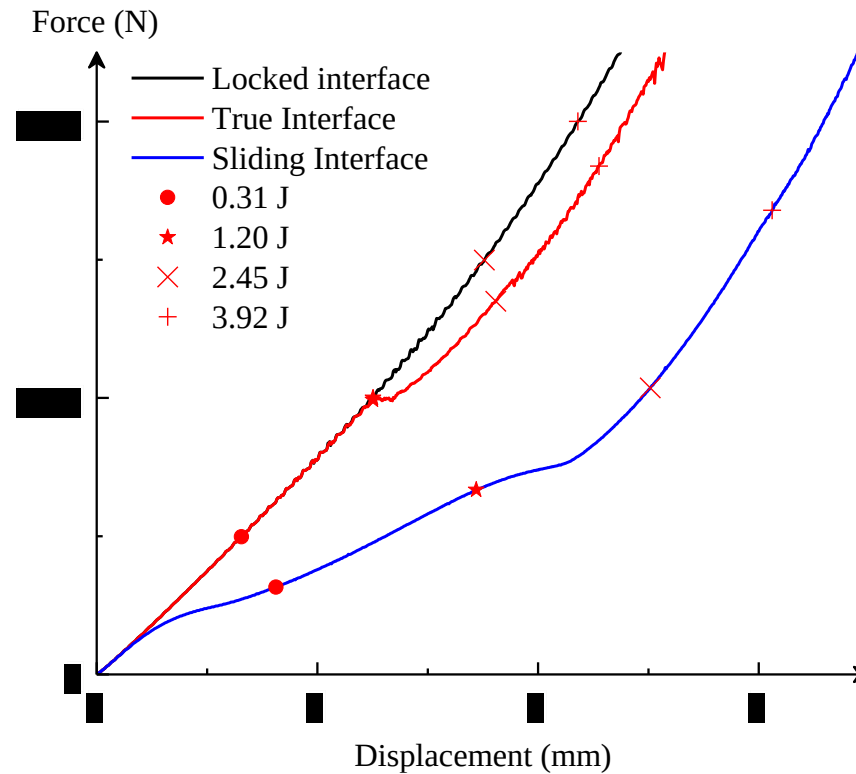
Sliding Interface

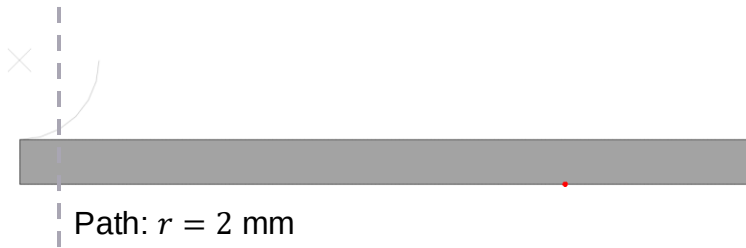


True Interface

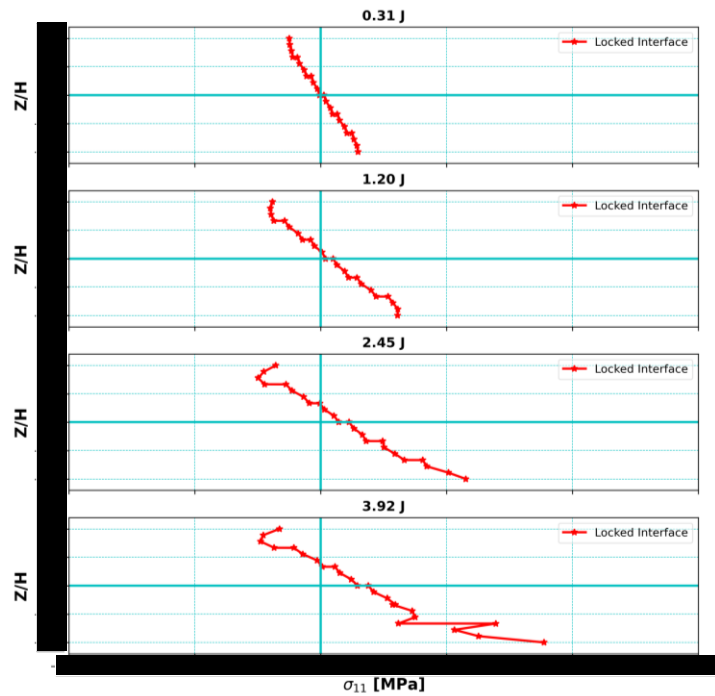


Stress at the same energy

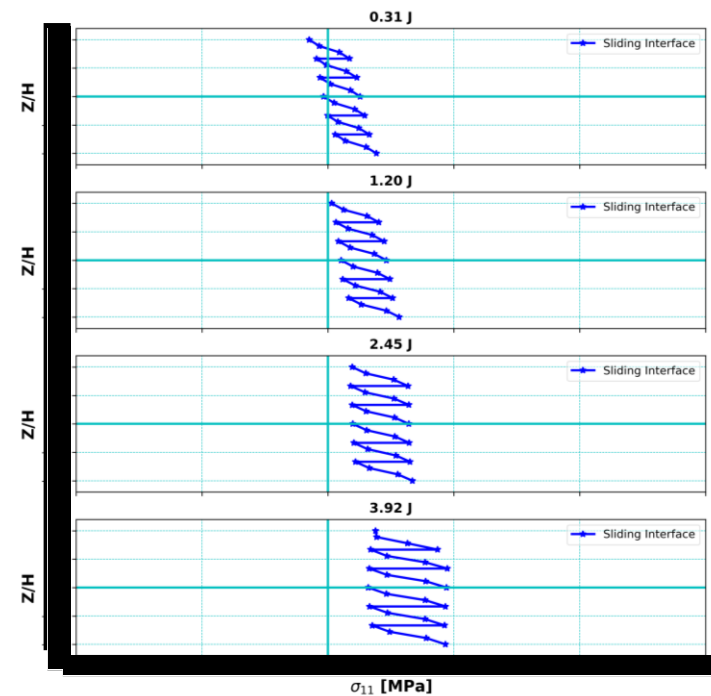




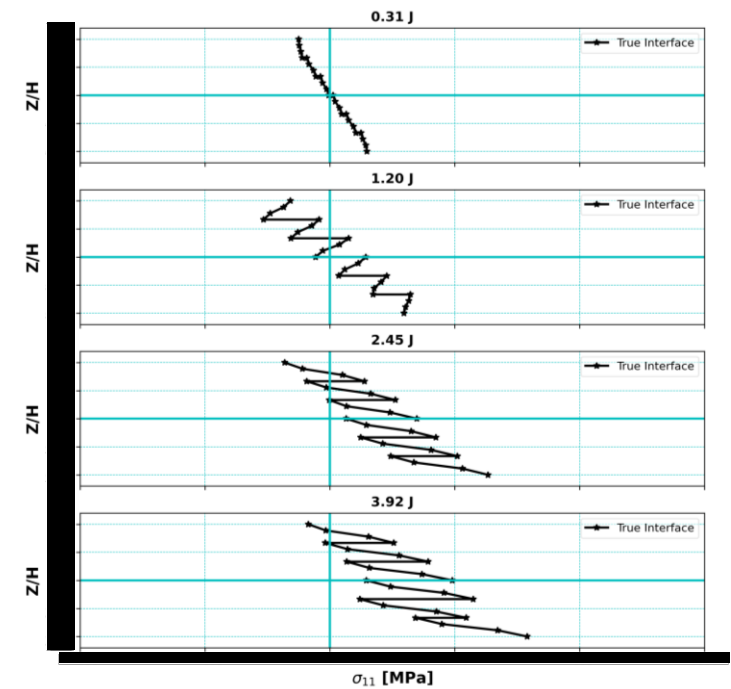
Locked Interface



Sliding Interface

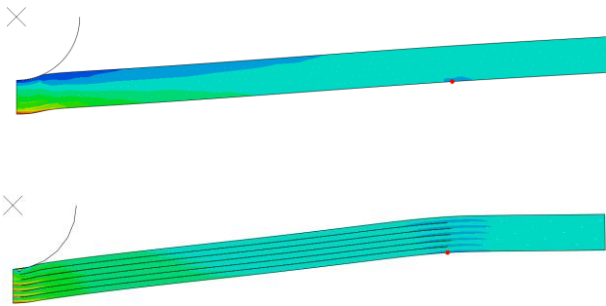


True Interface



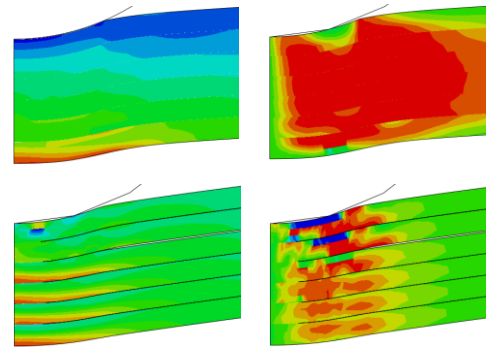
Conclusions

Deformation mechanics



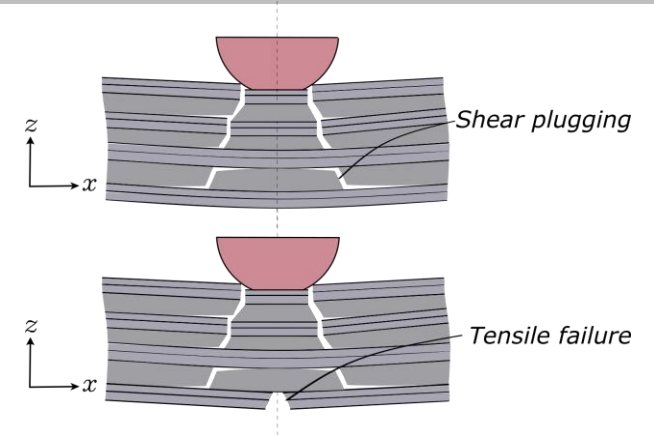
- Accelerate the transition from bending to membrane

Stress distribution



- Alleviate compression and shear
- Promote tension in larger volume

Failure mode



- Mitigate shear plugging
- Promote tensile failure
- Improve energy absorption



Thanks! Questions?

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Engineering and
Physical Sciences
Research Council



University of
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EPSRC Centre for Doctoral
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