Specimen design and instrumentation for monitoring fatigue crack growth initiating at ply drops

Stergios Goutianos, Leonardo Di Crescenzo, Malcolm McGugan and Bent F. Sørensen

Composites and Materials Mechanics Section
Department of Wind Energy
The Technical University of Denmark
DK-4000 Roskilde
Denmark

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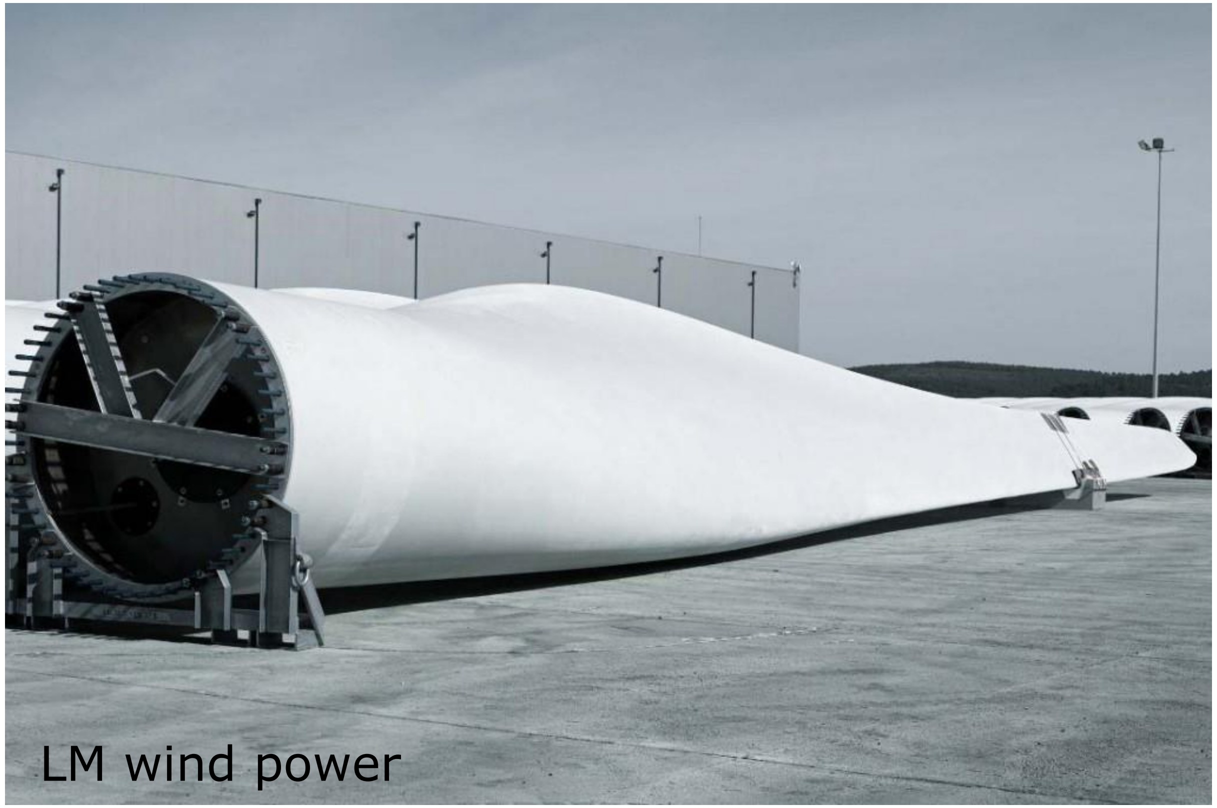
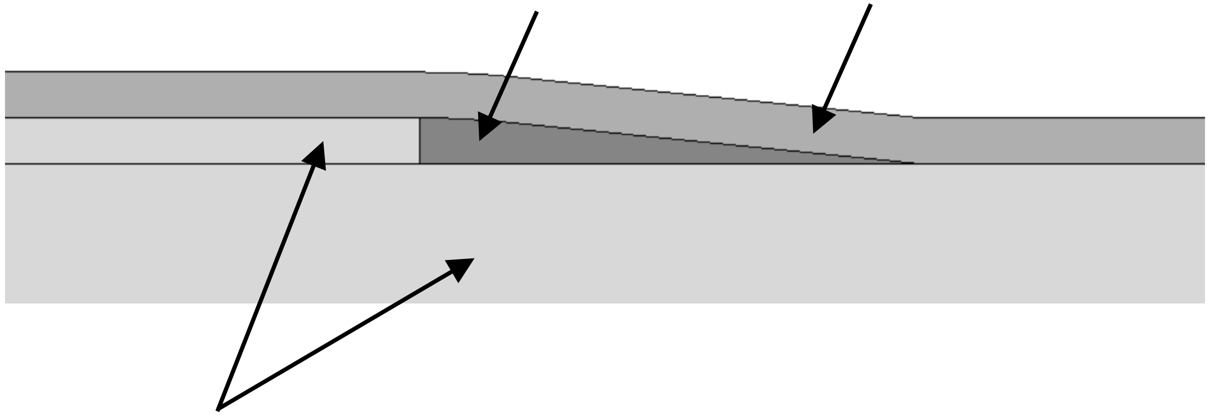
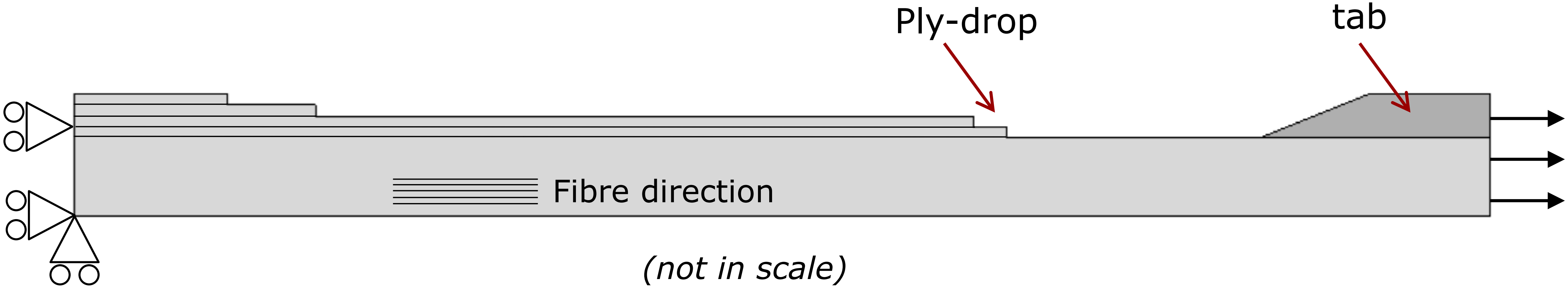
Introduction: Ply-drops



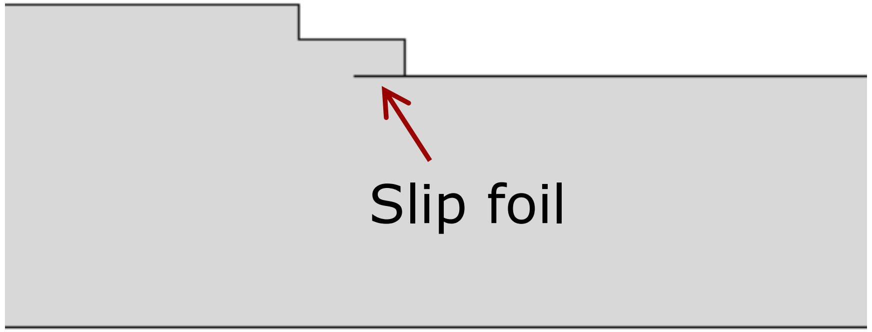


Ply-drop

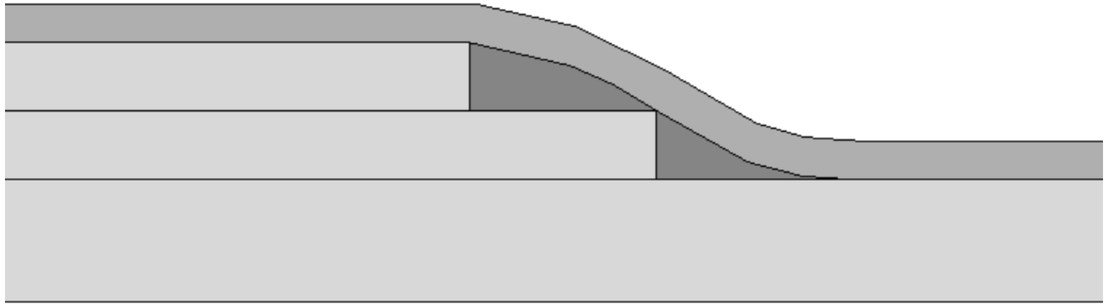
Introduction: Ply-drops specimen



(not in scale)

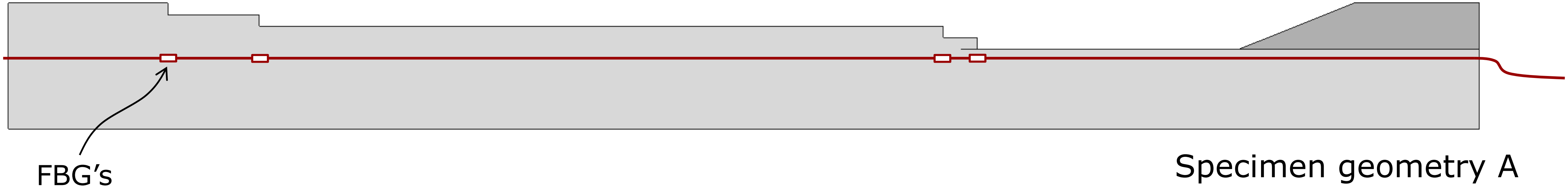


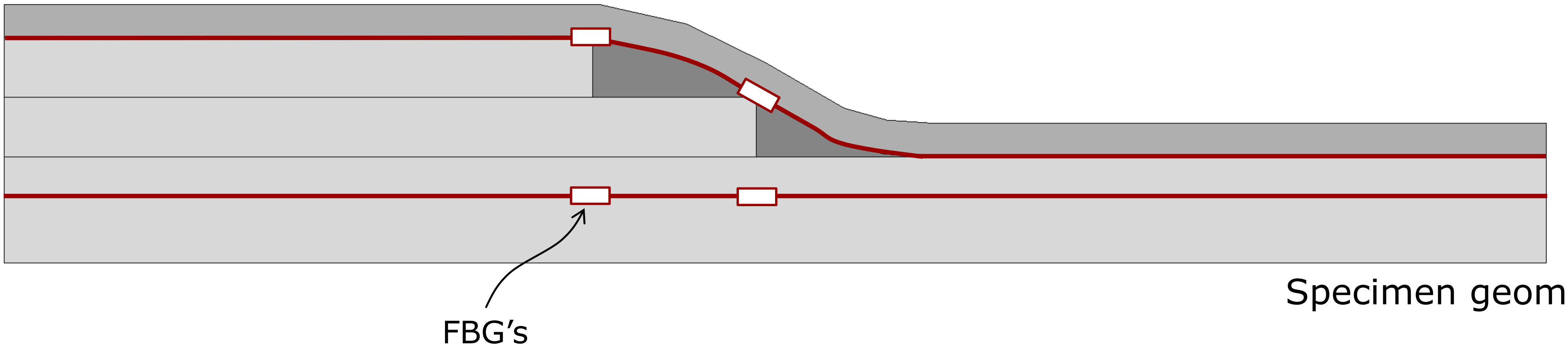
Specimen geometry A



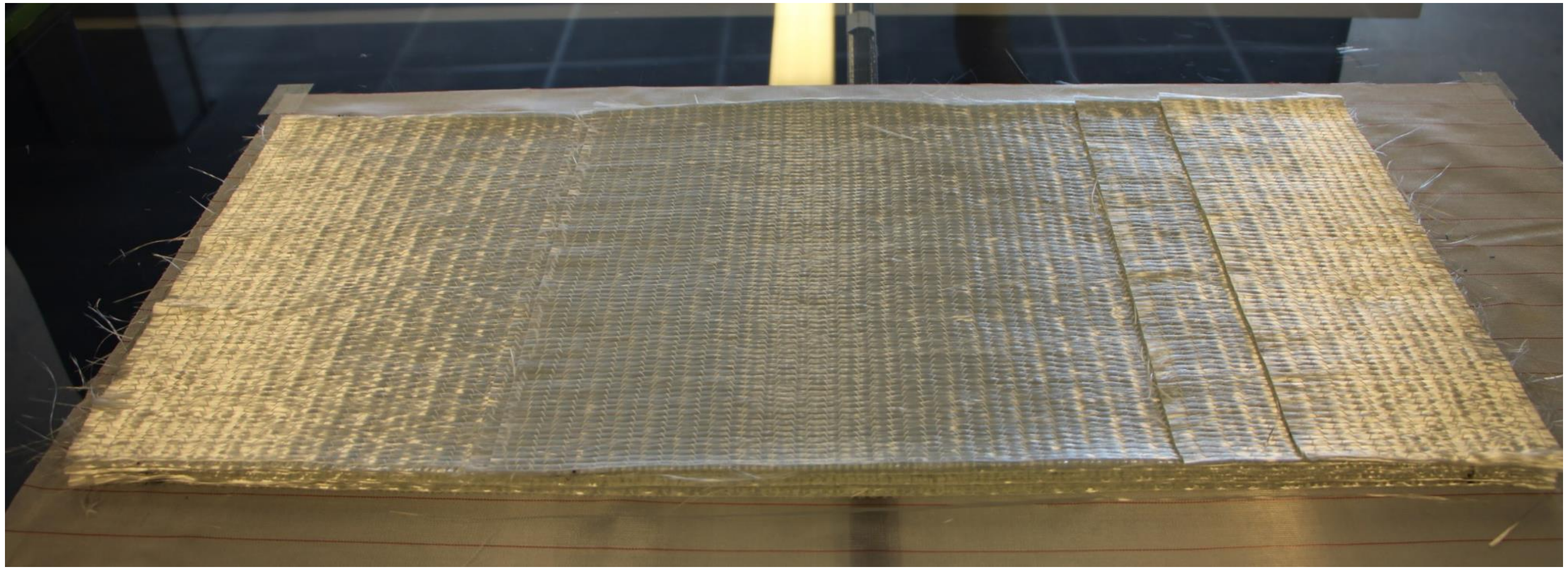
Specimen geometry B

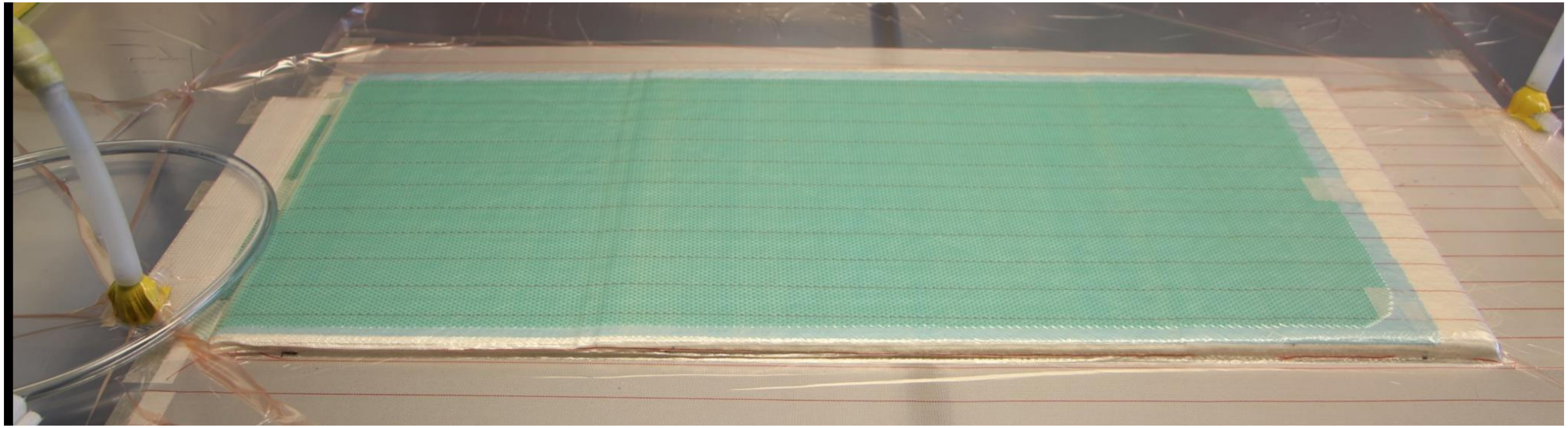
Ply-drops specimen: Manufacturing – FBG's





Ply-drops specimen: Manufacturing – FBG's

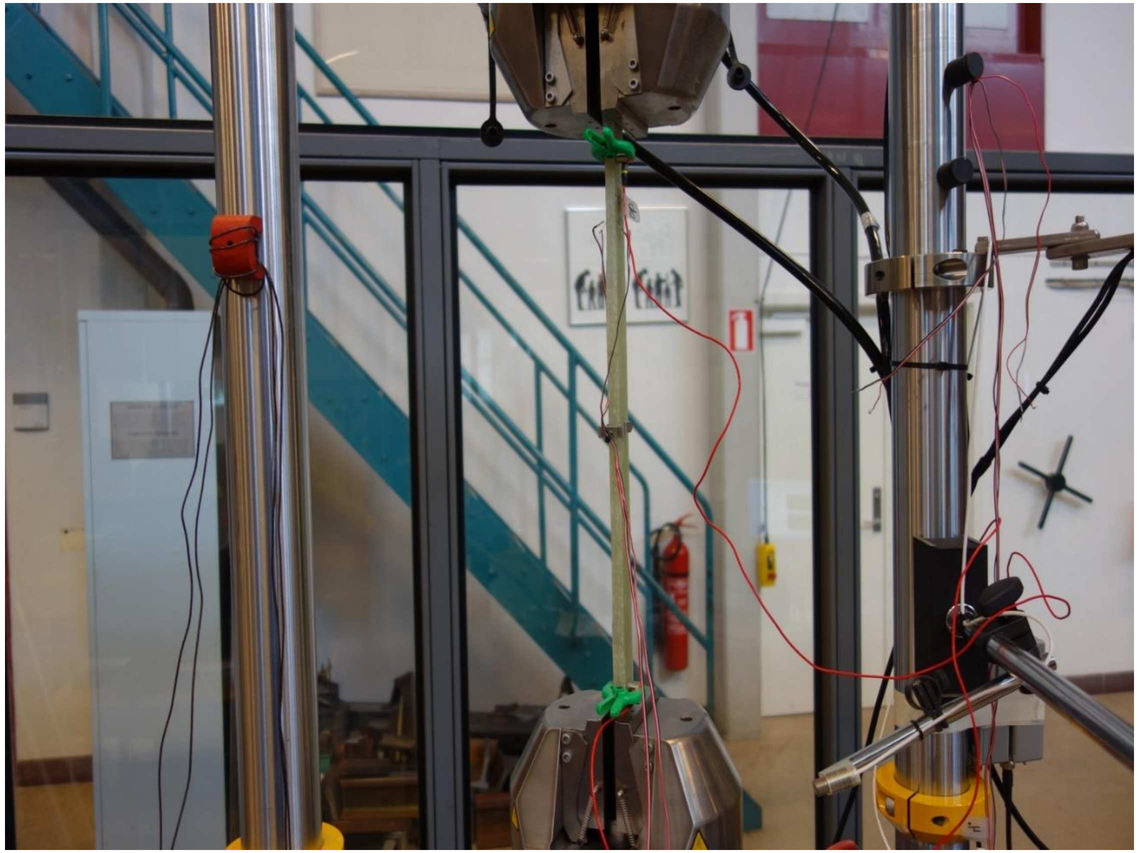


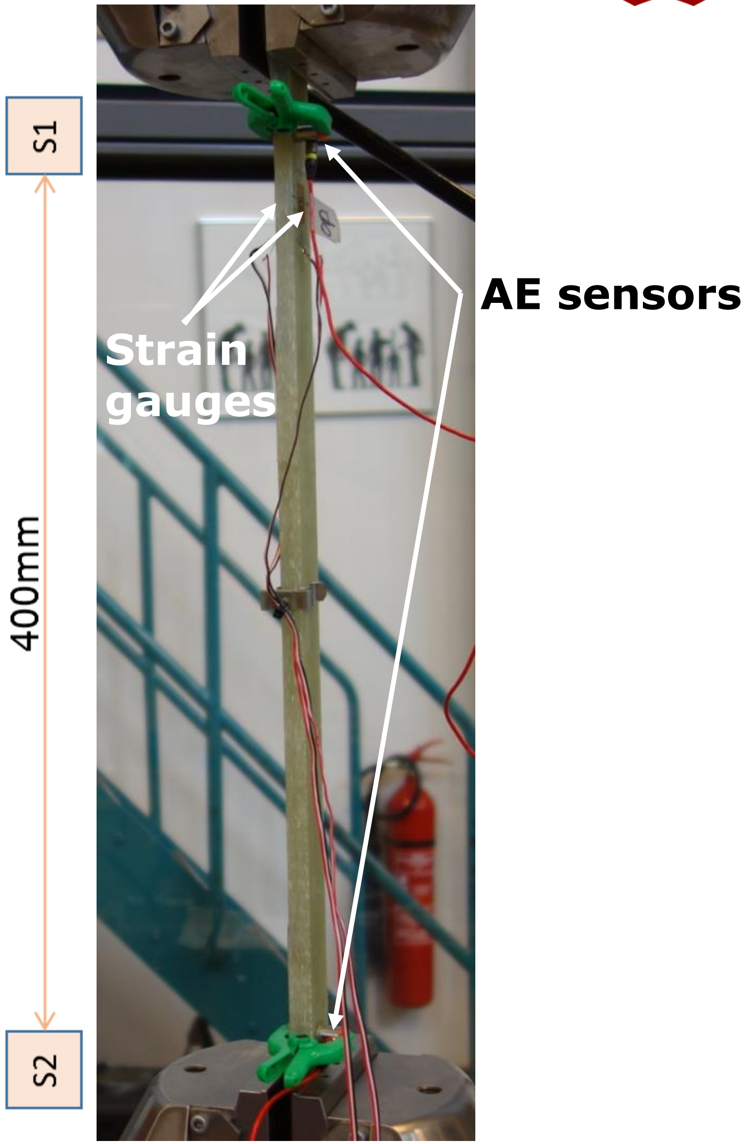


Fibres: Glass

Resin: Epoxy and Polyster

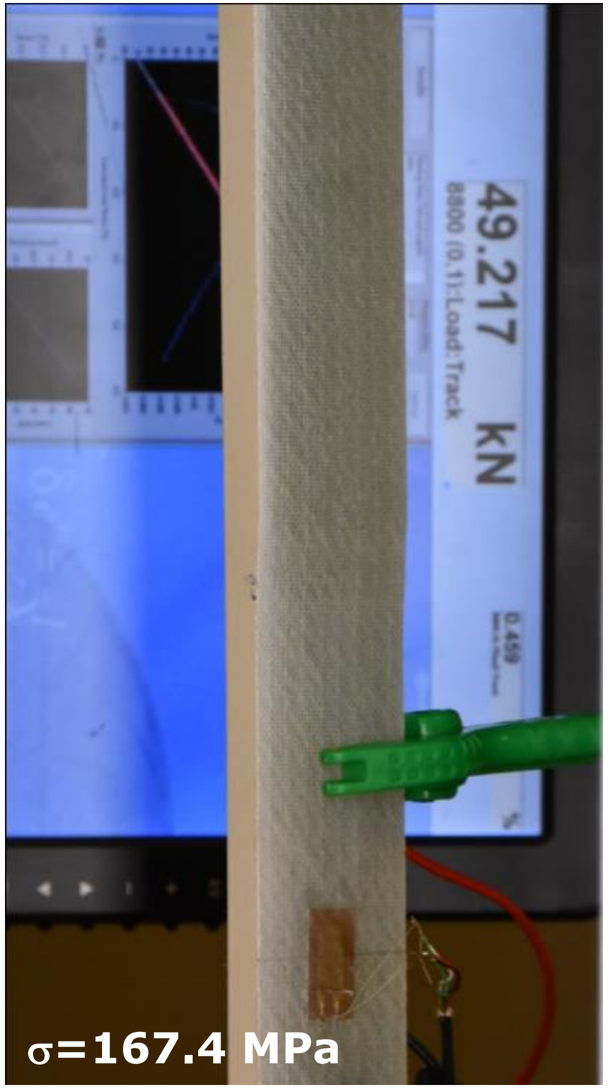
Ply-drops specimen: Acoustic Emission

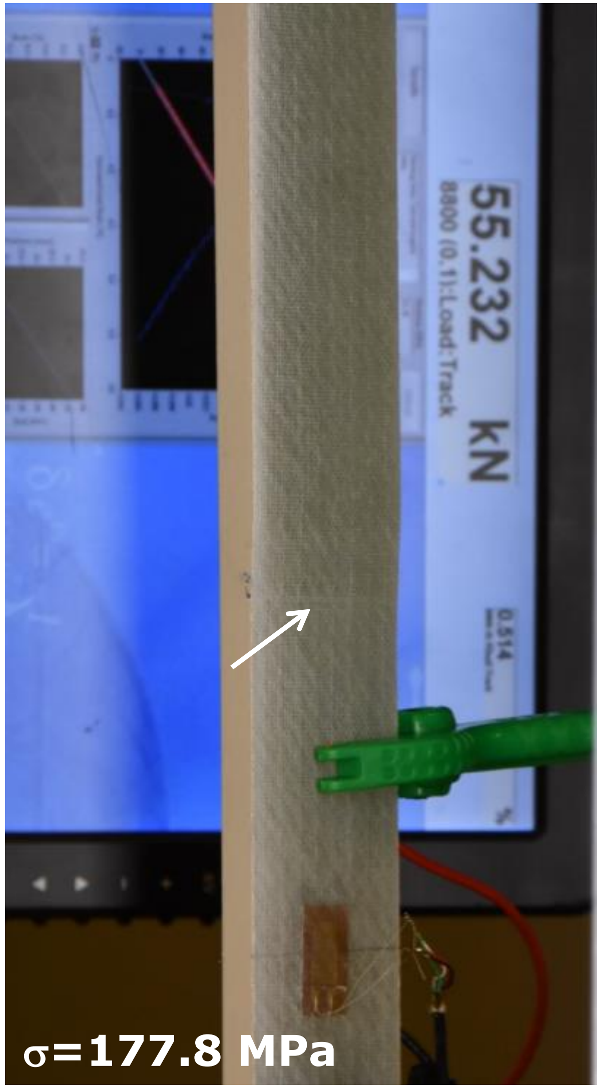


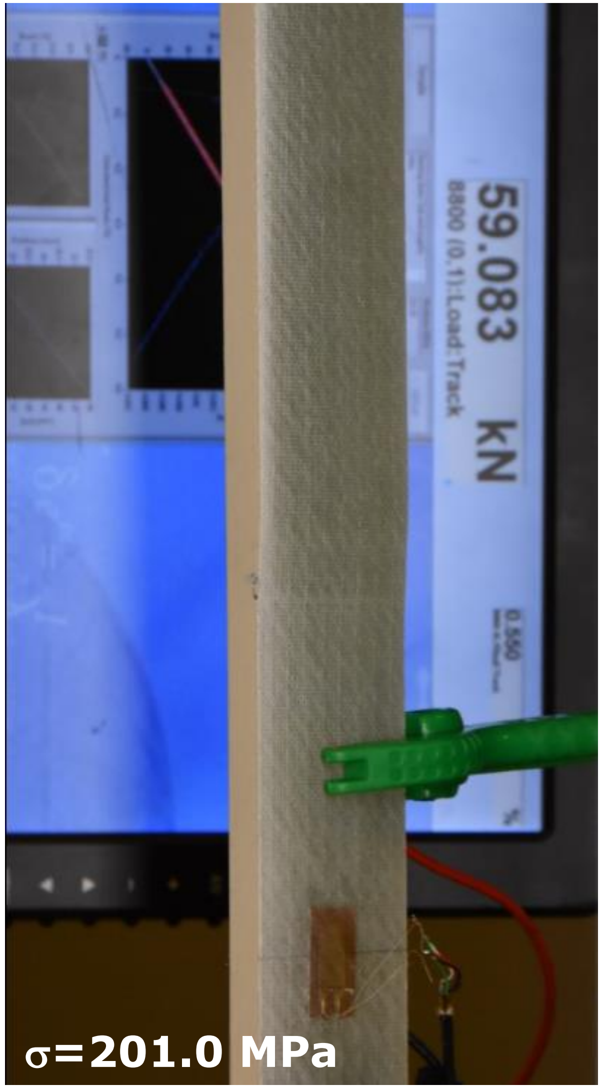


1. Two strain gauges on the thin section to measure bending.
2. Two acoustic emission sensors to detect and localise damage.

Static Tensile Results:

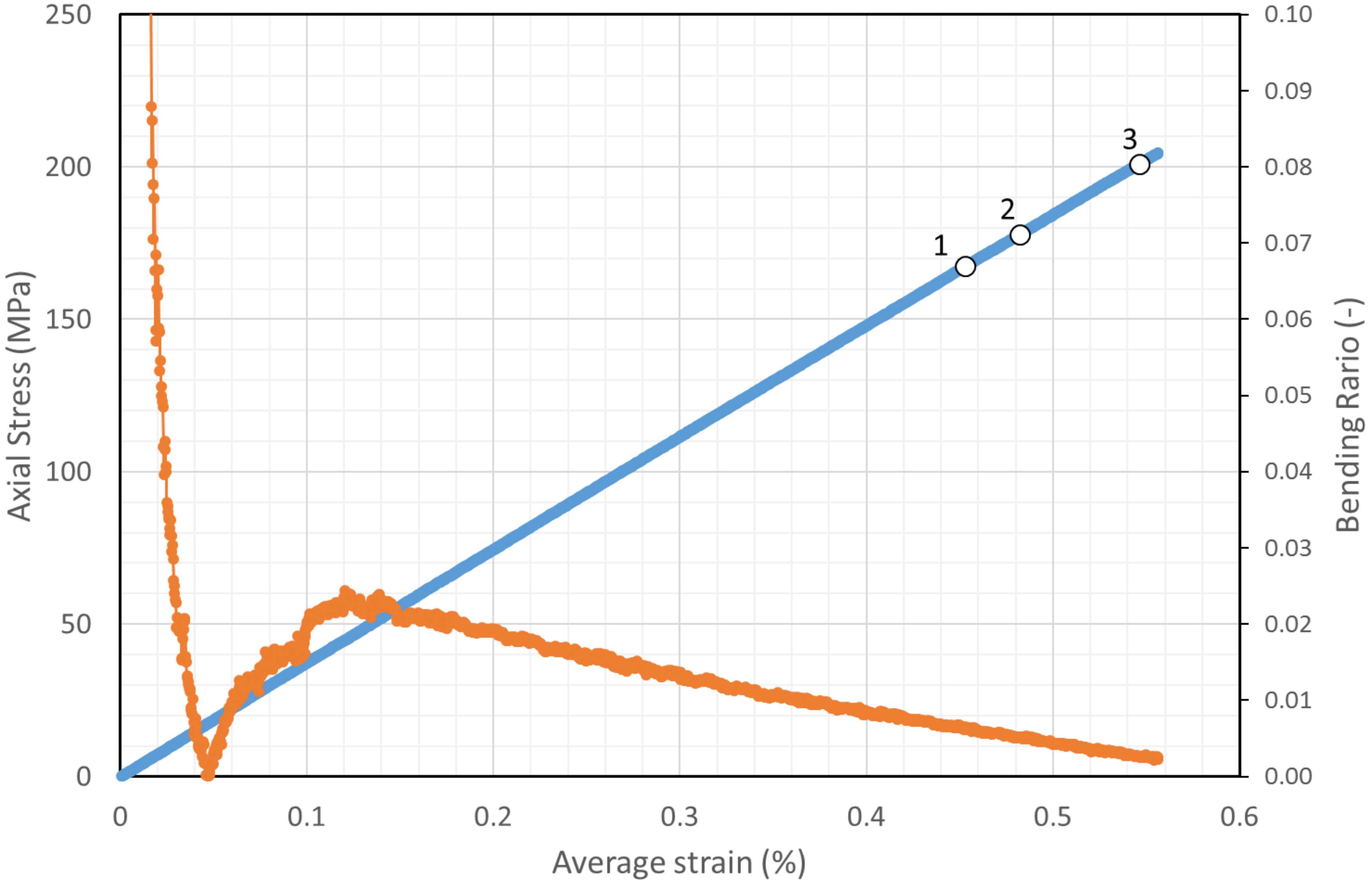






Specimen geometry B

Static Tensile Results:



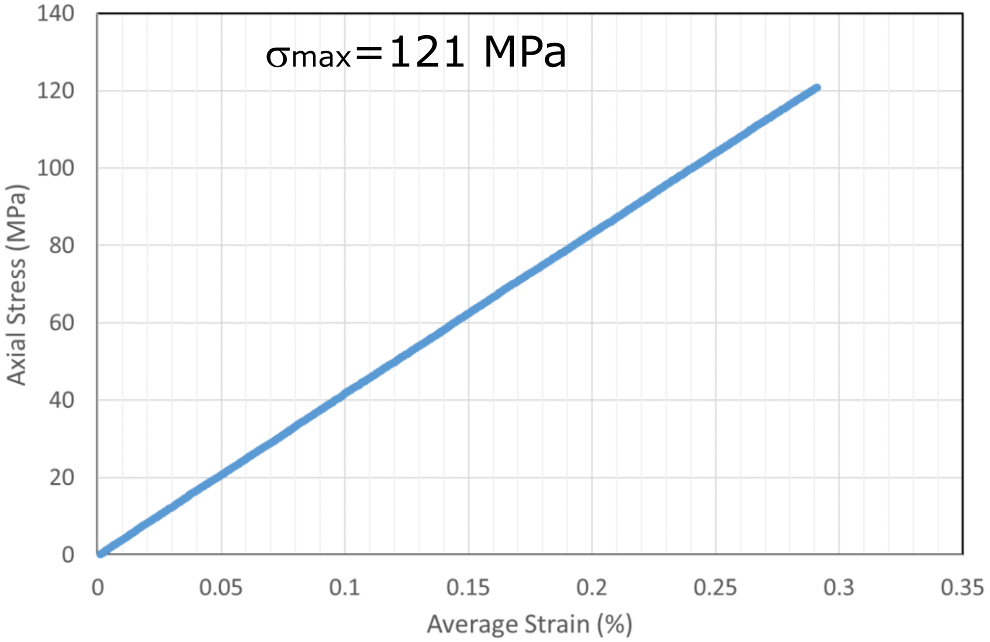
Bending ratio

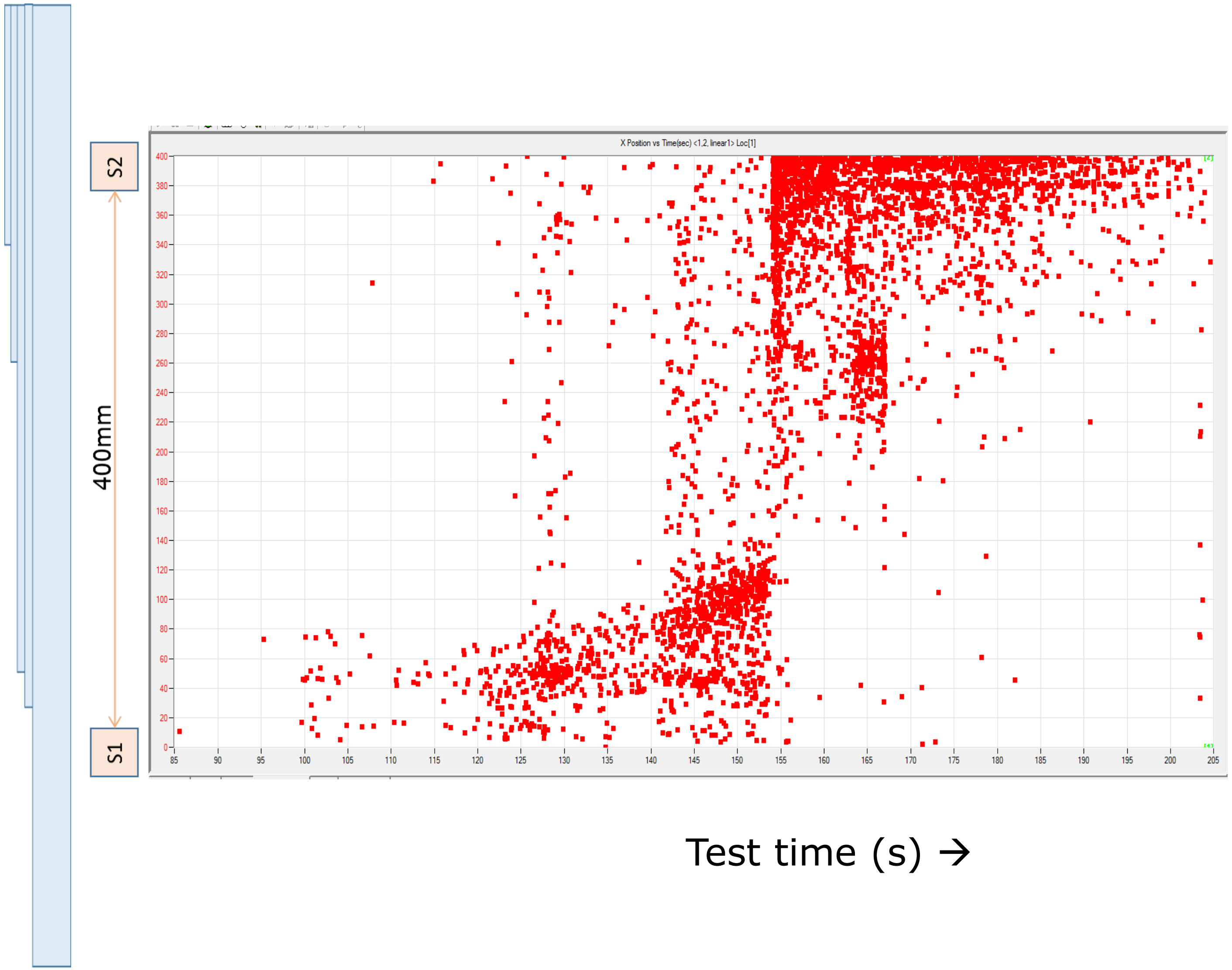
$$\left|\frac{\varepsilon_x^a - \varepsilon_x^b}{\varepsilon_x^a + \varepsilon_x^b}\right| \leq 0.1$$

Specimen geometry B

(epoxy resin)

Static Tensile Results: Acoustic emission

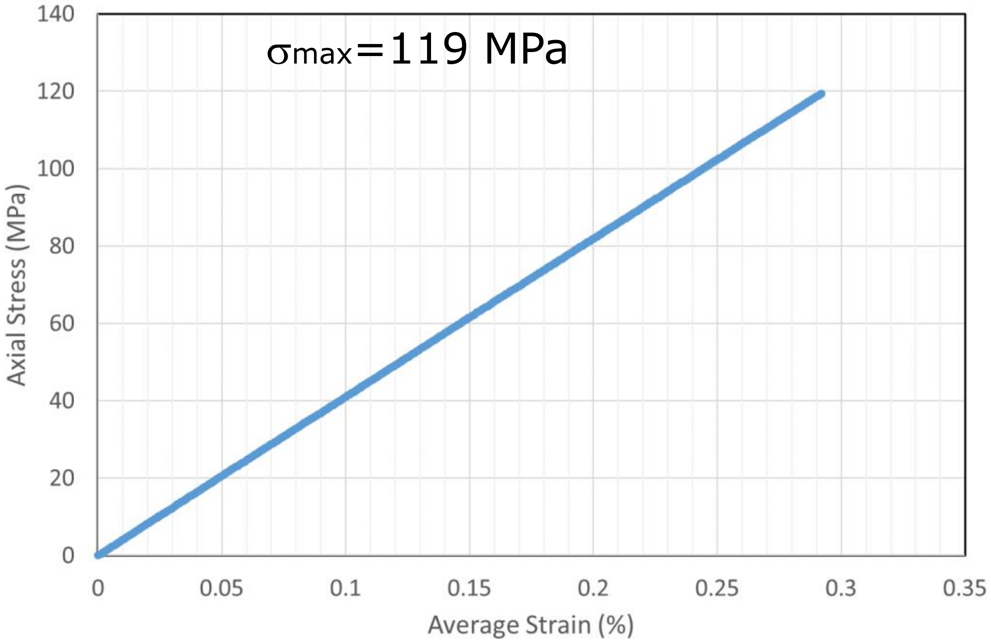


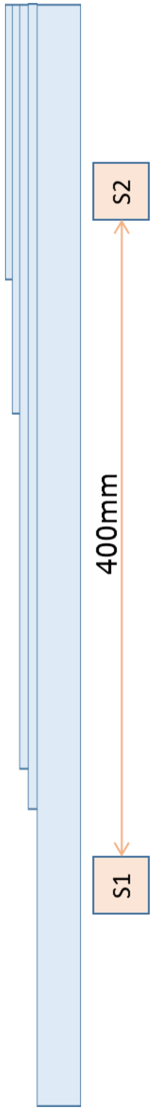


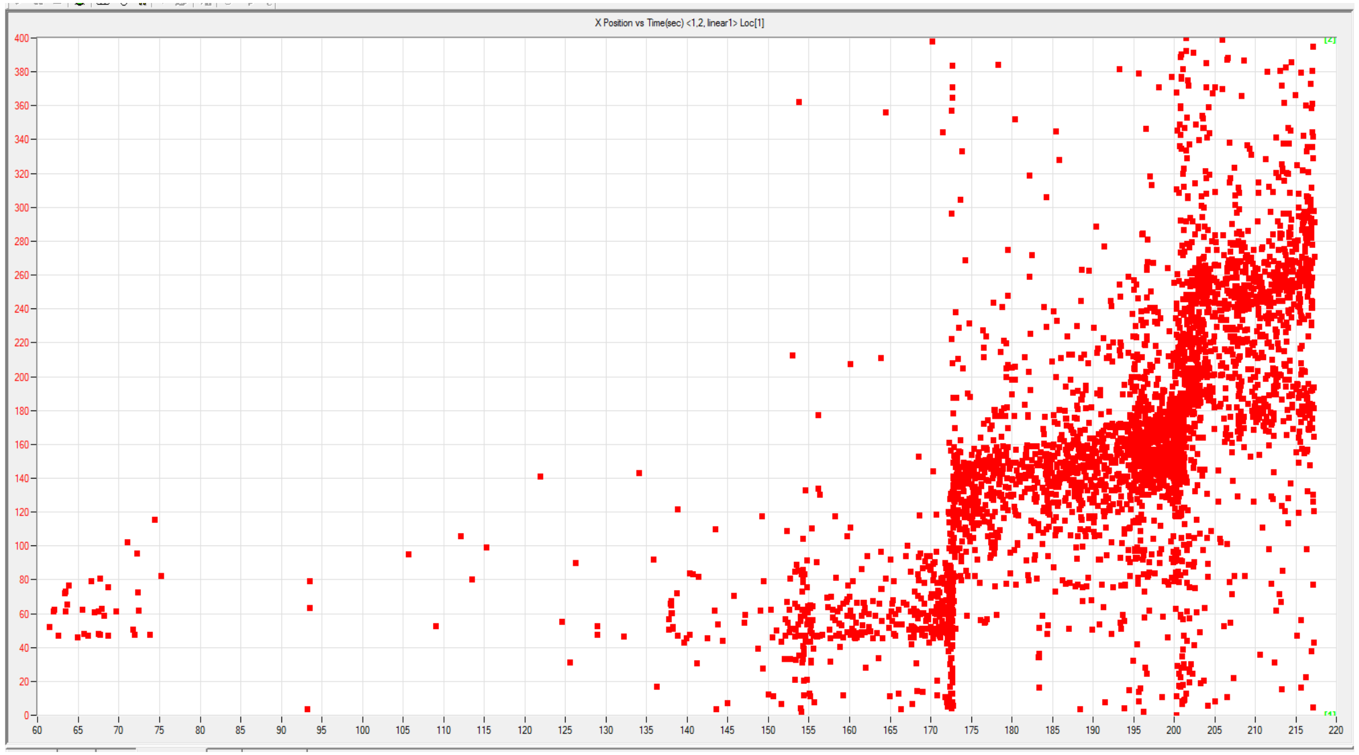
Specimen geometry A

(polyester resin)

Static Tensile Results: Acoustic emission





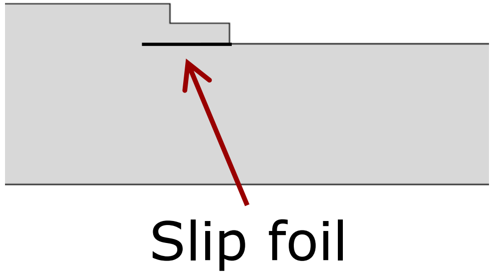


Test time (s) →

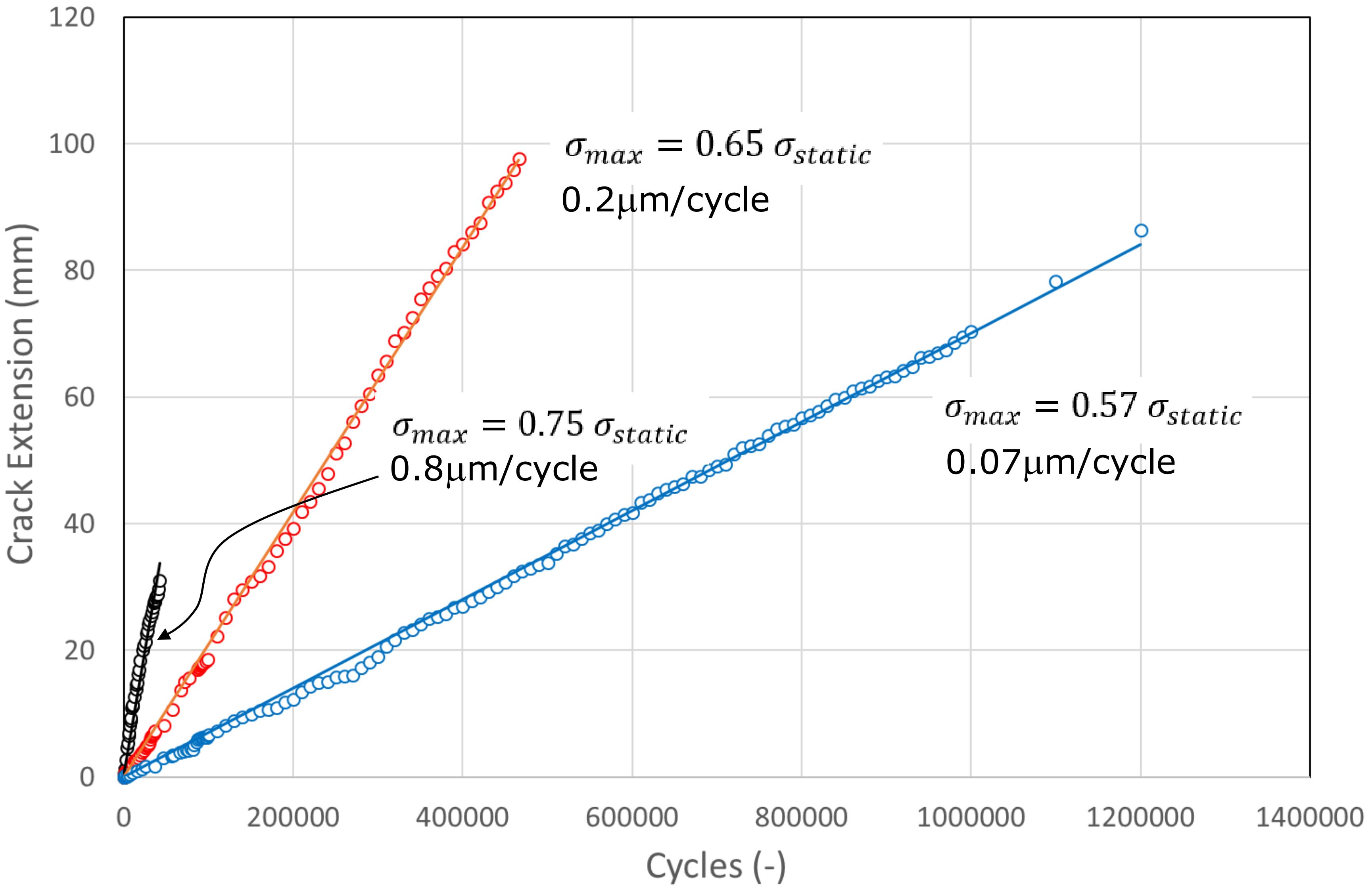
Specimen geometry A

(polyester resin)

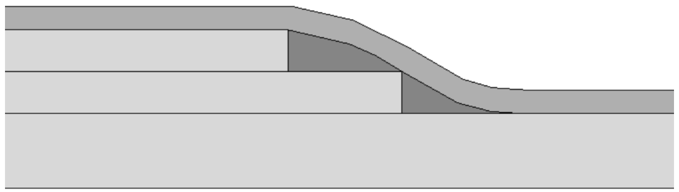
Tension-Tension Fatigue: Specimen geometry A – epoxy resin



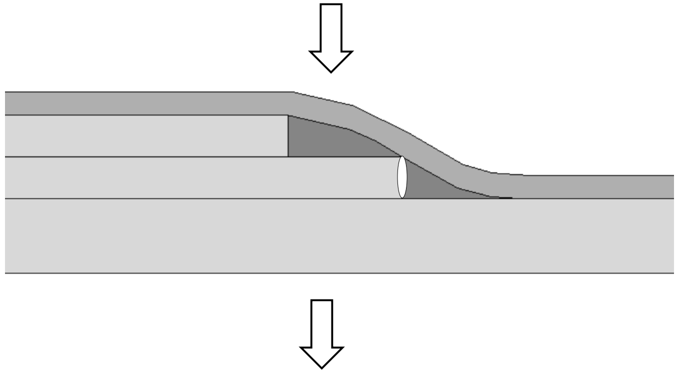
Tension-Tension Fatigue: Specimen geometry A – epoxy resin



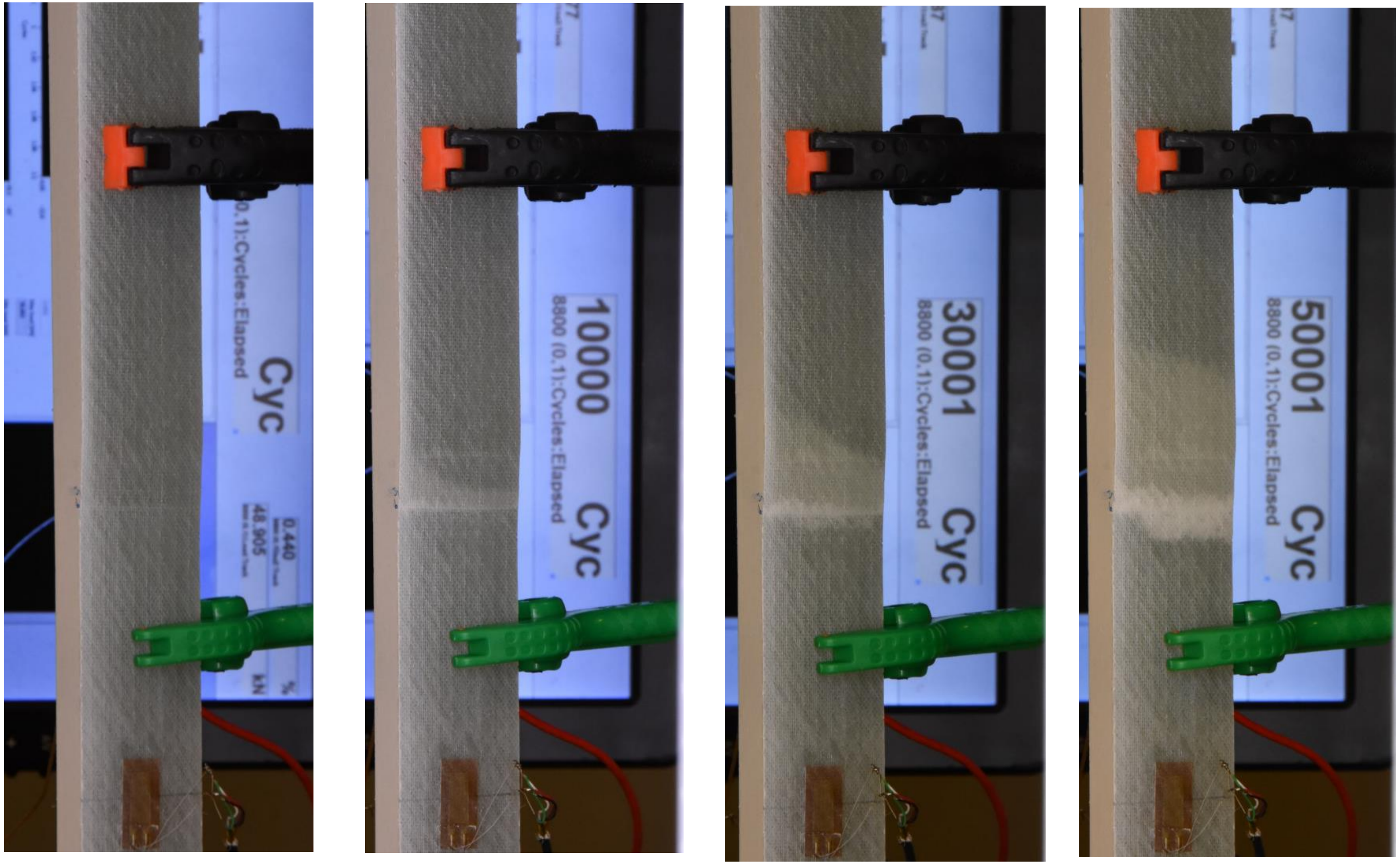
Tension-Tension Fatigue: Specimen geometry B – epoxy resin



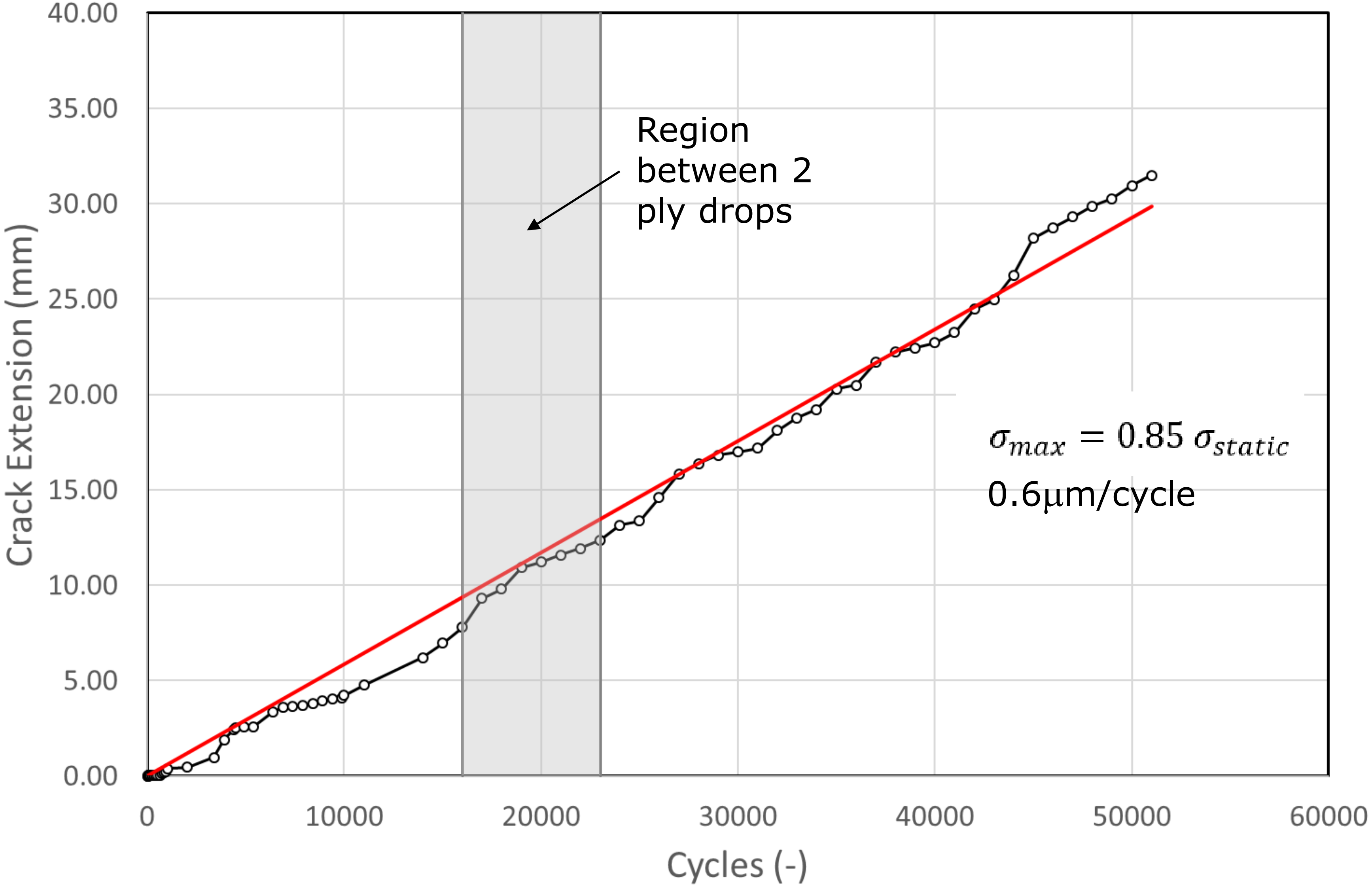
Static loading to form
a tunneling crack



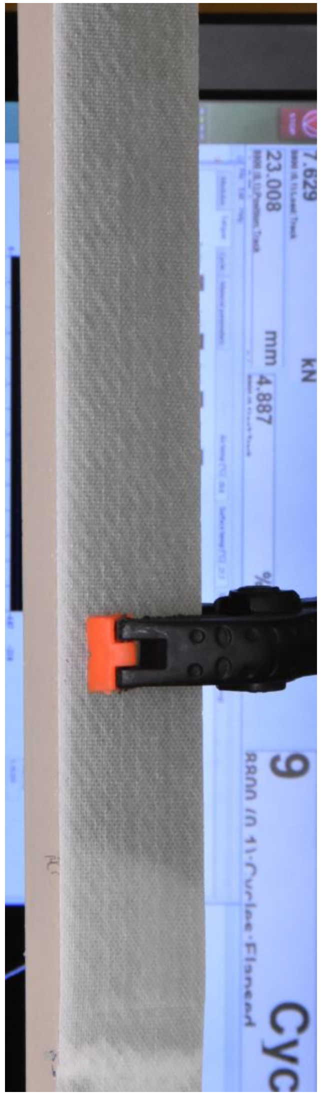
Fatigue loading

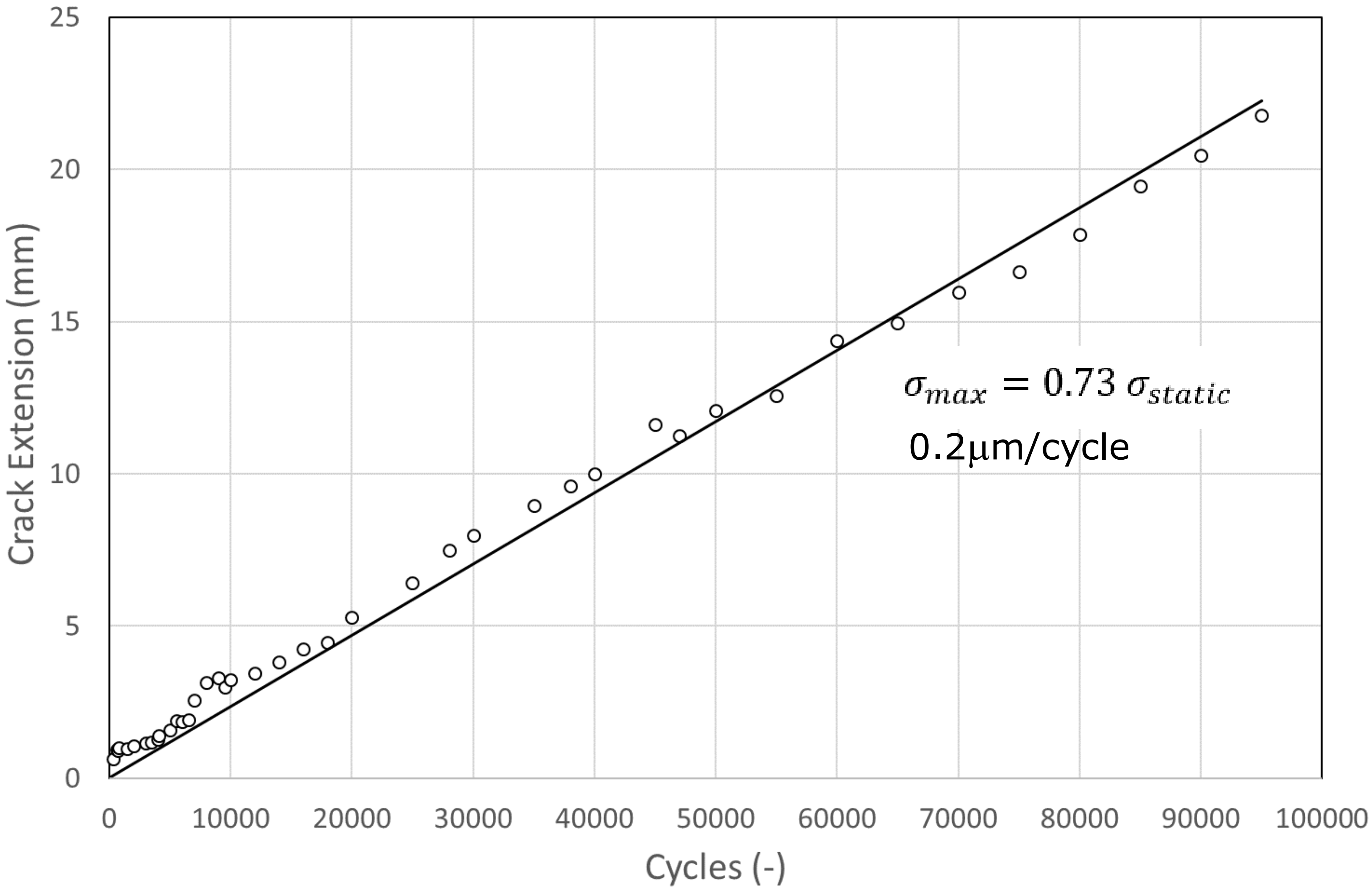


Tension-Tension Fatigue: Specimen geometry B – epoxy resin



Tension-Tension Fatigue: Specimen geometry B – epoxy resin





Conclusions & Future work:

- A test specimen is developed to measure fatigue crack (delamination) growth rates initiating from ply drops.
- FBG’s and AE sensors are included.
- Crack growth rate is measured through a series of optical images.

Future work:

- Experimental:

Use Acoustic Emission (AE) and FBG’s to locate the crack front and thus fatigue crack growth rate.
Use the optical images to quantify the accuracy of AE and FBG’s.

- Numerical:

Modelling of the tunneling crack: effect of ply-drop geometry on the critical energy release rate
Modelling of the delamination crack: effect of specimen geometry on the critical energy release rate

Thanks for your attention!

Any questions?