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# Compressive failure of unidirectional carbon fibre composites from bending tests

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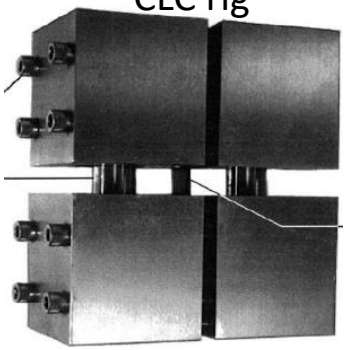
# Background

Compression Test Methods

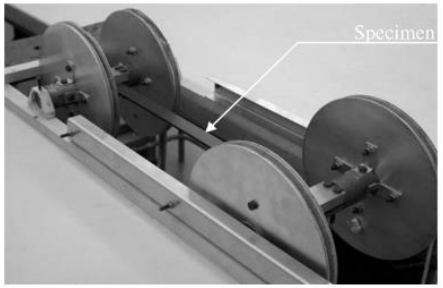
ICSTM rig

CLC rig

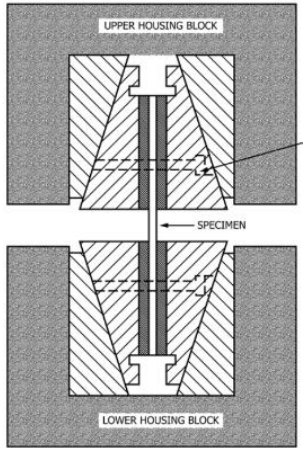


Four-point bending

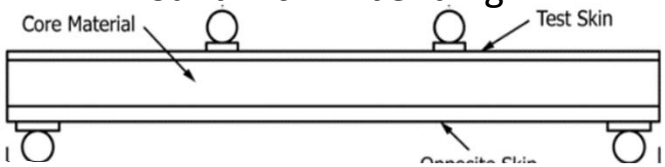
Buckling




Celanese

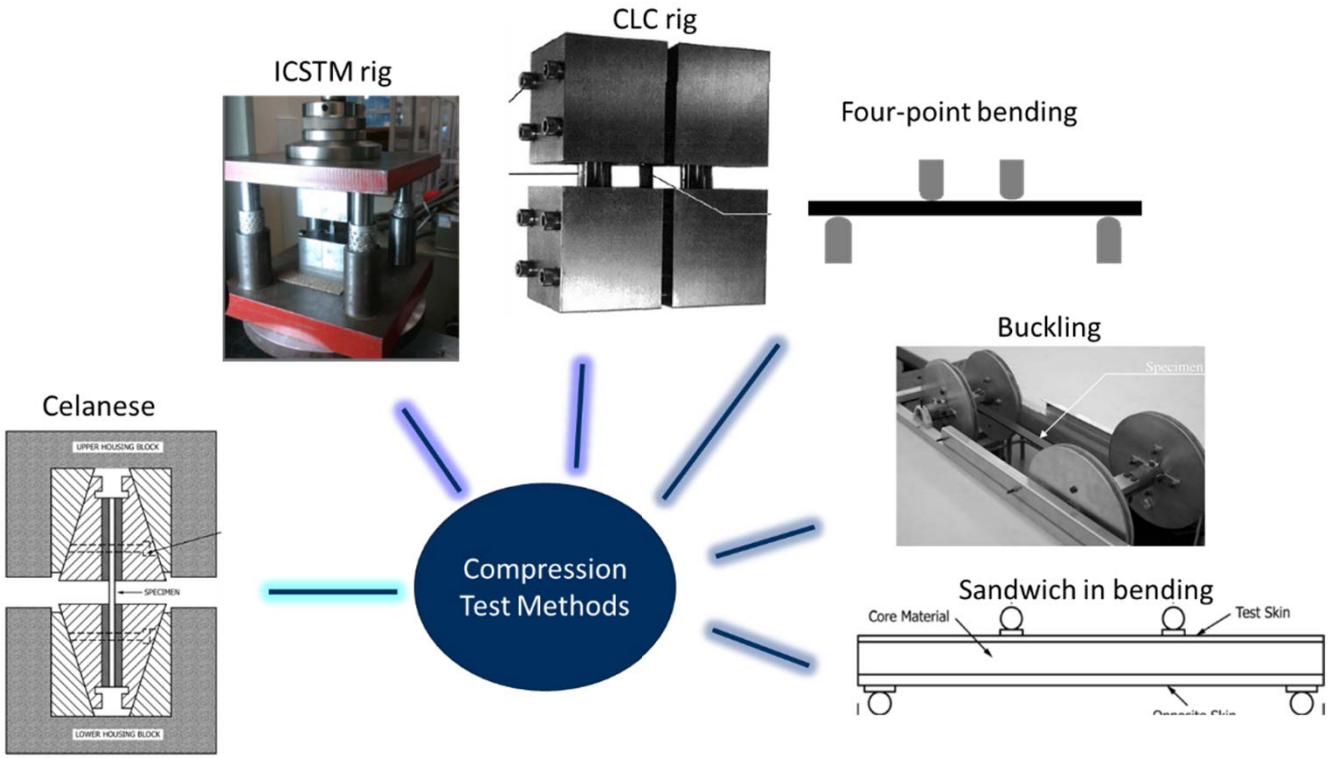



Sandwich in bending




Better test method, **higher strength** and **larger design allowable!**

# Background – flexural tests

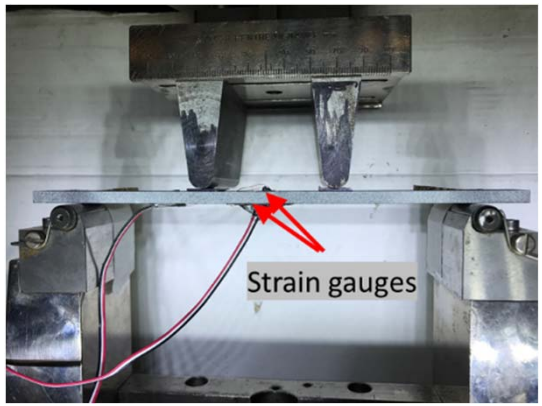



- ✓ Higher and more consistent compressive measurements.
- ✓ DO NOT require high precision and complex machining.

- × Premature failure under the loading noses
- × Strain gradient enhancement effect.
- × Size effect in bending is hard to quantify.

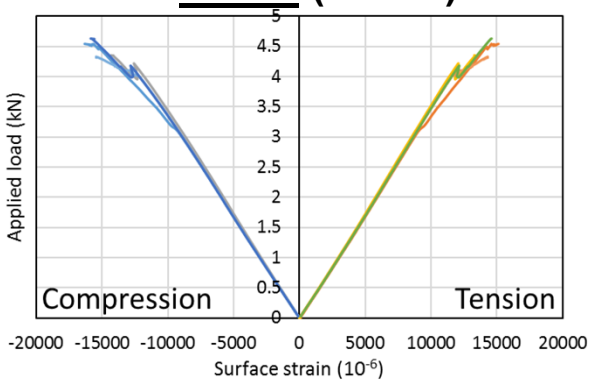
- **Challenge:** to understand and separate size and strain gradient effects and develop methods to get more reliable compressive strain allowable.

# Size effect of loading noses

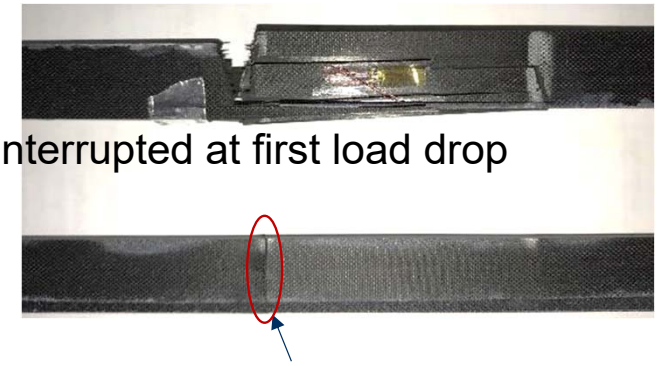



D = 10mm (ASTM)

Average compressive strain:
**1.19% (13.2%)**

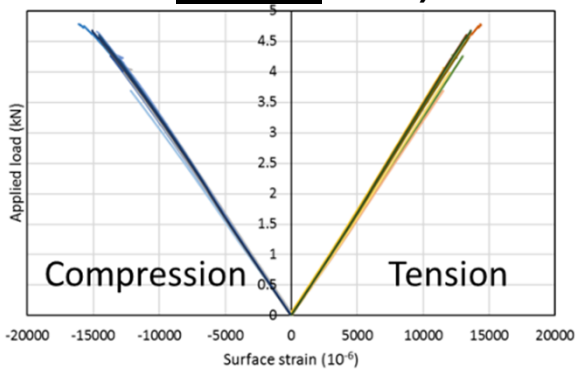



After ultimate failure




D = 25mm

Average compressive strain:
**1.41% (7.5%)**

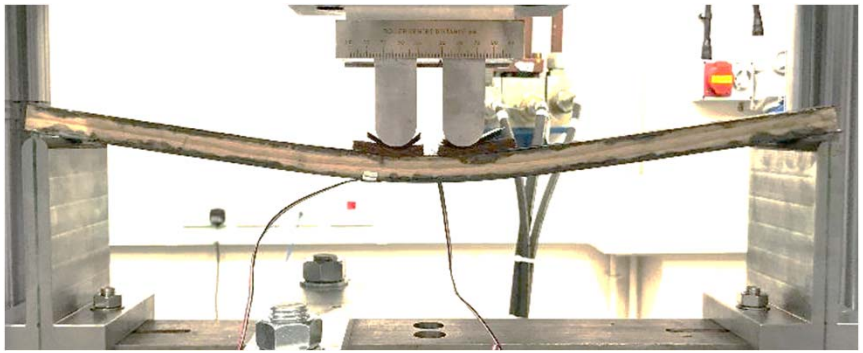


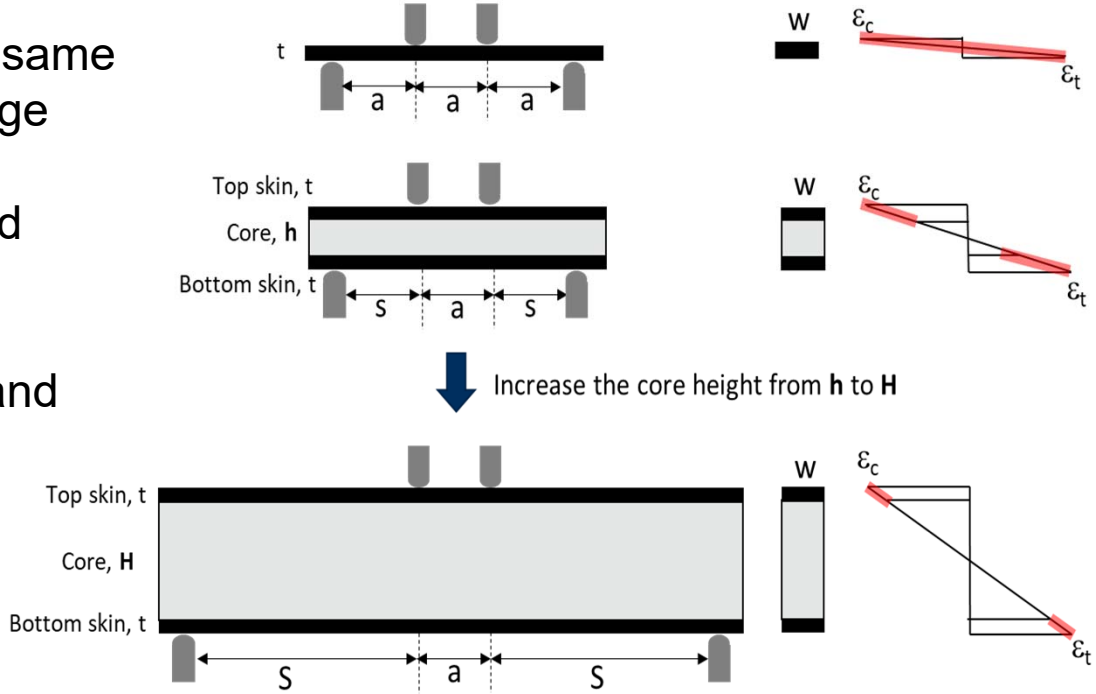


Conclusion: consistent gauge section failures and higher values in larger diameter rollers.

# Sandwich beam test

- Keep gauge section dimensions the same
- Keep the thickness of the carbon fibre skins the same
- Vary depth of the beam (6mm to 38mm) to change strain gradient
- Increase support span to maintain similar applied load.
- Larger roller diameter was used.
- Core material: Ash wood – high shear strength and easy to machine in different thicknesses

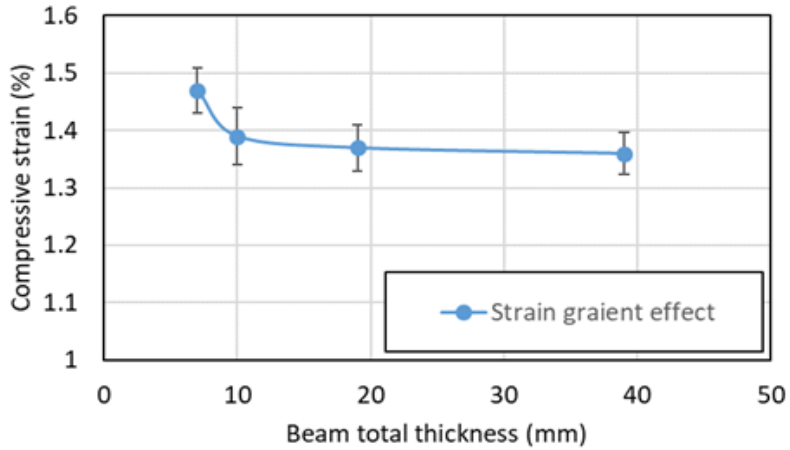


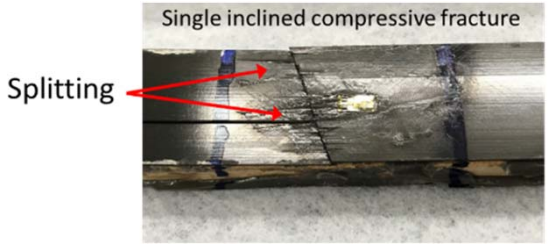


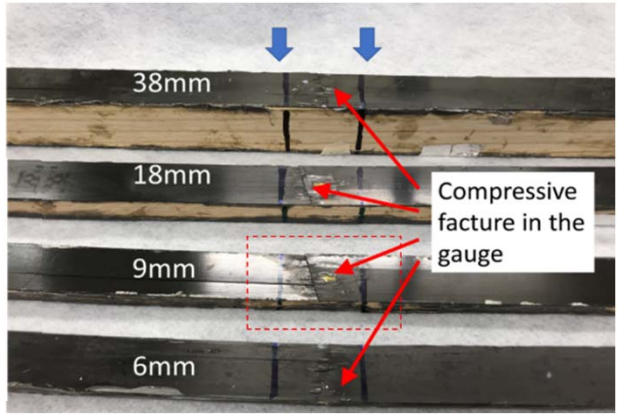
# Strain gradient effects

- The compressive strain to failure decreased with the increase of core depths of the carbon/wood sandwich beams.
- Little effect of strain gradient above 10mm thickness
- Low CVs were obtained.

Conclusion: carbon fibre-wood sandwich beam with a core depth larger than 20mm is recommend for compressive measurements.




| Testing methods | Compressive strain (%) |
|---|---|
| Combined Loading Compression [1] | 0.93 (9.7%) |
| Dog-bone compression [2] | 1.19 (2.8%) |
| Carbon/Wood sandwich [3] | 1.36 (2.7%) |

[1] Hussien A, Moehring M, Schwall C, Pipes RB. On compressive response of IM7/8552 lamina - A theoretical & experimental review. 2012
[2] Thomson D, Cui H, et al. A study on the longitudinal compression strength of fibre reinforced composites under uniaxial and off-axis loads using cross-ply laminate specimens, 2019.
[3] Wu X, Wisnom M. Compressive failure of unidirectional carbon fibre composites from bending tests, submitted, 2021