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Compressive Failure Strain of Unidirectional Carbon Fibre Composites from Bending Tests

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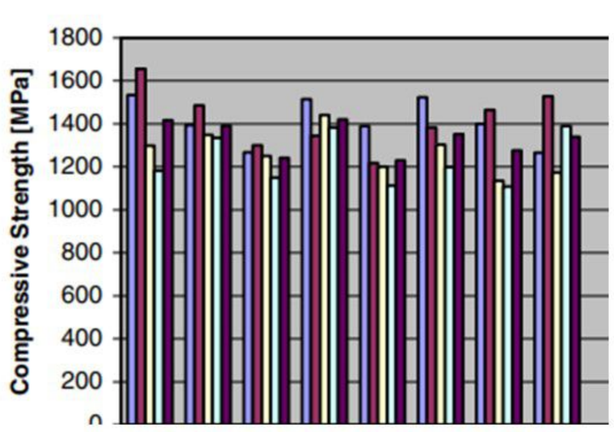
Compressive strength is a key limitation in the design of composite structures. It is difficult to measure and large variability is reported in standard compressive test methods. Indirect test methods such as bending or buckling usually give higher strength but the values may be affected by the strain gradient. Consequently, this research aims to develop a bending test method to obtain compressive strain with quantified strain gradient effect.

Background

Compressive properties:

- Key in composite design: open-hole compression, compression after impact and crashworthiness
- Underestimated values and large variability

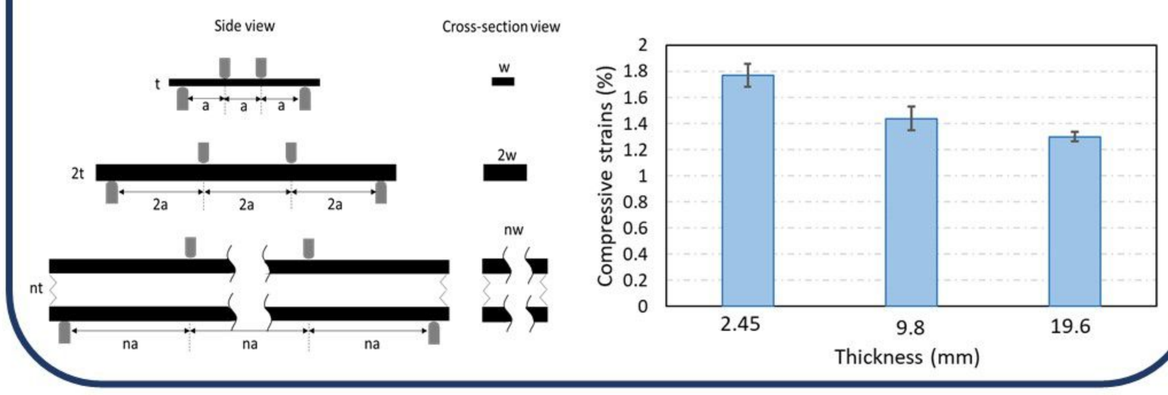
The challenge: *to develop a testing method to obtain the intrinsic material compressive strain with reduced variability due to testing.*



Round robin test: large variations were shown in compressive strength with the same material and testing method.
(K. Schneider, 2007)

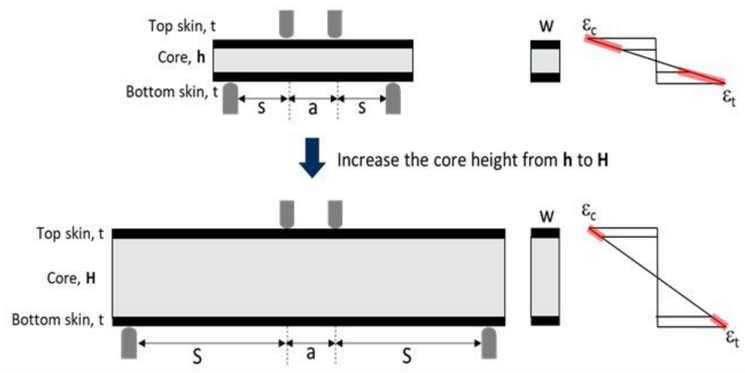
Scaled flexural tests

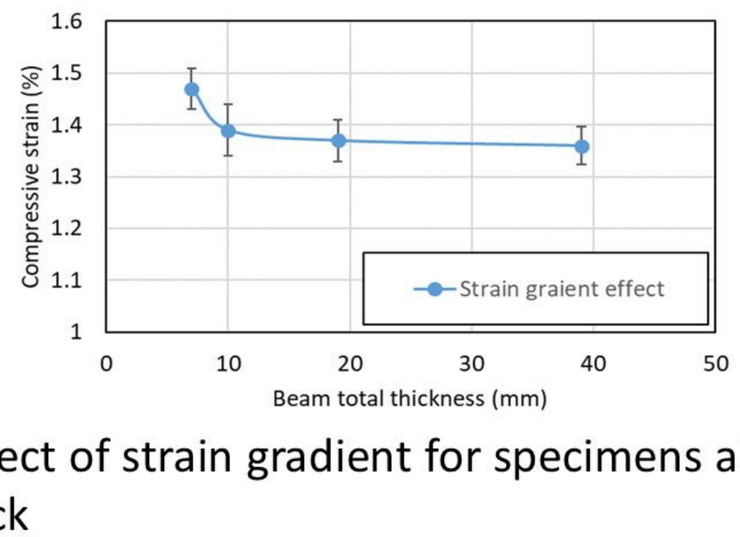
- Fully-scaled flexural tests on 2.45mm to 19.8mm thick specimens
- Premature failure at loading noses was eliminated using sufficiently large diameter roller.
- Compressive gauge section failure was obtained.
- Significant size effects were observed: 26% reduction in compressive strain from the smallest to the largest specimens.
- Strain gradient varies with different thicknesses.



Stain gradient effects

- Sandwich beams of varying depth with constant stressed volume were designed to determine strain gradient effects in bending tests.
- The design followed ASTM D5467.
- Ash wood and 0.5mm thick IM7/8552 material are used for the core and skins respectively.
- Gauge section dimensions are kept the same.





- Limited effect of strain gradient for specimens above 10 mm thick
- Measured compressive strain for IM7/8552 material is 1.36%, 14% higher than 1.19% in a modified direct compression test.
- Low degree of variability was observed.

Conclusions

- Bending tests gave high values and low variability in compressive strain measurements.
- Strain gradient was quantitively demonstrated in sandwich beam bending test.
- Strain gradient has shown limited effect for beams above 10mm, therefore the compressive strain measured in the thick beams can be representative of the intrinsic compressive strain of the material.