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Experimental investigation of NCF-on-tool contact

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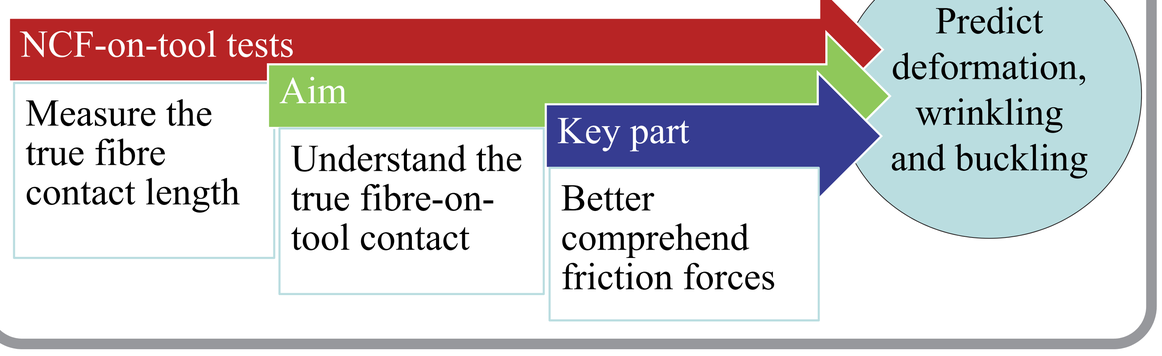
Introduction

- Non-crimp fabric (NCF) composites are reinforced with layers of straight (non-crimped) fibres held together by stitching.
- NCFs can offer good mechanical properties and fatigue performance, ease of handling and short process cycles in forming operations.
- The frictional behaviour of NCFs contacting the forming tool in composite pre-forming processes is poorly understood
- Improvements in understanding of friction can lead to better manufacturing process models for NCFs.

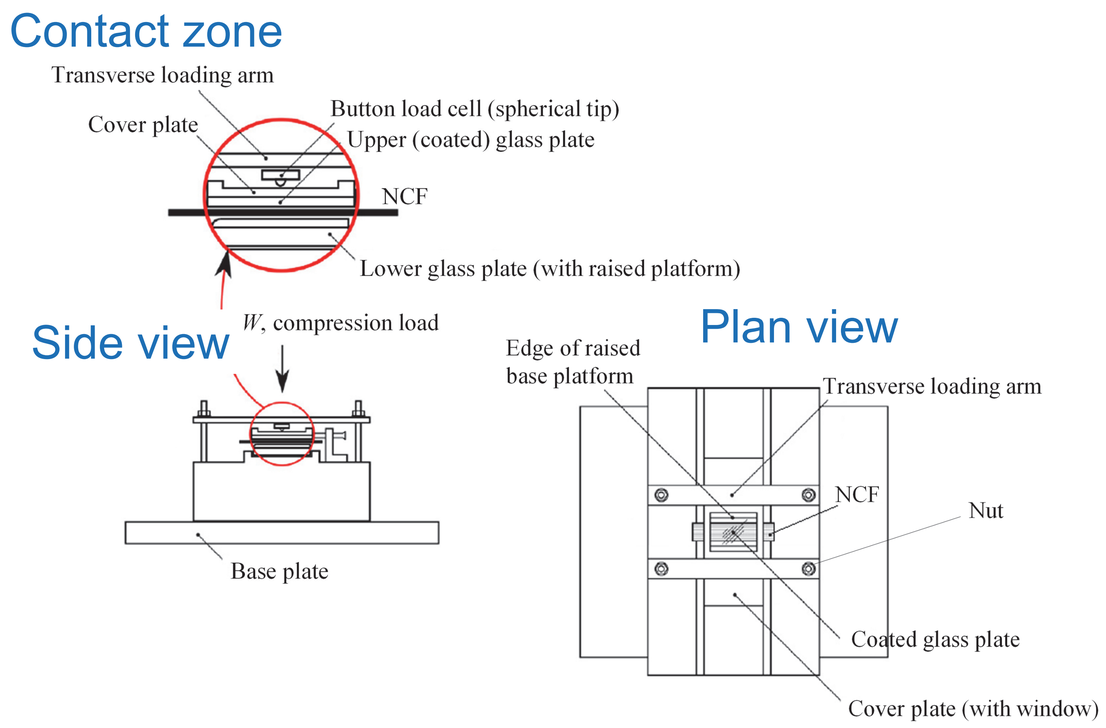
Aim



Experimental procedure

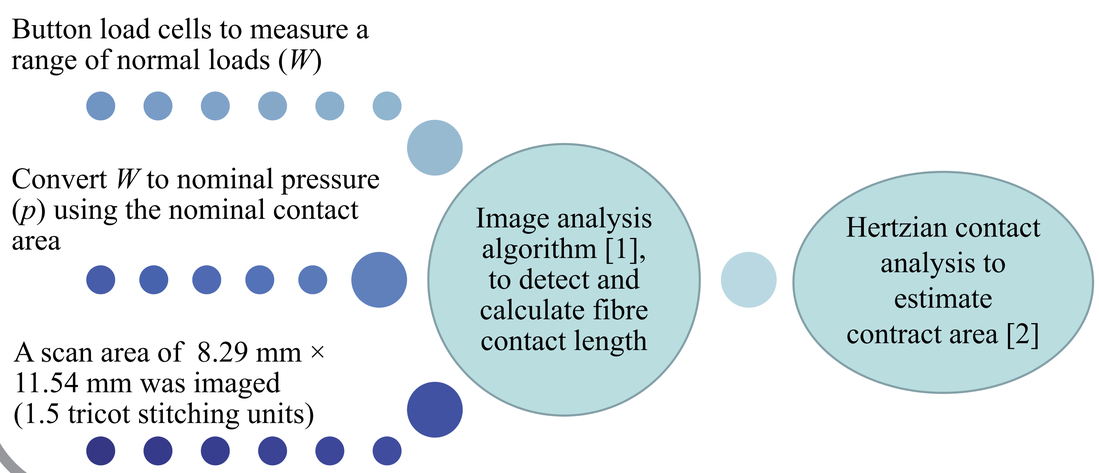
Method: fabric is compressed by a glass slide while under a microscope, allowing visualization of the true contact area between the fabric and the flat tool surface.

- ✓ A special semi-reflective coating was used on the glass plate [1].
- ✓ Enhances the contrast of the contacting fibres.



Material: biaxial -45°/+45° carbon NCF, 12K tows, 300 gsm, tricot stitched.

Experimental tests: a layer of NCF was clamped between a platform and the glass plate. Five tests were carried out (14 load steps).



Results

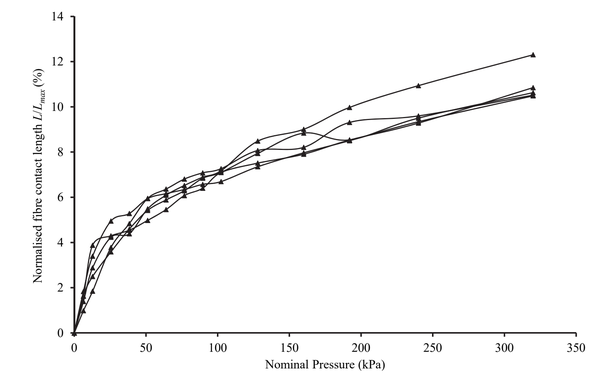
True **fibre contact** length (L) **increases** with nominal **normal pressure** (p).

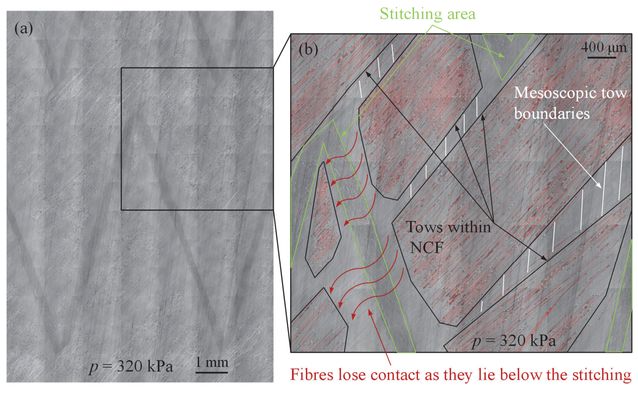
True contact length is given as a percentage of the **idealised contact length** (L_{max}) associated with the limiting case when all the **fibres** contacting the tool are **parallel and touching each other.**

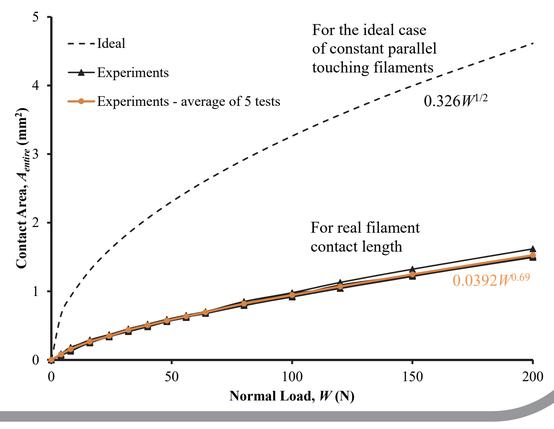
There is only a **very small true contact area**.

Contact-free areas are developed **around the stitching** of the NCF layers and **between the tows**.

Hertzian contact analysis used to estimate the true fibre contact area. A power-law fit to the data was found with exponent n = 0.69 and factor k = 0.0392.







Conclusions

An experimental investigation **to measure true NCF-on-tool fibre contact length** over a range of normal loads has been presented.

- The average contact length, expressed as a percentage of the idealised contact length, varied from 1.5% at 6.4 kPa to 11% at 320 kPa.
- In other words, only a small number of fibres are in contact at typical forming pressures
- The presence of stitching in NCFs reduces the true contact length of the fibres within the fabric for 67% comparing to tow-on-tool tests [2].

Acknowledgements

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References

[1] Smerdova, O, Sutcliffe, MPF. Novel experimental method for microscale contact analysis in composite fabric forming, Experimental Mechanics, 55(8), 2015, pp. 1475-1483.

[2] Mulvihill, D.M., Smerdova, O., Sutcliffe, M.P.F. Friction of carbon fibre tows, *Composites: Part A: Applied Science and Manufacturing,* 2016.