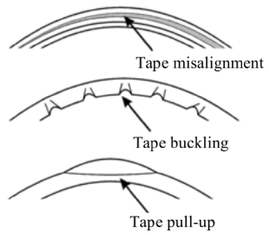
TOW STEERING OF STRETCHABLE T*u*FF THERMOPLASTIC TAPE WITH LASER TAPE PLACEMENT

Lukas Fuessel, (Ph.D.M.E.)[2], Dr. Thomas A. Cender[1], Prof. John W. Gillespie, Jr.[1,2] , Dr. Dirk Heider[1]
University of Delaware | Center for Composite Materials[1] | Department of Mechanical Engineering[2]

Introduction

Steering of fiber tows using the Automated Fiber Placement process has been shown to increase the versatility of composites design for highly tailored Variable Angle Tow (VAT) laminate structures.

Manufacturability is limited to the minimum steering radius which can be placed without defects. A recently developed, highly aligned, short fiber material called Tailored universal Feedstock for Forming (T*u*FF) allows forming of complex geometries due to its 40 % elongation capability. Utilizing the stretchability of T*u*FF it is possible to counter act stresses that develop during steering and minimize defects that develop during steering

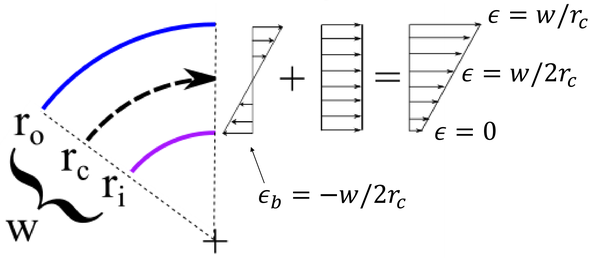


Equipment settings & Materials

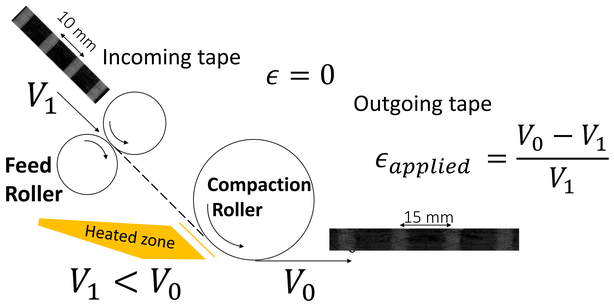
- Experiments were performed on a commercial single tow fiber placement system by Mikrosam.
- All experiments were executed with the same process conditions: 450C Set point temperature, 15mm/s layup speed and 900N on a ½ in roller. The tape width was ¼ in.
- Thermoplastic polymer matrices were used to produce a prepreg fiber volume fraction ranging from 50-57%. The prepreg was made with 120 gsm fiber areal weight using a film infusion process.

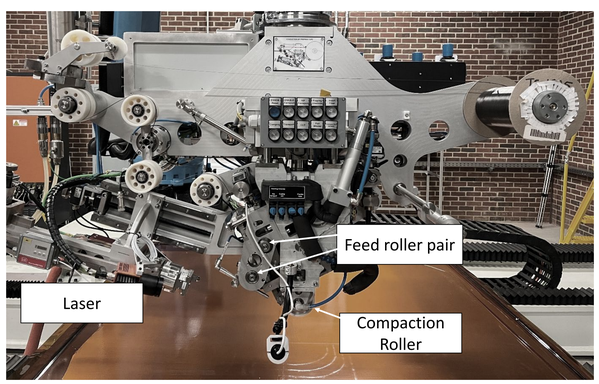
Methods

The compressive strains that develop during steering can be approximated with by pure bending around a given radius. Which is shown in the figure below:



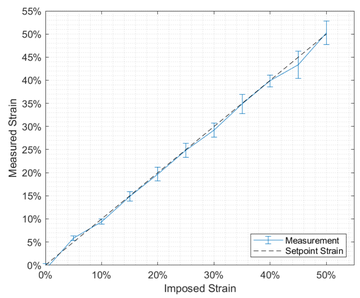
The conservative approach would be to off set the total compression force with a constant strain. In order to do so the a differential speed is applied between compaction and Feed roller. This was done programmatically using a MATLAB script which modified the feed speed.

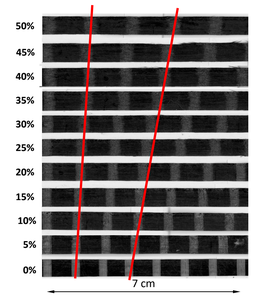




Straight Strain Accuracy

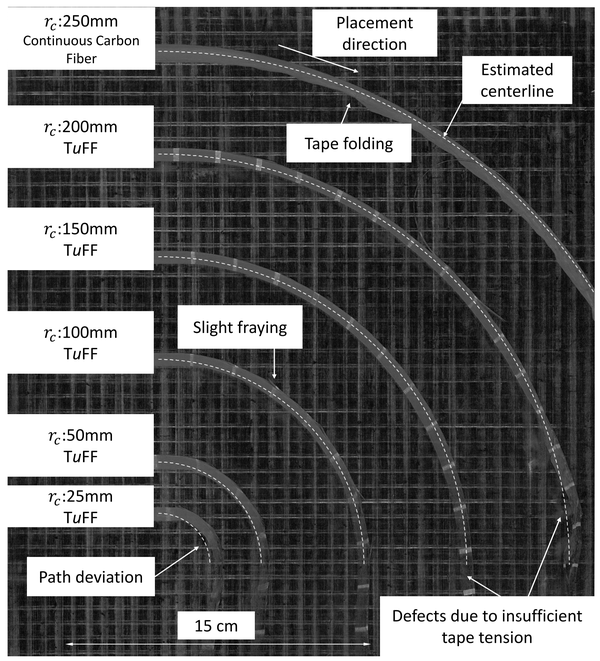
In order to test the accuracy of the strain that can be imparted straight trials where performed. 18in long strips of material were marked with lines with a distance of 10mm. The length change was measured after the process and as sown in the figure below the results agree well with the expected results.





Steering Trials

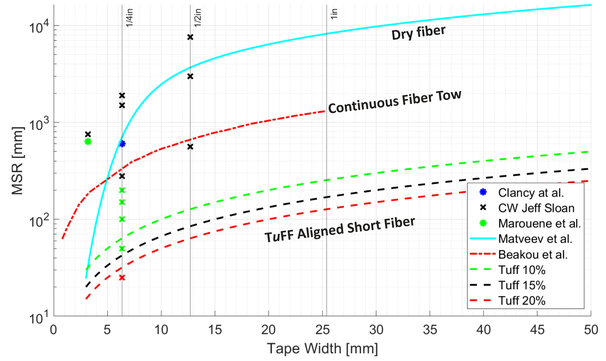
In a next step a steering experiment was performed where T*u*FF tape with decreasing radii were place. The figure below shows a high-resolution document scan of the experiment.



The stretch-steered T*u*FF tapes were visually inspected and show no wrinkling. While placing very small radii path misalignment was visible but over all the minimal exactable steering radius was around 100 mm.

Conclusion

This study demonstrates that ¼ in T*u*FF tapes can be stretch-steered on a minimal radius of 100mm which is one order of magnitude smaller than continues fiber tape. This could lead highly optimized structures due to the larger design freedom.



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Acknowledgements

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