MODELLING THE DISTORTIONS OF SKEWED WOVEN FABRIC REINFORCED COMPOSITES

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Introduction

Woven textile structures are often used as reinforcements in composite materials. Their ease of handling, low fabrication cost, good stability, balanced properties, and excellent formability make the use of fabrics attractive for structural applications in, for example, the automotive and aerospace industry.
However, due to the process of draping, the fibre orientation varies over the product (skew). During production, the resulting inhomogeneous properties will lead to internal stresses, which lead to product distortions such as shrinkage and warpage.

Objective

The objective is to develop a model to predict the inplane thermo-elastic properties of skewed woven fabric composites in order to predict the product distortions.

Experiments

Experiments were performed with single layer laminates of unbalanced Satin 5H fabric reinforced composites. The matrix material was Poly Phenylene Sulfide while the fabric consisted of carbon fibres. Due to thermal stresses induced during production, the laminates show curvatures which were measured immediately after production.

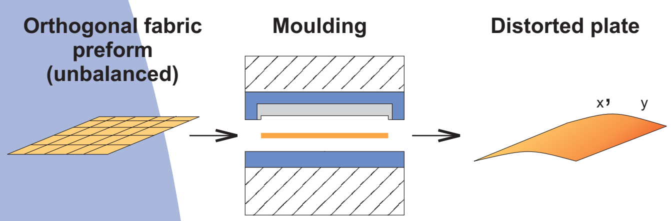

Figure 1: Curvatures of orthogonal fabric plate after production

The laminates were skewed to different angles up to the locking angle, introducing a twisting curvature in the moulded laminates.

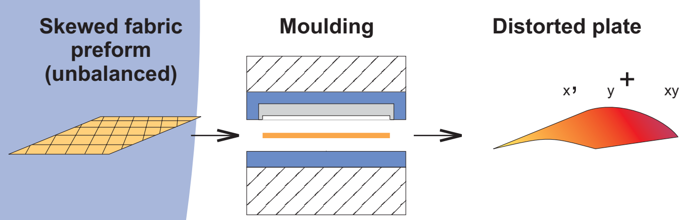

Figure 2: Curvatures of skewed fabric plate after production

Modelling

In the geometrical structure of the weave, repetitive units can be determined. Using geometrical shape functions, the yarn and the matrix regions are separated, similarly to the work of Akkerman and De Vries (1). From the geometrical description and the properties of the constituents, an upper and lower bound for the thermo-elastic properties are determined, respectively called *PP-* and *SS-model* (2).

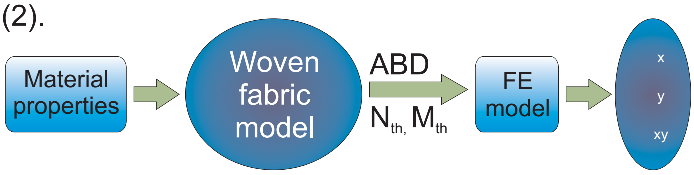

Figure 3: Modelling the curvatures of the plates

Results

In Figure 4, the results from the modelled and the experimental determined curvatures are depicted. The results agree well.

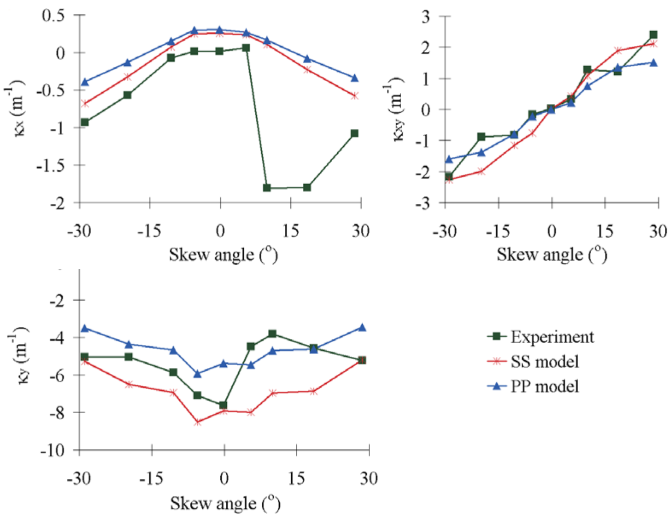

Figure 4. Modelled vs. experimental curvatures

Conclusion

A model was developed to predict the inplane thermo-elastic properties of skewed woven fabric composites. Curvatures were modelled and compared with experiments. The model gives quantitatively good predictions of the properties of skewed satin 5H weave.

References

1. Akkerman R., De Vries R., in: Gibson, A. (editor), *International Conference on Fibre Reinforced Composites* FRC'98, 422-433 (1998).
2. Lamers E.A.D., Wijskamp S., Akkerman R., *Proceedings of ECCM9* (2000).