MODELLING THE DISTORTIONS OF SKEWED WOVEN FABRIC REINFORCED COMPOSITES

E.A.D. Lamers, S. Wijskamp, R. Akkerman
University of Twente
Department of Mechanical Engineering, Composites Group
P.O. Box 217, 7500 AE, Enshede, the Netherlands
phone: +31 53 4892426, email: e.a.d.lamers@wb.utwente.nl

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. During production, the resulting inhomogeneous properties will lead to internal stresses, which lead to product distortions such as shrinkage and warpage.

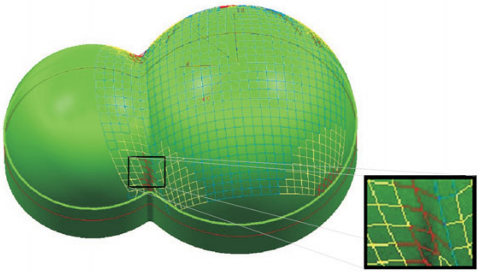

Figure 1. Resulting skew angle after production

Objective

In order to predict the product distortions, the thermo-elastic properties of the composite must be known. The objective is to develop a model to predict the inplane thermo-elastic properties of skewed woven fabric composites.

Modelling

In the geometrical structure of the weave, repetitive units (unit cells) can be determined. In these unit cells, basic elements are determined. In figure 2, the unit cell and basic elements of Satin 5H weave are shown.

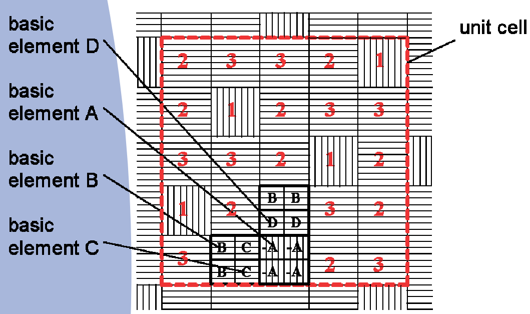

Figure 2: Unit cell and basic elements of Satin 5H weave.

In these basic elements, geometrical shape functions separate the yarn and matrix regions, similarly to the work of Akkerman and De Vries (1). From the geometrical description an upper and lower bound for the thermo-elastic properties are determined, respectively called *PP-* and *SS-model*.

Experiments

Experiments were performed on single layer laminates of satin 5H fabric reinforced thermoplastic composites. The fabric weave consisted of carbon fibres. The laminates were skewed to different angles up to the locking angle. After production the resulting curvatures of these laminates were measured.

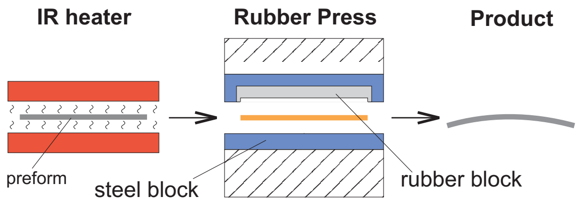

Figure 3: Curvature of Satin 5H fabric after production

Results

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

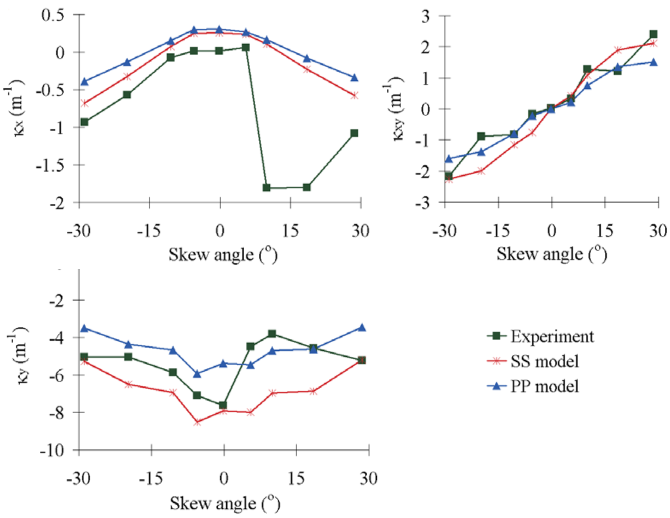

Figure 4. Comparison of modelled and experimental curvatures

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)