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MANUFACTURE OF A ROTOR BLADE PITCH HORN USING BINDER YARN FABRICS

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SUMMARY

The use of binder yarn fabrics in rotor blade applications is investigated in this work. A preforming procedure is incorporated in manufacturing, resulting in higher degree of automation and a reduction of process steps. The performance of the process is evaluated with respect to cost savings compared to prepregging technologies.

Keywords: Binder yarn, preforming, cost modelling, binder activation, rotor blade

EXTENDED ABSTRACT

The work presented here is part of the European FP7 project PreCarBi (Materials, process and CAE tools developments for pre-impregnated carbon binder yarn perform composites). The overall project aim is the development of new materials and technologies that bring together prepreg and liquid moulding technologies and combine cost effectiveness with high quality via the use of binder yarn fabrics. The present paper focuses on the applicability of binder yarn technologies in the context of the manufacturing of a rotor blade pitch horn.

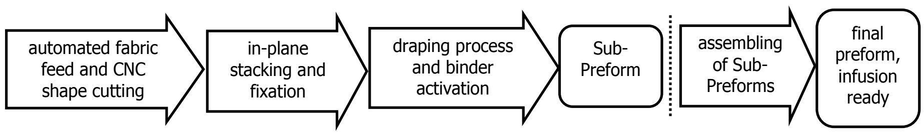

Figure 1 Preforming process chain

The layer sequence and the manufacturing process of the pitch horn was adapted to enable the application of automated preforming process elements and to reduce the number of process steps, as illustrated in Fig. 1. In the proposed process net shaped tailored reinforcements are produced with an in-line lay-up module, a 2D stitching operation and CNC cutting. A novel concept was developed for the combination of final assembly of sub-preforms and infusion in a single step.

Cost analysis and drape modelling were used to design and optimise the process. Cost analysis is based on the principles of Activity Based Costing [1], and is fully parametric with respect to process parameters. Cost Estimation Relationships are developed for all sub-processes using industrial cost and process data. The analysis is used to identify the most costly and time consuming sub-processes, which form the basic target of process optimisation studies. Drape modelling is utilised to minimise shear in the fabric. The distribution of shear angles when the multi-layer reinforcement is draped on the complex, rotation-symmetric tool is computed using the kinematic code PAM-QUIKFORM and different draping scenarios are evaluated.

Preforming involves an activation step which allows binder yarns to be repeatedly shaped prior to resin infusion [2]. A variety of activation techniques, including contact heating, ultrasonication and laser heating, were investigated experimentally. Double lap shear tests were used to evaluate the binder adhesion strength after activation. Fig. 2 illustrates the dependence of adhesion strength on activation temperature for a 0/0 and a 0/90 interface.

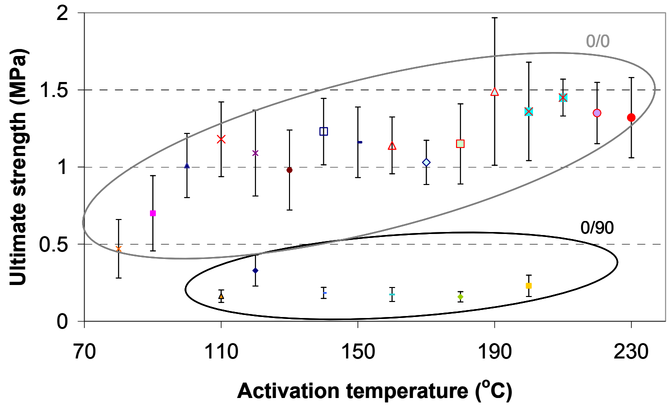

Figure 2 Dependence of adhesion strength on activation temperature; error bars correspond to one standard deviation.

Initial results have indicated a significant reduction in cost can be achieved using the new process. Additional benefits related to gains in performance as a result of reduced fibre misalignment and waviness after activation are currently investigated.

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