CONSOLIDATION OF FILAMENT WOUND LAMINATES: MODELLING APPROACHES

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ABSTRACT

The filament winding process is a manufacturing technique in which a resin-impregnated continuous filament (or tape) tow is wound over a rotating mandrel. The synchronized movement of both the mandrel and the delivery head accomplishes the precise positioning of the fibres on the mandrel surface, leading to the desired geometric pattern. The ability to control the process variables may allow improvements in the process optimization and the quality of the wound parts.

Over the last two decades, only a limited number of process models have been developed specifically for the filament winding process [1-4]. The majority of the approaches model the physical phenomena taking place at the layer/laminate level in a similar way. In particular, the consolidation pressure model due to initial fibre tension, the resin radial velocity model and the resin cure model are very similar. Thus, the main differences appear in the modelling strategy for the fibre motion, the fibre bed compaction, the thermo-chemical effects and the stress-strain constitutive relation. Moreover, the assembly of the various models, the iterative calculus sequence and the implementation in finite element codes have also been differently conducted.

In this work, a global process model is developed for the filament winding process. Firstly, analytical descriptions of the physical and thermo-chemical phenomena were developed for each phenomena based on well established models. Then a numerical algorithm was devised and numerically implemented in a commercial finite element software.

The critical analysis of the previous models as well as the description of the assembly strategy for the overall framework is carried out in this paper. In particular, the phenomena taken into account, the input and output variables, the sequence of the numerical algorithm and the range of applicability of the different modelling approaches for the filament winding process are discussed in detail.

References

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