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THERMAL AND MECHANICAL MODELING OF THERMOPLASTIC COMPOSITES DURING FORMING PROCESS

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Summary: CFRTP (Continuous Fibre Reinforcements and Thermoplastic Resin) composites are widely used in the aerospace industry because of its excellent mechanical properties, impact resistance and fatigue strength over its low density. Thermoplastic composites have many advantages over thermosets: a thermoforming cycle shorter than autoclave composite manufacturing, a higher impact resistance and the possibility to recycle the material. All these makes thermoplastic composites an appropriate material for mass production of high quality structures. In recent years, the automotive industry is increasingly interested in thermoplastic composites materials and in particular in two forming techniques: thermoforming and stamping of CFRTP. Both techniques can be easily automated and are based on the same technology that shaping metal sheets. The forming cycle consists of 4 phases in the case of thermoforming and 5 in the case of stamping: heating, transport (Stamping case), forming, consolidation and finally demolding and cooling phase.
Modeling and numerical simulation of these processes is an important step in order to predict the final structure geometry and its mechanical properties which are mainly due to the position of the fiber reinforcements in final configuration. Forming simulation allows to determine the feasibility conditions of the structure and optimize the process. For this presentation we propose a new nonlinear visco-hyperelastic model for the simulation of thermoforming and stamping of CFRTP. The thermal dependence of the mechanical behaviour of the CFRTP is taken into account for this modelling.