DESIGN METHOD FOR 3D PRINTED CARBON REINFORCED COMPONENTS FOR AEROSPACE APPLICATION

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Recent developments in the field of plastic additive manufacturing have seen the introduction of carbon fibres in printed products. These fibres improve the strength and stiffness of thermoplastic-based components. Two approaches are currently seen: very short fibres embedded in the printing filament and continuous fibres. Adding fibres improves strength and stiffness and it could be used to optimize parts and reduce weight, which is important for aerospace applications. However the current design approaches currently use a trial and error process in order to determine the fibre content in the parts. In addition to this, technical limitations in the printing process itself limit the design possibilities. More efficient and flexible approaches are needed to exploit fully the potential of continuous fibre 3D printing.

A design method developed for the continuous fibre reinforced 3D printing based on a finite element approach is presented here. The method can predict the mechanical behaviour of the material and of the printed components at the varying of parameters such as fibre type, geometry and filling. The proposed method can further be used to predict the residual stresses induced by temperature changes during manufacturing. By evaluating these thermal effects the risk of failures during the printing can be reduced.

To verify the proposed method, a demonstrator has been redesigned for manufacturing using continuous CFRP 3D print technology. The redesign has been influenced by limitations of the printing process itself, making not possible to achieve an optimal design. Nonetheless the resulting redesign has been analysed, manufactured and tested for this research. The design has been based on the test data from coupons. The coupon test data show good stiffness and strength values in tension, in a range comparable with aluminium; while the compression strength results significantly lower. Good correlation between finite element analyses and testing is observed, which verifies the modelling approach.

With the presented approach, 3D printing with continuous carbon fibres can move from the trial and error approach currently used to a first time right approach. This will enable further optimization of the component design and of the manufacturing process parameters, provided that technological limitations of the printing process itself can be overcome. Overcoming these design and technology limitations is essential for applying CFRP 3D print technology to the aerospace industry, for repairs or critical load-carrying parts.

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