The 8th European Congress on Computational Methods in Applied Sciences and Engineering
ECCOMAS Congress 2022
5-9 June 2022, Oslo, Norway

Data-driven analysis of failure mechanisms in FDM printed parts

Joris J.C. Remmers[1], Sifra Kramer[1], Luc H.A. van de Plas[1] and Hans H. Gommans[2]

[1] Eindhoven University of Technology, PO Box 513, 5600 MB, Eindhoven, The Netherlands, J.J.C.Remmers@tue.nl, www.tue.nl

[2] Signify, High Tech Campus 48, 5656 AE Eindhoven, The Netherlands, www.signify.com

Keywords: *Thermo-Mechanical Analysis, Additive Manufacturing, Data-driven analysis, Thermo-viscoelastic material*

Fused deposition modelling (FDM) is an additive manufacturing technique in which a product is printed by pushing a wire (filament) of thermoplastic polymer through a hot extruder. FDM is used for both prototyping as well as for the production of parts [1]. Currently, a wide range of materials is available, such as acrylonitrile butadiene styrene (ABS) and polycarbonate (PC) as well as filaments with metal particles or carbon fibres in order to print metallic and fibre reinforced structures.

The quality of the printed product can be controlled by various process parameters such as the nozzle and build chamber temperatures, the printing speed and the thickness of the printed layers. A mismatch can result in large residual stresses and deformations and even poor adhesion of layers with delamination as a result.

In order to study the quality of the printed products in relation to the print process settings, a fully coupled thermo-mechanical finite element model has been developed [2]. In this model, the deposition of the material is simulated by the addition of new elements under stress-free conditions. The material property evolution is governed by a thermo-viscoelastic constitutive relation [3]. Apart from the complete thermal history of the material, the evolution of residual stresses and deformations can be studied.

In order to predict the onset of delamination of subsequent layers for a given set of process parameters, a hybrid data-driven / physics based modelling approach will be followed, where the numerical results are coupled to experimental data. In this presentation, we will reflect on the accuracy as well as the computational efficiency of this approach.

REFERENCES

[1] O.A. Mohamed, S.H. Masood, and J.L. Bhowmik *Advances in Manufacturing* **3**, 42–53, 2015.

[2] S. Westbeek, J.J.C. Remmers, J.A.W. van Dommelen and M.G.D. Geers, *Computational Materials Science* **180**, 109647, 2020.

[3] M. Domingo-Espin, J.M. Puigoriol-Forcada, A.A. Garcia-Granada, J. Llumá, S. Borros, and G. Reyes, *Materials and Design* **83**, 670–677, 2015.