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Simulation of the Visco-Elasto-Plastic Deformation Behaviour of Short Glass Fibre Reinforced Polyphthalamides

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Abstract : The importance of fibre reinforced plastics continually increases due to the excellent mechanical properties, low material and manufacturing costs combined with significant weight reduction. Today, components are usually designed and calculated numerically by using finite element methods (FEM) to avoid expensive laboratory tests. These programs are based on material models including material specific deformation characteristics. In this research project, material models for short glass fibre reinforced plastics are presented to simulate the visco-elasto-plastic deformation behaviour. Prior to modelling specimens of the material EMS Grivory HTV-5H1, consisting of a Polyphthalamide matrix reinforced by 50wt.-% of short glass fibres, are characterized experimentally in terms of the highly time dependent deformation behaviour of the matrix material. To minimize the experimental effort, the cyclic deformation behaviour under tensile and compressive loading (R = −1) is characterized by isothermal complex low cycle fatigue (CLCF) tests. Combining cycles under two strain amplitudes and strain rates within three orders of magnitude and relaxation intervals into one experiment the visco-elastic deformation is characterized. To identify visco-plastic deformation monotonous tensile tests either displacement controlled or strain controlled (CERT) are compared. All relevant modelling parameters for this complex superposition of simultaneously varying mechanical loadings are quantified by these experiments. Subsequently, two different material models are compared with respect to their accuracy describing the visco-elasto-plastic deformation behaviour. First, based on Chaboche an extended 12 parameter model (EVP-KV2) is used to model cyclic visco-elasto-plasticity at two time scales. The parameters of the model including a total separation of elastic and plastic deformation are obtained by computational optimization using an evolutionary algorithm based on a fitness function called genetic algorithm. Second, the 12 parameter visco-elasto-plastic material model by Launay is used. In detail, the model contains a different type of a flow function based on the definition of the visco-plastic deformation as a part of the overall deformation. The accuracy of the models is verified by corresponding experimental LCF testing.

Keywords : complex low cycle fatigue, material modelling, short glass fibre reinforced polyphthalamides, visco-elasto-plastic deformation
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