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The effect of tension compression asymmetry on modelling the bending response of sheet moulding compound composites

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Abstract

Phenomenological models are required to predict the behaviour of a glass fibre reinforced Sheet Moulding Compound (SMC) composite material for use in the automotive industry. Material testing is conducted in tension, compression, in-plane shear, and three-point bending. The SMC composite exhibits tension-compression asymmetry and in-plane anisotropy. A model, which incorporates an anisotropic and asymmetric yield function, is developed. The model is calibrated to the experimental tension, compression and in-plane shear tests and are validated using the three-point flexure test. The model captures the flexure response within 8.1% of the experimental observations. The importance of including tension compression asymmetry within the model is demonstrated.

Keywords: A. Moulding compounds, B. Anisotropy, C. Computational modeling, D. Mechanical testing

1. Introduction

Fuel economy and safety regulations in the automotive industry are become stricter [1], vehicle manufacturers need to reduce weight and improve crashworthiness. A reduction of vehicle mass by 10% results in a 6.8% fuel economy improvement [2, 3]. Sources of weight reduction and improved crashworthiness include material selection, and component design optimization [4]. Depending on the type of reinforcement and matrix material, composites have a higher strength and stiffness to weight ratio than metals [5, 6]. In the past, composites were mostly used in low production volume vehicles as composite components were manufactured through low volume production methods, such as hand lay-ups, which were slow and expensive [7]. Interest in composite materials for mass production vehicle components has increasing significantly. High volume manufacturing methods, such as compression moulding, decrease the material and manufacturing costs associated with composites and makes materials such as Sheet Moulding Compounds (SMC), viable for mass-production vehicles [8, 9]. Exterior body panels and structural elements of a vehicle can be made of SMC and effect both passenger and

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