FAILURE BEHAVIOUR OF GLASS-MICROBALLOONS/THERMOSET-MATRIX SYNTACTIC FOAMS SUBJECT TO HYDROSTATIC LOADING

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This investigation deals with a lightweight syntactic foam constituted by an epoxy matrix filled with polydispersed glass microballoons up to 75% volume fraction.

We present experimental results on hydrostatic loading which demonstrate the possibility of different failure modalities depending on whether the surface of the composite is painted/coated or not.
In order to explain this peculiar behaviour, we develop a three-dimensional Finite Element (FE) micromechanical model. The model enables a detailed analysis of the stress diffusion from the external surface, subject to uniform pressure, through an appropriately thick layer of composite. The FE model includes 300 randomly placed microballoons and accounts for their polydispersion, in terms of both size and radius ratio.
The FE model is first validated by comparing its prediction on the elastic moduli with experimental findings and accurate analytical homogenisation techniques.

Towards modelling failure, we adopt a structural criterion for the glass microballoons, as recently proposed by our group. The criterion assumes brittle failure when the average elastic strain energy density reaches a critical value. On the basis of the effective strength measured under uniaxial stress, we identify different critical values for selected types of microballoons constituting the filler employed in the syntactic foam under investigation.
Finally, the new micromechanical model, through a detailed analysis of the collapsed microballoons and the matrix stress state, allows us to demonstrate the influence of the paint/coating on the syntactic foam failure.