

Homogenisation of a microcellular integral sandwich structure using virtual representative models

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Advanced foaming technologies were employed to fabricate tailored LDPE integral cellular sandwiches. These structures were composed of a microcellular core with a medium relative density and two denser faces made of the same bulk material. Monitored three point bending tests have been carried out with the aim of determining the flexural rigidity and failure mode of these structures.

In parallel, representative volume element (RVE) virtual models were developed for medium-high density cellular material based on a random sequential absorption algorithm. These micromechanical models closely imitate real structures and they were successfully employed for the prediction of mechanical properties of real foams under compressive loads. Once they had demonstrated their high predictive capability, these cell-level models were utilized to simulate more complex tests which are required to adjust constitutive models (crushable foam, Deshpande-Fleck) and multiaxial yield behavior. Simulated tests were carried out by applying prescribed deformations with appropriate periodic boundary conditions to finite element RVE models. This homogenisation methodology was useful to compute the macroscopic stress-strain behavior of an equivalent continuum under multiple load conditions.

The studied methodology was employed for the determination of the yield surface on the deviatoric-hydrostatic stress plane avoiding the performance of rather complicate real tests such as hydrostatic compression or biaxial tension. From the derived yield surfaces equivalent constitutive models were adjusted for different high density foams. The macroscopic finite element analysis of a real LDPE integral cellular sandwich subjected to three points bending test was simulated by assigning the corresponding constitutive models to the core and faces. The comparative response of the macroscopic bending simulation and real test was discussed.