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Review of “Ductile crack initiation and growth on a plasticized Polyvinylchloride during air bag deployment”

 Laurence Brassart^{1,E}

¹ University of Oxford, Department of Engineering Science, Parks Road, Oxford OX1 3PJ

^E Editor

1 Reviewer #1 (Anonymous)

This rather long article (30 pages including Figures) deals with the evaluation and prediction of ductile fracture of plasticized PVC in the special context of thin parts (airbags). Lab tests were investigated first; then, the transferability to full-scale tests on dashboard was discussed in a second part. An extensive work was reported, including a large set of fracture tests in notched specimens, simulations of crack propagation from Finite Element Method and fractography from SEM observations.

A large campaign of full-scale drop tower impact tests (CEAST) was conducted first, to capture the temperature and strain rate conditions for ductile fracture, including the usual discrepancy observed in fracture issues.

Single Edge Notch Bending tests (SENB) were performed to characterize the mechanisms of ductile crack propagation. Again, the experimental campaign was rigorous and results well supported. A large number of tests were performed to ensure repeatability. Experimental testing and analysis were carefully depicted and the processed parameters clearly defined. In particular, the loss of linearity of the load vs. COD (Crack Opening Displacement) curve was deeply analyzed.

The theoretical background of the fracture mechanics frameworks considered then was clearly reminded. FE simulations of crack initiation and propagation allowed respectively the fracture toughness to be estimated and the impact strength of drop tower impact tests to be corrected. A methodology to predict ductile crack initiation was defined for drop tower tests and at the dashboard scale. The paper was judged within the scope of JTCAM. Beyond the specific application targeted here, the work provided useful methodology and results about ductile fracture in soft and thin media.

Results were carefully and extensively discussed, compared to the literature, leading to well supported conclusions. The reviewer recommends to publish it.

2 Reviewer #2 (Anonymous)

The authors present a very nice and interesting work, that will certainly interest the journal audience. The paper contains a coupled experimental and theoretical (+ finite elements calculations) in which polymer fracture is adapted to an industrial problem. However, the authors have formulated interesting scientific questions on how to analyse a "simple" punch test to derive parameters controlling the failure process. The paper is very carefully written and for me, which is rare, can be accepted in the present form.

This is a very nice piece of work.

3 Editor’ assessment (L. Brassart)

The paper proposes a critical assessment of non-linear fracture mechanics (NLFM) concepts, as well as an original combined experimental/numerical methodology to predict crack initiation in thin PVC sheets. Based on an extensive and carefully-conducted experimental campaign on clamped SENB samples, the authors report nonlinear effects in the load-COD curves (attributed to early crack initiation), and develop a methodology to account for these effects when estimating the fracture toughness. The paper also discusses how to transfer results on SENB samples to CEAST and full-scale tests.

Although the study is conducted within a specific engineering application context (failure of polymer dashboard during airbag deployment), the identified pitfalls in applying standard NLFM approaches, and proposed finite element-based strategy are of general interest, and particularly for the expanding area of the mechanics of soft materials and structures. I also found the paper very valuable from a pedagogic standpoint. Both reviewers gave a very positive reports and the paper was accepted with only minor corrections.

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