

JOINT EVENT

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Book of Abstracts

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capacity of the columns Hashin criterion is employed. The results of FEM analyses are compared with the experiment.

Material model for plain weave fabric composites under compression load

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In composite aircraft structures, woven carbon-fiber reinforced composites are used as elements of the boxes to mitigate damage during crash events and provide a measure of protection for the passengers against abrupt decelerations. Due to their multiscale damage effects and complex coupling between failure mechanisms, despite years of extensive works of researchers around the world, a complete and validated methodology for predicting crushing behavior of woven composite structures has not yet been achieved. The aim here is thus to present, for the best of our knowledge, a new material model developed to predict the crush behavior of CFRP plain weave composite hat-shape cross section coupon. Quasi-static crush tests for plain weave fabric composite coupons CMO are performed and detailed numerical investigations are proposed. Eight layers of stacked solid elements model was used with saw teeth-type and 45° chamfer-type triggering mechanisms to ensure a continuous stable crushing mode of failure. The elementary failure mechanisms involved in the crushing of specimens are analyzed. A computational model, which accounts for intralaminar damage, implemented as a user subroutine VUMAT in Abaqus/Explicit was developed and used. A comparison between experimental and numerical results confirms the computational tool's accuracy in predicting the energy absorption and damage mechanisms of Hat-Shape specimens. The developed approach could significantly reduce the cost of physical testing required in the development of crashworthy structures and help provide a predictive tool to estimate the energy absorption.

Experimental testing and of modelling of gradual degradation of Al₂O₃/ZrO₂ ceramic composite under slow and high strain rates

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Gradual degradation of brittle composites exhibits different mechanical response under uniaxial tension and uniaxial compression. In this paper we analysed cracking processes and failure under quasi-static loading of 2 phase ceramic material made of Al₂O₃ and ZrO₂ mixture, subjected to tension and compression. Constitutive modelling of two phase ceramic composites obeys description of: (1) elastic deformations of initially porous material, (2) limited plasticity and (3) cracks initiation and propagation. Modelling of polycrystalline ceramics at mesoscopic level under mechanical loading is related to analysis of a set of grains, i.e. Representative Volume Element (RVE). The basic elements of the defect structure inside polycrystal are: micro- and meso-cracks, kinked and wing cracks. To get macroscopic response of the material one can calculate averaged values of stress and strain over the RVE with application of analytical approach. High strain rate degradation process was illustrated for Al₂O₃/ZrO₂ composite, which was subjected to short compressive impulse. The pulse duration was 10-7s. In the proposed more advanced finite elements formulation it was necessary to take into account the following data and phenomena appearing inside of the RVE: (1) spatial distribution of the composite constituents, (2) system of grain boundaries/binder interfaces modelled by interface elements, (3) rotation of brittle grains. The numerical model of gradual degradation of the Al₂O₃//ZrO₂ composite response due to pulse compressive loading presents correctness and capability of the proposed FEM approach.
