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INFLUENCE OF THE FOAM FILL OF BASIC COMPOSITE STRUCTURES ON THE FAILURE ENERGY

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ABSTRACT

Energy absorbing panels are applied in structures designed for the protection of people or the limitation of complete structural failure, e.g. in the case of a helicopter or car crash etc. In literature, some authors investigate this problem in the context of stability loss and resulting progressive failure [1]. The failure progressing in a relatively uniform manner results in the fact that the work used for failure of an energy absorbing element causes a substantial reduction of the impact load results, e.g. a helicopter's fall to the ground. Another application of energy absorbing elements may be a system dissipating the energy of a car impact into a crash barrier or the energy of the blast [2]. The highest specific absorbed energy occurs in the case of energy absorbing elements made of composites [3].

The aim of this work was to assess the influence of the applied fill on the energy absorption capability of a thin-shell structural element under dynamic load and to compare the effect of different kinds of fill on the energy absorbed by the examined structural element. The tests concerned energy absorbing elements in a shape of sleeves with an additional foam fill. The elements were subjected to axial kinematic loads.

In the tests, models differed by the angle of impact of the stiff plate into the cone-shaped energy absorbing element. The tests were conducted on the universal tasting machine INSTRON at the speed rate of the machine's traverse equal to 10 mm/min.

The numerical analysis has been performed using MSC.Dytran software based on the Finite Element Method. The assumed model accounted for physical (material model) and geometrical (large displacements and deformations) non-linearities. For the analysis, surface type contact modelling was used. The contact was defined between the bottom plate with energy absorbing elements, and the impacting plate. The loading of the numerical model, as in the case of experimental tests, was of a kinematic character. The analysed models were subjected to the load of a stiff plate with a mass of 1000 kg, moving at the velocity of 0.01 m/s. On the whole, the crush failure force and the specific absorbed energy are higher for composite structures than for metal ones.

The destruction mode of the composite structure failure has a significant influence on its ability to absorb energy. The phenomena occurring during the progressive failure mode of basic foam-filled composite structures shows higher energy dissipation of

impact than in the case of the catastrophic collapse failure mode. This phenomenon is undesired in the context of energy absorption capability.

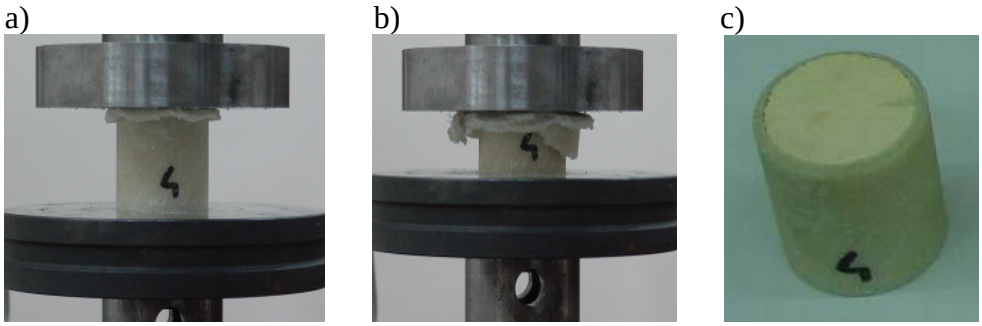

Fig.1. Progressive (a) and catastrophic (b) failure modes of a basic sleeve element made of foam-filled epoxy-glass composite (c)

The failure progressing in a relatively uniform manner results in the fact that the work used for failure of an energy absorbing element causes a substantial reduction of the impact load results. The lack of an initiator can cause a catastrophic failure mode. The application of a foam fill resulted in an increase of the specific absorbed energy. The presented results are introductory attempts at selecting the fill for a protective element.

On the basis of a preliminary assessment of the obtained results it was concluded that a proper selection of the fill material allows to achieve a higher energy required to destroy the tested structure. The future application of numerical analysis will considerably improve the process of the fill parameters optimisation.

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