Development of passive protection systems using cellular materials

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This work attempts to explore the possibility of cork to act as material devoted to the absorption of impact energy within the passive safety in road helmets. It is studied numerically the feasibility of establishing mixed padding consisting of micro-agglomerate cork and polystyrene in road helmets, through numerical simulations of double impacts, according to the more recent standards. Expanded Polystyrene (EPS) is a widely used material with excellent performance in applications for energy absorption. However, once deformed, it presents no springback, which means that its capacity for energy absorption is greatly reduced after the first impact. On the other hand, cork is a material characterized by having a good capacity of energy absorption, with almost total springback, which means that their ability to absorb energy is almost unchanged. In the first part of this work, a compression test-case is used to assess the effectiveness of the material laws chosen to model the cellular materials under study. The results show that the models chosen for either the EPS and the micro-agglomerate cork can adequately model the actual behaviour of the material on a no springback case. In the second part of this work, it is developed a simplified model of a road helmet padding, which is subjected to double impacts, as specified in the standards. It studies numerically the application of micro-agglomerated cork padding on the energy absorption helmet through various set-ups and arrangements. It is confronted the results obtained with regard to acceleration of center of gravity of the head, and final weight of the helmet with micro-agglomerate cork/EPS padding.

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