Study and understanding of dynamic phenomena during an impact - Application to a composite shock absorption system for the automotive sector

Jeremy Niez, Mohamed Ben Amara, Julien Capelle, Vanessa Bouchart, Pierre Chevrier

[1]Université de Lorraine, CNRS, ENIM, LEM3, F-57000 Metz, France

Abstract

In the automotive field, the absorption of the energy released during a car crash is partly achieved by the plastic deformation of metal absorbers and bumper beam. However, with the tightening of laws on the emission of greenhouse gases, the automotive sector seeks to reduce the mass of vehicles and thus limit consumption and therefore the production of harmful gases. The aim of the thesis is to propose new lighter and more efficient energy absorbing systems based on the optimization of a thermoplastic matrix glass fiber composite material. These new materials, whose mechanical properties are similar to metals ones, have the advantage of introducing greater performance in terms of energy absorption and lower density than current materials, while being recyclable. As regards composites, the energy absorption is in particular due to a set of phenomena of damages (rupture, delamination ...). The understanding of the rupture of composite systems is therefore essential: understanding the real crushing scenario makes it possible to optimize the type of composite used and the geometry of the pieces in order to maximize the energy absorbed.

In this goal, a first material mapping phase was launched in order to provide the mechanical parameters necessary for the elaboration of a numerical model of Finite Elements under Abaqus. The pseudoplasticity property of +/- 45 ° laminated composite was highlighted as well as its energy absorption benefits. From these data, a more precise study phase was conducted: the influence of ply orientation and strain rate on the laminate’s response has been checked to provide an optimal material for shock absorption. Finally, a study of the geometrical parameters led to the optimization of the section of the absorber as well as to the use of triggers to take advantage of the potential of the material and to maximize the amount of energy absorbed.