DEVELOPMENT OF THE ADAPTABLE ENERGY ABSORBERS FOR CAR CRASHES

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1. Introduction

Passive safety of vehicle is one of the basic parameter defining the overall safety of the vehicle. It is determined primarily by the ability to protect the passengers in case of an unavoidable accident. It is given by ability of the structure (body) to absorb the kinetic energy of the impact by the conversion to potential energy in their deformation and/or damage. This ability is fixed at the present designs by the structure design (shape and choice of material). It is clear that such a construction meets safety requirements in different collision scenarios but in none optimally. It potentially means that cars are safe only in the cases of configured collisions that were considered during the design. There are unlimited amounts of real crash scenarios which show the need to adapt the design according to real crashes. Because of all these facts our intention is to develop composite beam that can adapt its force response as required by the actual situation. Fiber composite materials compared with conventional structural materials excel in their ability to absorb the damage energy and subsequent fragmentation.

Price of these materials is still quite high, which has prevented its wider application so far. Increased demand for electromobility and related requirement for better mass to absorbed energy ratio will nevertheless require their use. For further development, it is necessary to find reliable mechanism of damage initiation and completely understand the mechanism of fragmentation.

2. Searches

At the beginning of this project the searches were done. There are many possibilities how to influence the energy absorbers in the passenger cars during the impact. We focused on methods, which has potential to affect the material response very quickly. There is the possibility of modification the properties of composite material using temperature. Thermoset and thermoplastic matrix could be used. Both can be affected by heat as is written in [1]. Another option is an infraction of the beam by controlled impacts circumferentially before the front impact during the vehicle crash. The suggestion is based on the results from the literature [2]. Here was confirmed that initiation of fragmentation is possible to achieve by a localized weakening before impact. Controlled impacts could cause both interruption of fibers and delamination of the composite material. Both can influence the stiffness of the absorber during impact. The suggested absorber might be impacted before compression in several (2-3) levels circumferentially.

![Energy absorber device and components](image)

**Fig. 1.** Energy absorber device and components [3]
holes from that the rupture materials goes through. This option is still used in the aerospace industry as is written in [3], see Fig. 1.

3. Experimental investigation and numerical simulation

The experiments to test these methods written above were designed. The all specimens have a shape of the composite tube and its length corresponds to size of the space in the real car. The specimens are made from the eight layers of fabric prepreg (carbon fibers and epoxy resin). The dimensions of the beam and material is written in Tab. 1 below.

| Length [mm] | 170 |
| Inner diameter [mm] | 70 |
| Thickness of the wall [mm] | 3 |
| Number of layers [-] | 8 |
| Material SIGRAPREG C W305 - TW2/2 - E323/42% |

Tab. 1. The characteristics of the specimen

One simulation example of the absorber idea: Different configurations of the initiation damage (circular holes of varying size) along the circumference at the end of tested tube was chosen as the first realization.

![Fig. 2. FEM model of the configuration before and after the impact](image_url)

Numerical calculations have shown a significant effect of location and diameter of the initiation damage (circular holes) on the absorbed energy. It is shown that various initiation damage configurations can be used for the solution of adaptive energy absorbers.

4. Conclusions

The searches in the issue of vehicle safety were done. It was selected several different approaches to energy absorbers in car crashes. There are possibilities of the modification the properties of composite material using temperature, infraction the beam by the controlled impact, or fixing the beam in the head with holes to initiate fragmentation of the composite material. All these methods will be tested in the further research. The first research was done on the composite tube, which was pre-damaged by circular holes along the circumference on the end of tube. Numerical calculations have shown a significant effect of location and diameter of the initiation damage (circular holes) on the absorbed energy. It is shown that various initiation damage configurations can be used for the solution of adaptive energy absorbers.

Acknowledgements

Development of the adaptive composite materials and structures for crash applications SGS16/214/OHK2/3T/12

References


[3] Heimbs, S., et al., Composite crash absorber for aircraft fuselage. [Online] [Citation: Commento [NS1]: Nevypusití?]