ANALYSES OF THE RESCUE CUSHION DESIGN – SENSITIVITY STUDY

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1. Introduction

The contribution presents analyses of a rescue cushion, the system which is based on an airbag (Fig. 1a) and is used by Fire Brigades for evacuation of people from high altitudes. A person landing on the airbag compresses the air enclosed in its volume, what results in an increase of the pneumatic force. The compressed gas is simultaneously released by a number of vents located on the side surfaces of the rescue cushion. As a result, the impact corresponding to touchdown is significantly reduced and its harmful effects are limited. Two types of rescue cushions are available on the market. The first type, which is a subject of presented research, is a system based on the inflatable frame. The second alternative is represented by a group of constantly powered rescue cushions, which are inflated with a use of special fans. Impact absorption effectiveness of the latter devices is typically higher than for the frame-based systems. On the other hand, they are less compact and more complicated from a technical point of view. Because of that, the rescue cushions inflated by fans are mainly used in geographical areas where the heights of buildings exceed 20 m.

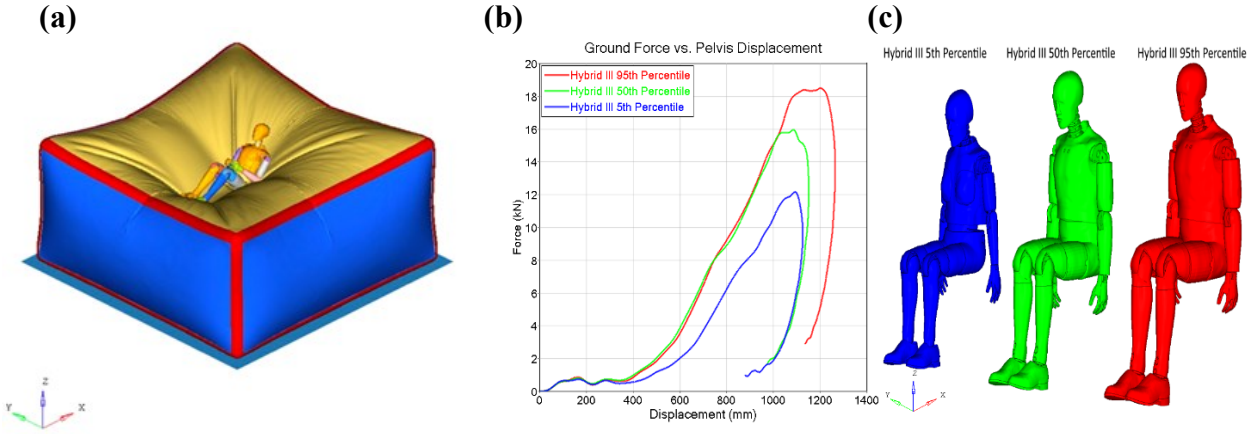

Figure 1: a) dummy landing on the airbag – visualization of the numerical model, b) force responses of the rescue cushion, c) models of dummies used for computation of the system response [3].

2. Possible improvements of the rescue cushion

Every rescue cushion introduced to the market has to meet a number of functional, operational and legal requirements. Moreover, efficiency of the impact mitigation is evaluated by drop tests, during which strictly specified reduction of decelerations acting on a head, chest and pelvis has to be ensured [1]. The construction of currently used rescue cushions with inflatable frame is based on the idea introduced over 30 years ago by Peter Lorsbach in his patent [2]. All requirements mentioned above make the process of rescue cushion design very challenging. Probably, this is the reason why a number of solutions available on the market is limited.

Within this contribution the influence of selected system parameters is investigated and the possibilities for improvement of the rescue cushion's performance are analysed. The discussion is based on numerical simulations conducted in LS-DYNA and ABAQUS software environments, where the models of the airbag with inflatable frame are implemented. Results of the parametric study are used to elaborate concepts for

system adaptation. The effectiveness of adaptation methods is evaluated with the use of appropriately selected impactors and models of dummies (Fig. 1c), which relates to 5^{th}, 50^{th} and 95^{th} percentile in terms of people height and weight [3]. According to the conducted analyses, significant reduction of the impact loading can be obtained for all considered cases. Discussed results include simulations in case of different heights of evacuation as well as different masses of the landing person.

3. Conclusions

The presented work concerns the analyses of the rescue cushion, which is equipped with the inflatable frame. Using the results of numerical simulations the selected adaptation mechanisms are proposed. As a result, the response of the airbag can be improved for the range of impact conditions. The effectiveness of proposed solutions is evaluated with the use of different models of dummies, which are dropped from various heights. Based on presented results it can be concluded that the concept of adaptive rescue cushion has been introduced and it provides adaptation to both the height of evacuation and the mass of landing person.

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References

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