Risk of Injury During the Explosion of a Low-Mass Charge under a Vehicle

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Abstract. The paper includes the analysis of results of measurements performed on the testing ground of the Military Institute of Armour and Automotive Technology using an explosive detonated under a vehicle. The paper concerns the analysis of injury risk in the context of significant, short-term accelerations caused by explosive charges of various weights. The aim of the analysis was to assess the risk of micro-injuries in soft tissues induced indirectly by the blast using a numerical analysis. The measured parameters such as: acceleration and forces generated in the Hybrid III dummy have been assumed as the boundary conditions.

INTRODUCTION

The primary mechanism of the lower limb injury was examined by Ramasamy, where it was discovered that the injuries are the result of moving the limb or objects near to it, commonly known as third-rate damage from the blast [1]. The fracture characteristics included three-point bending, spiral fractures and long bone fractures directly related to the axial load. In the case of smaller impulse loads, the injuries are more often related to micro-injuries and soft tissue injuries, which lead to joint instability[2].

The paper includes the analysis of the influence of the charge mass on the risk of injuries for the cases in which the experiments have not exceeded the critical values inside the Hybrid III dummy. The analyses have been based on numerical models and have showed details about the behaviour of the selected tissues in the lower limb.

MATERIAL AND METHODS

A one-sided pendulum with the passenger cabin of a military vehicle has been used as the model of the vehicle under which the load exploded. The Hybrid III dummy has been placed in the cabin and accelerometers measuring acceleration have been installed. The acceleration sensor has been mounted centrally in the front part of the cabin and between the dummy's feet (Fig. 1). The experiment has been conducted for three TNT values: 0.5 kg, 1 kg and 1.5 kg.

The pendulum model is equipped with a cabin in which the Hybrid III dummy is placed. In addition, acceleration sensors have been used. The explosive charge has been placed directly under the cabin which caused the pendulum

lift during the detonation. In the presented model, the values of accelerations generated in the floor (Fig. 1c) have been assumed as the loading acting on the limb model. The model has been validated based on the tibia forces generated in the dummy during the explosion.

a) b)

c) d)

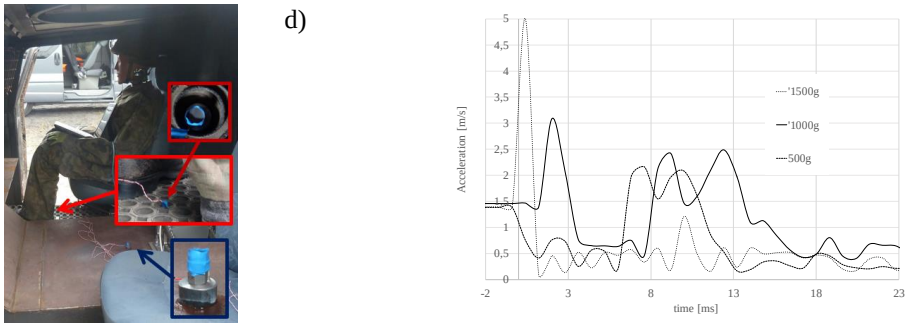

FIG. 1. The station of the pendulum a) The passenger space with manikin Hybrid III, b) pendulum with closed passenger cabin, c) place of fixing acceleration sensors, d) The accelerations of the floor for different charge mass

RESULTS AND CONLUSIONS

This paper presents the method to analyse the risk of injury of the human body placed inside a vehicle subjected to an explosion. The numerical model of the lower limb has been used to calculate the stress inside tissues. Based on these results, the estimation of the potential injuries has been carried out for low loads. The results suggested that for the forces and accelerations of the Hybrid III dummy below critical values, injuries and micro-injuries of the limb tissues may occurred. The values of the effort occurring in the tissues indicate contusion such as bruises or pulling the ligaments.

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