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EXPANSION LIMIT ESTIMATION OF PISTOL HOLLOW POINT BULLET PENETRATING THE BLOCK OF SUBSTITUTE MATERIAL

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Abstract: *The article presents a numerical model of expansion pistol hollow point bullet penetrating the block of simulator representing the organic material (tissue). The hollow point bullet has an expansion ability to increase its wound potential, but only in case of exceeding the specific limit impact velocity. The simulation using FEM system Ansys Autodyn v14 presents 2D results of estimation the bullet velocity limit for expansion occurrence based on experiments. Also the analysis and influencing factors of the penetration process are presented as well. The results obtained help to evaluate the bullet post-penetrating characteristics.*

Keywords: ***Pistol cartridge, expansion bullet, wound effect, expansion limit, FEM simulation.***

1. Introduction

Expansion bullets, so called hollow point bullets, are characterized by functional deformation of the front part (so called expansion) while penetrating a soft target. Functional deformation of the expansion bullets in the target increases its radial dimensions and its front cross section (Rosenberg, 2002). The bullet transmits more energy into the target and is therefore considered as the bullet with enhanced wound potential. The cartridge Action 5 used in the experiments and analysis is of the caliber 9 mm Luger with a homogeneous brass bullet with front expansion hollow covered with a plastic cap. The goal of the work presented in this article is to estimate the expansion characteristics of the cartridge Action 5 firing on various velocity conditions using experiments and FEM simulation.

2. Experimental and FEM simulation analysis

Two kinds of Action 5 cartridges were used for the experimental shooting – original cartridges and delaborated cartridges with modified propellant with lower weight in order to reduce the velocity of the bullet and therefore to achieve a different expansion behaviour of the bullet. The character of deformed bullets after penetration of the gel block is shown in Fig.1 for experimental impact velocities. The expansion of the front part of the bullet is more extensive with higher impact velocity of the bullet. The residual velocity of the bullet is higher for lower impact velocity due to the smaller expansion and therefore a smaller resistance of the bullet shape when penetrating the gel block.

In order to simulate the penetration process an explicit nonlinear transient hydrocode Autodyn v14.0 was used. The model of the bullet and gel block was created using 2D axial symmetry, so only a half of the parts of all components were modeled (Hub 2011). The impact velocities of the FEM model follow experiments. Deformed shapes of the bullets are shown in Fig. 1 with good correspondence to experimental results in terms of comparing the bullet shape and residual velocities of the bullet.

The graph in Fig. 2 shows the course of impact velocity v_{imp} of the bullet with respect to the decrease of residual velocity of the bullet $\bar{v}_{res}$ for both experimental and simulation values. The break of the graph course for the shot No. 3 indicates the increased influence of the bullet expansion to the reduction of its velocity and therefore it is close to the upper expansion velocity limit of the bullet.

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No. of shot: No. 1 No. 2 No. 3 No. 4

Bullet velocity v_{imp}: 248 m/s 349 m/s 395 m/s 454 m/s

Fig. 1: Bullets after penetration of the gel block – upper line shows the experimental results and the bottom line the simulation results; velocities represent impact velocity of the bullet

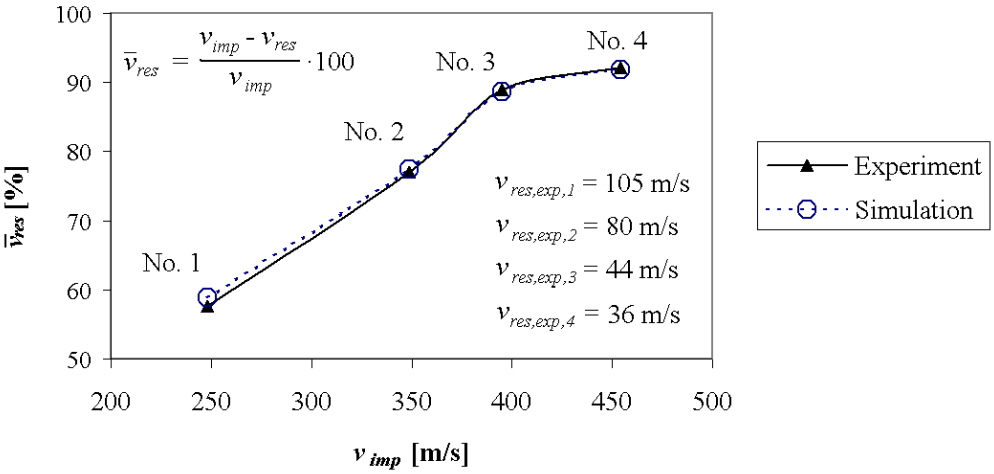

Fig. 2: Graph of the dependance of the decrese of residual velocity of the bullet with respect to the impact velocity; included are residual velocities and equation for decrease of residual velocities

3. Conclusion

According to presented anlysis it is possible to estimate following expansion velocity limits: the lower expension limit – approx. 248 m/s (shot No. 1), where the expansion starts to occure, next the expansion limit with expansion coefficient equal to 1 – approx. 349 m/s (shot No. 2), where the diameter of bullet expansion reaches the bullet caliber and finally the upper expansion limit – between 395 m/s and 454 m/s (shots No. 3 and 4), where the expansion reaches its maximum dimension. For better estimation it is necessary to carry out further experiments with mentioned cartridge Action 5.

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