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Terminal ballistics analysis using Finite Element Method (FEM)

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Abstract
Terminal ballistics analysis is most often performed experimentally. However, it requires a controlled environment, weapon, ammunition and the target, or a virtual experiment can be performed, where a mathematical model is solved in order to answer the questions. In this study a 4,5 mm air gun was fired at a windshield, and the deformation of the pellet was compared with the results obtained in a numerical model using Finite Element Method (FEM), the results are consistent.

Keywords: Terminal Ballistics; Finite Element Method

Introduction
Terminal ballistics is the regime that the projectile enters at the conclusion of its flight (CARLUCCI; JACOBSON, 2018). Terminal ballistics analysis can be performed experimentally, or numerically where a mathematical model is solved in order to calculate de bullet and target deformation.
Gunshots are common in crime scenes, and determining whether a certain weapon is capable of doing certain damage to a certain object, or, the speed at which the projectile hit the object are valuable answers in a criminal investigation. In contexts like these, numerical simulation can be used as a faster and cheaper alternative to answer these questions.

Objective
The objective of this study is to compare the results obtained in the numerical model and the experimental data.

Method
The air gun was fired at the windshield at a distance of approximately 5 meters, it was used a Beeman P17 with pellet nominal speed of 125 m/s. The pellet used is a 0,5 g diabolo. The pellet impact was modeled using the software Ansys and solver Explicit Dynamics.

Results and discussion
The deformation perceived in the pellet collected in the experiment and in the one obtained in the numerical model are similar. In figures 01 and 02 shows the pellet shot at the left and simulation result at the right.
The final diameter in the experimental case is 8 mm and 7,5 mm in the numerical one. It is an error of 6,25%.

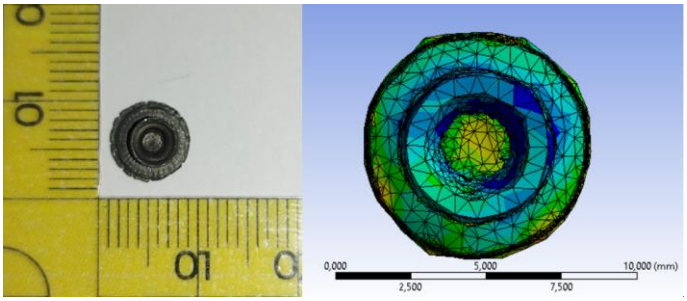

Figura 01. Experimental and numerical comparison

Conclusão
The presented model has consistent results, the deformation obtained in the experiment and numerical model is similar. This method is complex and has high computational cost, but it is promising and can be used in a variety of terminal ballistic cases.

Referências bibliográficas (padrão ABNT)
CARLUCCI, Donald E.; JACOBSON, Sidney S.. **Ballistics**: theory and design of guns and ammunition. 3. ed: Crc Press, 2018.