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Deformation Analysis of Gun Bullet's Collision

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ABSTRACT

The gun crime has been increasing year by year. Collecting the bullet after firing is need to solve the affair[1]. It is often that a bullet is only evident in the affair. Therefore, the study about the bullet deformed by collision is very important. For example, rifling marks on the bullet after firing give information about the type of gun used; in the same way, deformation of the target will indicate the firing position and firing angle.

In this research, the bullet-firing test was done in the different velocity and collision angle of the bullet. The influence of its velocity and angle on the deformation shape after firing was discussed by comparison with experiment and simulation. The velocity of the bullet was chosen in several kinds of speed ranges at 80m/s-250m/s. As for the angle of incidence with the collision object, four kinds of angles 90° (head-on collision) , 45° , 30° and 60° were set. The deformation shape was measured by 3D coordinate measurement machine and reconstructed with 3D-CAD based on the 3D digital data. The bullet hole and deformation of the polycarbonate board caused by the bullet's collision with the object was examined, too. In addition, the collision simulation of the bullet was done by using LS-DYNA, and this analytical results were compared with the 3D digital data of bullet. The comparison of the FE-simulation analysis results of the experiment enabled the quantitative evaluation in the collision deformation.

In this experiment, authors used three types of bullet with full metal (1) 38SPL, (2) 25AUTO, (3) 380AUTO which are called "round nose bullet" and the lead core is coated with copper film. These bullets were shot by using 38Auto and Wheel (S&W) gun (Figure 2). Polycarbonate plate (PC) of 10mm thickness was used as target. Distance from gun to target is about 6.4m and the velocity of bullet was measured by laser ballistic chronograph. By adjusting the amount of explosive powder in the cartridge case, the bullet velocity was controlled. The head on and the oblique collision (collision angels, 30° , 45° ,60° were executed. The shot bullets collected and the configurations were measured with 3D measuring instrument.

The commercial FEM code "LS-DYANA" was used for this simulation. As analysis conditions, the collision velocities and the angles in experimental conditions were used. In addition, the spinning of bullet, material’s strain rate dependence, Mach number and friction were considered [3]-[6].

Comparison between the analysis results with the experimental ones is good agreement in both case of the head-on and the oblique collision. Cracks on copper coated bullets were recognized in the collision experiments. These cracks caused by the rifling mark in spirals, has little influence on deformed shape of bullets. However, the non-coated lead bullet breaks with cracks cased along rifling marks. From these experiments and simulations, it is found that the deformation and fracture behaviors can be evaluated by simulation quantitatively.

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