ABSTRACT

Computational Study of Aerodynamic Forces and three-dimensional flow around 5.56 mm Caliber Bullet

by

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In this thesis, a computational study of three-dimensional 5.7×23.2 mm projectile was investigated at different Mach numbers M ($M \approx 1.89, M \approx 2.67$) and angle of attacks α ($\alpha = 0, \alpha = 10$). Open source CFD software OpenFOAM version 6 was used to solve the flow around the projectile with inviscid and compressible flow assumptions. In this analysis, sonicFOAM solver was selected to compute a $0.25 \times 0.02 \times 0.04$ m flow domain with 1 009 635 cell elements. The results showed that the flow at the vicinity of projectile is highly dependent with M and α. For both $M \approx 1.9$ and $M \approx 2.8$ at $\alpha = 0$, oblique shock waves were attached at the sharp-edge of projectile with angle of 33° and 28° respectively and follow by the expansion waves near trailing edge. Interestingly, for $M \approx 1.9$ case, expansion waves were formed starting at ~ 10 mm before the trailing edge which accelerate the flow behind it, and then compressed again at the trailing edge. Moreover, from the simulation, a compresion waves was generated upstream of projectile, unlike the case of $M \approx 2.67$. In addition, the increase of α resulted in the occurance of oblique shock and expansion waves at the lower and upper surfaces of leading edge, respectively.The dependency of coefficient lift c_l on Mach numbers is small, in contrast with that of coefficients of drag c_d and pitch moment c_m, i.e $c_d = 6.51 \times 10^{-2}$ and 5.98×10^{-2} , and $c_m = -6.26 \times 10^{-1}$ and 3.26×10^{-1} , For cases of $M \approx 1.9$ and $M \approx 2.8$ respectively. The dependency of coefficient lift c_l on α is significantly higher yielding $c_l = 1.56 \times 10^{-1}$ and $c_l = 1.80 \times 10^{-1}$ for each respecting M, whilst c_d and c_m only shows slight increases in their values, i.e $c_d = 7.17 \times 10^{-2}$ and $c_d = 5.69 \times 10^{-2}$, and $c_m = -5.75 \times 10^{-1}$ and $c_m = -3.00 \times 10^{-1}$ for each respecting Mach number M.

Keyword: *Aerodynamic forces, projectile, shock and expansion waves, sonicFoam, OpenFOAM*