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BALLISTIC EFFECT OF DIFFERENTBULLET GEOMETRY ONALUMINUM PLATES

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Abstract: Along with the development of armor in recent years, the pre-determination of the behavior under ballistic influence of materials to be used in armor has gained importance. Depending on the geometry of the projectile, the damage it creates in the material changes. The armor material depends considerably on the geometry of the bullet, which depends on the speed, weight and material of the bullet which affects the behavior. In this study, the difference between the flat and inclined projectile was investigated. Bullets made from the same material at the same speed were subjected to the same material and analyzed in the Ansys / Dynamic Explicit module.

Keywords: Aluminium Alloys, Ballistic, Projectile Geometry

INTRODUCTION

M. A. Iqbal, A. Diwakar and friends (2012) modeled the lead shape and lead angle entry angle in various possibilities using the finite element method and performed the analysis in the ABAQUS program. 12 mm thick steel targets, 20 mm steel lead, 6 different projectile angles and 5 different penetration angles are examined. Damage caused by the change of angle on the bullet tip was discussed and compared with other numerical and analytical model results in the literature. T. Børvik, S. Dey and A.H. Clausen (2009) investigated five different high strength steel plates which are frequently used in military and civilian ballistic protection systems, in accordance with EN1063 standard, at two different projectile types at impact speeds of 830m / s. Johnson-Cook model and Cockcroft fracture criterion were applied in all steels, material properties of projectile were taken from the literature.The inelastic properties of alloys and their behavior are defined by the Johnson-cook model.The ductile plastic deformation in the material describes the empirical bond obtained by the JC model based on experimental results of plastic stresses, strain rates and temperature[1]. When the literature is examined, it is suitable for deforming and modeling of metals at high deformation rates. Machining turning, milling and so on. It is also used in areas.

ε^p is the plastic strain, T^m is the dimensionless temperature according to equation 2, T is the test temperature, T_m is the melting temperature, T_r is the reference temperature.A is the measured yield stress under reference temperature, B and C are the resultant

$$\sigma^0 = \left(A + B\left(\varepsilon^p\right)^n\right)\left(1 + C\,\log\left(\frac{\dot{\varepsilon}^p}{\dot{\varepsilon}_0}\right)\right)\left(1 - \hat{T}^m\right)$$

$$\hat{T} = \begin{cases} 0 & T < T_r \\ \dfrac{T - T_r}{T_m - T_r} & T_r \le T \le T_m \\ 1 & T > T_m \end{cases}$$

constants obtained from the tests and are found in the graphs.In equation 1, the 2nd parenthesesshow the strain rate and 3. parenthesesshows thermal softening. The aim of the formula is to find strain hardening, strain hardening rates, and temperature as independent variables, which are derived from each other and effectively find plastic deformation, strain rate and temperature[2].Calibrating the coefficients to achieve real results is easy because it can isolate various effects. Due to this reason, its use in ballistic areas is widespread.
Monolithic (one piece, homogeneous, solid) armor is considered to be a method by which can absorb the kinetic energy efficiently.There is no loss of material on the armor. In low-strength steels, in the ductile aluminum or titanium alloys, radial outward from the entrance of the bullet, depending on the diameter of the bullet, the formation of the nose as seen in Fig1.

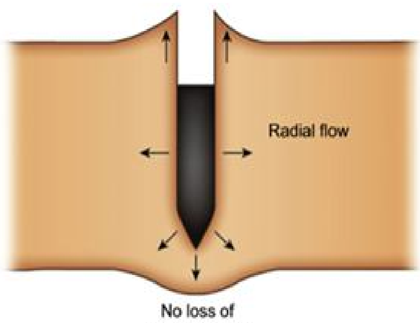

Figure 1

Damage formation is a mechanism controlled by the transverse shear properties of the material.As seen in Figure 2, a blind bullet is hit and become is a transverse cut.Since the shear cut is regional, very little plastic deformation occurs.The best-known geometric relationship feature of this damage mechanism is; it is more likely to occur if the caliber (diameter) of the projectile and the material thickness ratio are close to 1: 1.For example, fine steel in the range of 5-8 mm for a 7.62 mm projectile is likely to cause this damage[3].

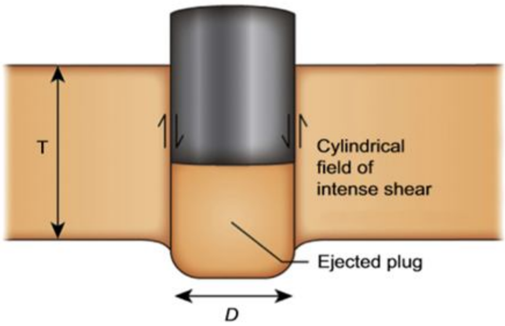

Figure 2

Conical fracture is a damage mechanism that reduces the effectiveness of ballistic success in fragile materials, which is a major disruption. The effects of taper angle, impact velocity, poisson ratio were investigated in the studies [4-6]

DETAILS EXPERIMENTAL

The bullet measures are 7.62mm in diameter and 40mm in length. Ansys was chosen as lead bullet material.Al6061-T6 plates with a thickness of 4 mm were selected in 150*150 mm dimensions. Analysis was carried out by fixing it on 4 edge surfaces.As shown in the Figure 3, more detailed meshing is applied to the top of the projectile.The part where the projectile is touched is also mesh-processed by more detail than the other parts.

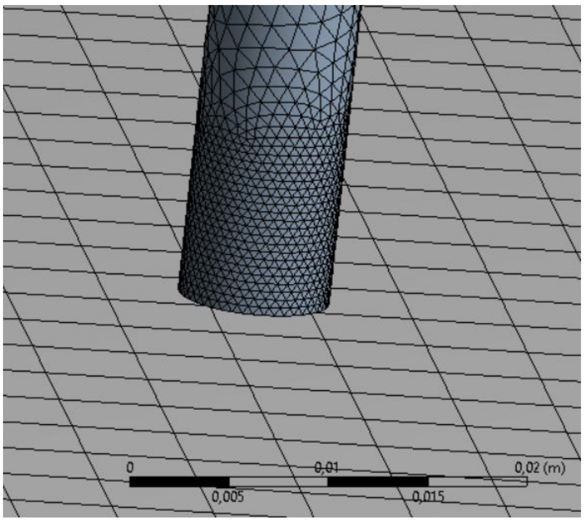

Figure 3 Mesh Model

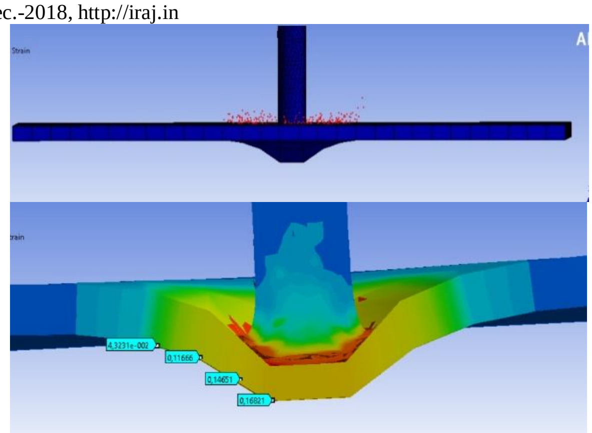

Figure 4 Analysis of Ansys of Blunt Projectile

Figure 4 shows that the bullet was hit by the sample at 850 m / sec and caused a deformation of 16.8 mm without any perforation.

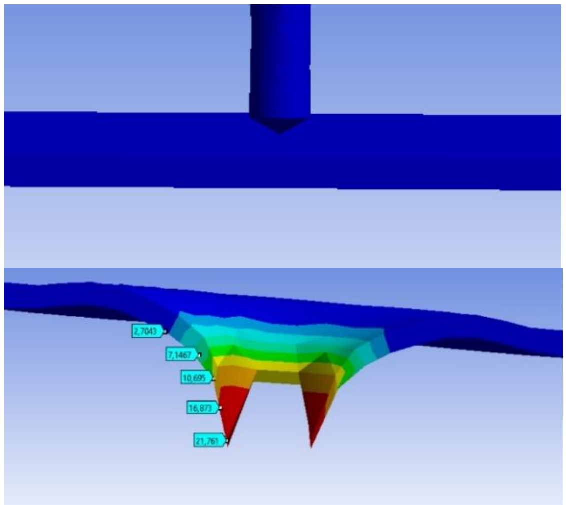

Figure 5 Analysis of Ansys of 30°Projectile

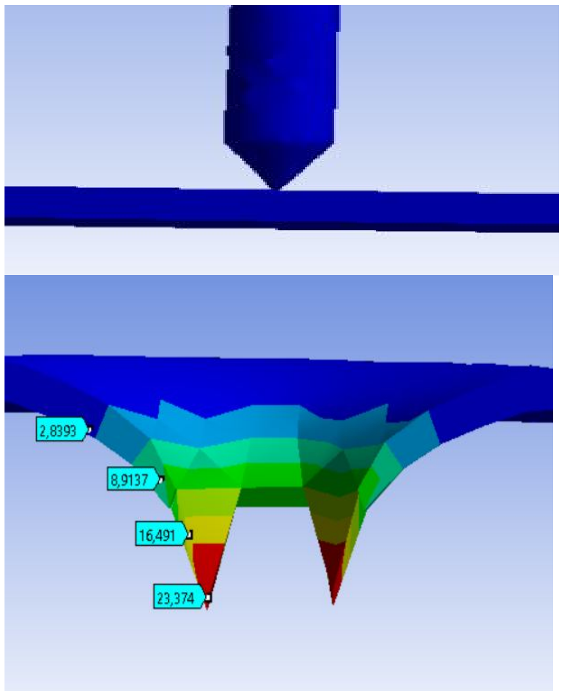

Figure 6 Analysis of Ansys of 60°Projectile

Figure 5. The bullet at an angle of 30 °, Figure 6. The bullet at an angle of 60 ° was struck at 850 m / sec. it gradually deformed by plastic deformation to reach a maximum of 21.7 mm for 30 ° and 23.4 mm for 60 °.As a result of the analysis in Figure 7., in the actual experiments, the mushroom that appears at the tip of the projectile appears clear.

Figure 7 Mushroom Shaped Bullet After Impact

RESULTS

There was no perforation on the Al6061 plate hit by the bullet, which was flat. Depending on the width of the cross section of the bullet, the puncture did not occur due to the energy dissipation.

The specimens with pointed ends have a certain puncture at a speed of 850 m / sec. The sample with the blunt end has a maximum deformation of 16.8 mm, the sample with 30 ° angle is 21.7 mm and the sample with 60 ° has a deformation of 23.4 mm. As the tip was narrowed, the damage in the specimen was prolonged. At the same speed, it was seen that in the analysis works, the shape change at the rear part was increased due to the tapering at the tip of the bullet.

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