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IMPACT ANALYSIS OF INSAS RIFLE BULLET AGAINST THE VEHICLE ALUMINIUM COMPOSITE ARMOUR PLATE USING LS-DYNA

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ABSTRACT

When a bullet strikes the heavy metal it gets caught or stopped by that metal and makes an impact on the metal. The research work aims at the explicit dynamics analysis of striking of the bullet on heavy metal made components like hull material for boats, vehicles armours and cryogenic propellant tanks etc., Which helps to overcome the difficulties by improving material properties of bullet such as strength, hardness etc. The result of the analysis may help in changing the properties and improving the result.

Keywords: Bullet, Armour plate, Composite, LS-DYNA, CFD.

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1. INTRODUCTION

Two or more material with chemically and physically different material combined together with micron level. The alloy materials have the properties of both base materials. The properties of the materials have more strength than the base materials. It is a known fact that ordinary bullet cannot penetrate heavy metal-like armor. The kinetic energy of the bullet is not enough to do that action is analyzed by using LS-DYNA in Ansys, we can overcome those failure actions by changing the material properties or else the whole material. In addition to that certain design changes in the shape of the bullet is made, after the design changes the bullet is analyzed for its drag and lift in CFD (computational fluid dynamics), along with that aluminum 5059, silicon carbide and molybdenum sulfide alloys properties are included. The result of the analysis is helpful in further improving the precision and perfection in the action of the bullet [1-3].

1.1. NATO history

In nearly 1947's, 7.62mm×39mm, among many rifle cartridges NATO was selected as Standard cartridges, at the selection time critics came to appear about NATO's excessive recoil due to overpowering, which affects the automobile fire rate on comparison with modern weapons. The British had a lot of evidence with their own experiments in intermediate cartridges since 1945 and were on the point of adopting a 7mm cartridge. When the selection of the 7.62×39mm NATO was made. The FN Company was also involved in the development of the round, including developing a version of the FN FAL in 7mm.US within NATO was concerned about recoil effect and effectiveness, and the other NATO nations accepted the standardization was more important at the time that the selection of the ideal cartridge.

Figure 1 56mm NATO shown difference with other cartridges

1.2. M16 rifle history

The M16 rifle also called AR-15 assault rifle developed by American engineer Eugene Stoner of ArmaLite Inc. It has lightweight, good accuracy and provides a high volume of fire. The AR-15 was developed next to 7.62mm rifles, but its success rate is greater compared to NATO rifles, it is being used at American army. The AR-15 licensed company was colt's patent firearms manufacturing company the U.S. Air Force in 1962, the AR-15 was designated the M16 by the Department of Defence. AR-15 American combat troops were used in the war happened in Vietnam. The AR-15 has lots of advantages, but it was prone to jamming because of convergence factors. Providing training, improving circulation of cleaning kits and a change in the chemical properties of the powder used in the ammo reduced the malfunction rate.

1.3. Cartridge dimensions

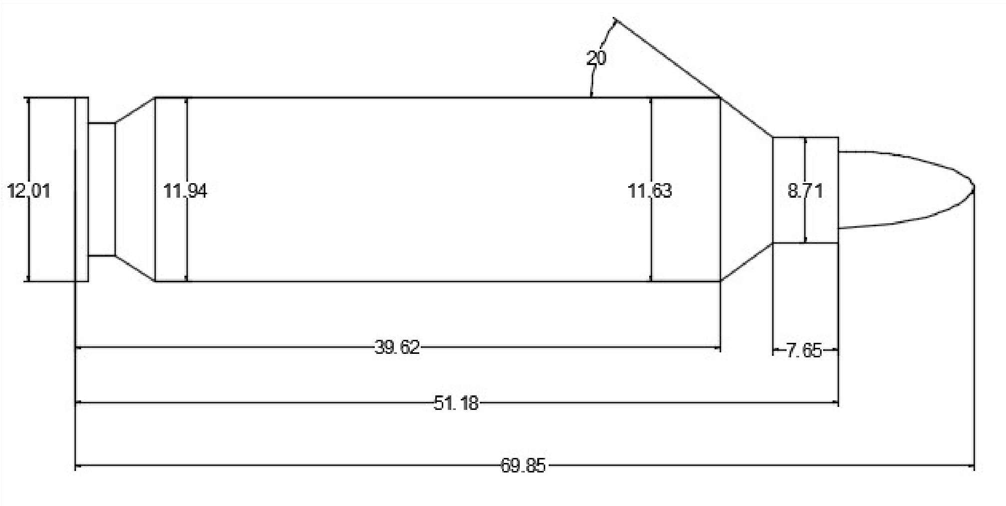

Figure 2 Dimensions of Cartridge

1.4. Criticism

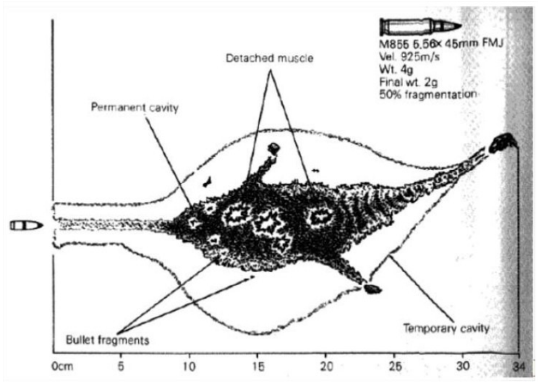

Figure 3 Wound profiles in ballistic

2. MATERIALS SELECTION FOR TARGET BODY (ARMOUR)

2.1. Aluminium 5059 alloy

Aluminum is a versatile, lightweight, and malleable metal. Aluminum alloys are manufactured to meet specific product needs. Aluminum 5059 alloy have very good corrosion resistance. This alloy cannot be heat treated to gain strength but can be readily welded and retains most of its mechanical strength. Aluminum 5059 alloys can be strengthened using strain hardening, or cold mechanical working processes if required. The composition of Aluminum 5059 alloys is given below. [5-8].

Table 1 Chemical properties (AL5059)

Element	Content
Aluminum, Al	89.8 - 94
Magnesium, Mg	5-6
Manganese, Mn	0.60 – 1.2
Iron,Fe	<0.50
Silicon,Si	<0.45
Zinc,Zn	0.40 – 0.90
Chromium,Cr	<0.25
Copper,Cu	<0.25
Titanium,Ti	<0.20
Zirconium,Zr	0.050 – 0.25
Other(each)	<0.050
Other(total)	<0.15

Table 2 Mechanical properties (AL5059)

Properties	Metric
Density	2.7 g/cm^3
Young's modulus	71GPa
Poisson ratio	0.33
Elongation at break	12%
Modulus of resilience	630 kj/m3
Specific heat capacity	890 j/kg-k
Tensile strength	410MPa
Yield tensile strength	300MPa
Thermal expansion	22um/m-k
Ultimate resilience	45 mj/m^3
Strength to weight ratio	150 kn-m/kg

The physical properties of aluminum 5059 alloy are shown in the following table.

Table 3 Physical properties (AL5059)

Properties	Metric	Imperial
Density	2.66 g/cm^3	/cm^3

2.2. Silicon carbide

Silicon carbide has conductivity and less thermal expansion. Silicon carbide increases the hardness of the material and high wear resistance. This will improve the bearing performance.

Table 2.4: Material properties

Properties	Metric
Density	4360
Bulk modulus	100/ 1e+8 pa
Compressive strength	130
Ductility	0.01
Elastic limit	172
Endurance limit	175
Fracture	14
Poisson ratio	0.35
Shear modulus	32 GPa
Tensile strength	240 GPa
Young's modulus	GPa

2.3. Molybdenum disulfide

It is a silvery black solid. Molybdenite - the ore for molybdenum which was Unreactive with dilute acids and oxygen. It is highly used solid lubricant due to flow friction. Bulk MoS2 is a diamagnetic, indirect bandgap semiconductor similar to silicon, with a band gap of 1.23 eV.

Table 5 Physical properties (MoS_2)

Properties	Metric	Imperial
Density	10.3g/cm^3	0.369 lb /in^3
Melting point	2625 C	4760 F

The *Mechanical properties* of molybdenum disulfide in the following table:

Table 6 Mechanical properties (MoS_2)

Properties	Metric
Tensile strength	324MPa
Shear strength	500MPa
Compressive yield strength	400MPa
Modulus of elasticity	330MPa
Poisson ratio	0.3

The bullet material is copper. The properties are shown in the table

Table.7: Material properties (Cu)

Properties	Metric
Density	8.96 g/cm^3
Bulk modulus	140 GPa
Poisson ratio	0.34
Fracture	81.9 Ksi
Ductility	0.02
Tensile strength	79.8 Ksi
Young's modulus	110–128 GPa

2

3. TOOLS USED

3.1. Geometrical Dimension Preparation

Initial requirements for the simulations are the geometry, specifications and flow conditions. With the design study, the geometry of the existing design was studied and the dimensions were fixed. Otherwise no need to give the geometry. The main objective and constraints were fixed and given as input. The flow condition was fixed with the Reynolds number and Mach number for the flow of an aerofoil. [9-12]. during simulation, the basic requirements are level of accuracy, the time required and the parameter of the interest. As an example of solution parameters of interest in computing the flow of field about an aerofoil, one may be interested in

- The lift of the aerofoil
- pitching moment of the aerofoil
- The same way the drag, lift and pitching moment, or
- The detailed of the flow at over the bullet. The finalized model is drawn for the required dimension and drawn using the CREO 2.0 software

Figure 4 Bullet layout using cero 2

3.2. Explicit Dynamic

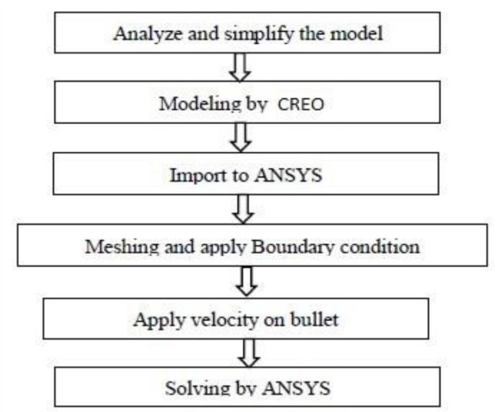

Figure 5 Methodology Flowchart

4. RESULTS AND DISCUSSION

4.1. Analysis of bullet using Explicit dynamic

In dynamics, the model extracted as IGES format aluminum 5059 alloys are chosen as material subjected to boundary condition plate was fixed and bullet velocity as 950 m/s.

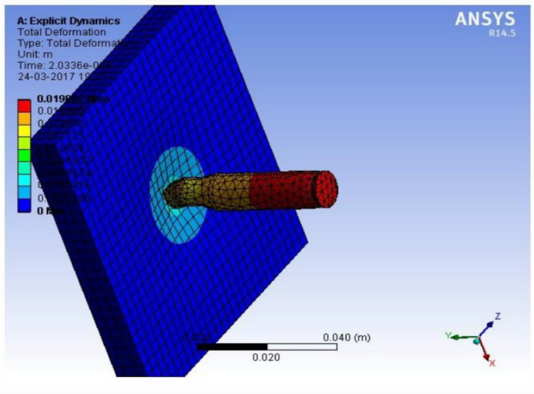

Figure 6 Total Deformation

In dynamics, the model extracted as IGES format silicon carbide are chosen as material subjected to boundary condition plate was fixed and bullet velocity as 950 m/s.

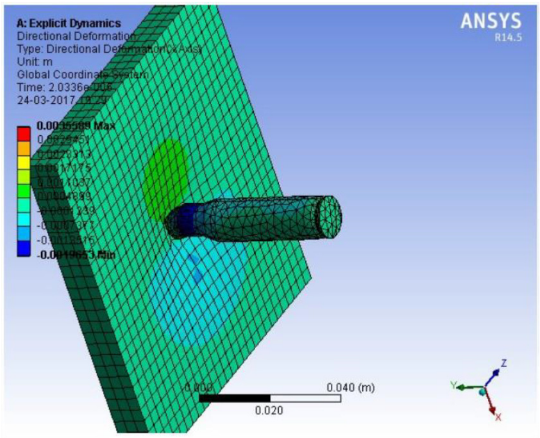

Figure 7 Directional deformation

In dynamics, the model extracted as IGES format molybdenum disulphide are chosen as material subjected to boundary condition plate was fixed and bullet velocity as 950 m/s.

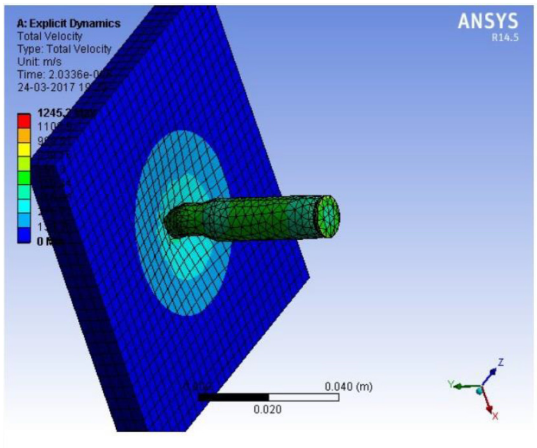

Figure 8 Total velocity

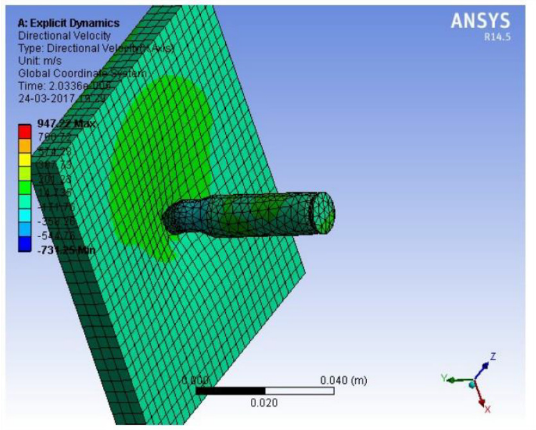

Figure 9 Directional velocity

5. CONCLUSION

Finite element analysis is carried out on three materials that are Aluminium 5059, Silicon carbide (sic) and Molybdenum disulphide to determine the deformations and stresses when it is strike with a high bullet of velocity 950m/sec. From the results and tabulations, when compared to Aluminium 5059 and Silicon carbide with minimum deformation and stresses when subjected to bullet impact. Aluminum 5059 based composites are having the desired mechanical properties like resistance to chemical reactions, higher strength, and negligible moisture sensitivity.

REFERENCE

[1] Pushpa Bajaj &Sriram,' "Ballistic protective clothing; an overview" Indian Journal of Fibre and Textile Research Vol.22, December1997, pp274-291.

[2] Kin Herbent Yeung &Khamenei Pitches ware Rao, "Mechanical properties of Boron & Kevlar 149 Reinforced thermosetting composite Economic implications" Journal of Engineering Science Vol 10, 19-29, 2014.

[3] PurnaSingh, Vikas Malik, Priyawast Lather, "Analysis of Composite Materials Used In Bullet Proof Vests Using FEM Technique" International Journal of Scientific & Engineering Research, Volume 4, Issue 5, May-2013 ISSN 2229-5518.

[4] RimanatasBarauskas, AusraAbraitiene, "Computational analysis of impact of a bullet against the multilayer fabrics in LS-DYNA" International Journal of Impact Engineering34 (2007)1286-1305.

[5] BarzinMobasher, SDRajan, "Experimental Study of Dynamic Behaviour Of kevlar149 Proceeding of the SEM." annual conference June 7-10, 2010 Indianapolis, Indiana USE @2010 Society for Experimental Mechanics.

[6] Anderson, J. D. Jr., Fundamentals of Aerodynamics, 4th ed., McGraw-Hill, New York, 2007, Chap. 9.

[7] Liepmann, H. W. and Rosko, A., Elements of Gas Dynamics, Dover Publications, New York, 2001, Chap. 4.

[8] G. Odeshi, M. N. Bassim, and M. Bolduc, "Dynamic Impact Behavior of 6061-T6 and 5083-H131 Aluminum alloys," in ICF12, 2009, pp. 1–9.

[9] S. Abrate, "Impact engineering of composite structures," CISM Courses and Lectures, vol.526, Springer Wien New York., 2011.

[10] Arbor, H. Wang, Y. Cui, D. Rose, A. Socks, and D. Ostberg, "Designing an Innovative Composite Armor System for Affordable."

[11] A. Ramadhan, A. R. Abu Talib, A. S. MohdRafie, and R. Zahari, “High velocity impact response of Kevlar-29/epoxy and 6061-T6 aluminum laminated panels,” Mater.Des., vol. 43, pp. 307–321, 2013.

[12] M. Karahan, A. Kuş, and R. Eren, “An investigation into ballistic performance and energy absorption capabilities of woven aramid fabrics,” Int. J. Impact Eng., vol. 35, no. 6, pp. 499–510, 2008.

[13] S. N. Monteiro, É. P. Lima, L. H. L. Louro, L. C. da Silva, and J. W. Drelich, “Unlocking Function of Aramid Fibers in Multilayered Ballistic Armor,” Metall. Mater. Trans. A, vol. 46, no. 1, pp. 37–40, 2015.

[14] L. Cannon, “Behind armour blunt trauma--an emerging problem.” Journal of the Royal Army Medical Corps, vol. 147, no. 1. pp. 87–96, 2001.

[15] K. S. Rao, K. El-Hami, T. Kodaki, K. Matsushige, and K. Makino, “A novel method for synthesis of silica nanoparticles,” J. Colloid Interface Sci., vol. 289, no. 1, pp. 125–131, 2005.