Impact Analysis of Bullet on Different Bullet Proof Materials

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Abstract: **When a handgun bullet strikes body armour, it is caught in a 'web' of very strong fibers. These fibers absorb and disperse impact energy that is transmitted to the vest from the bullet causing the bullet to deform. The project aims at studying various materials used in bullet proof jackets and to identify the best one based on directional deformation, total deformation, shear stresses and principal stresses when it is subjected to bullet impact. Ansys-14 is used for the analysis. Data obtained could be utilized for designing an optimized bullet proof jacket.**

Keywords: **Catia, Ansys, Bullet Proof Materials.**

I. INTRODUCTION

A composite material is defined as a material comprising of two or more chemically and or physically distinct constituents (phases) combined on a macroscopic scale. The constituents present in the composite material retain their individual identities and properties, but together they produce a material system, the properties of which are designed to be superior to those of the constituent materials acting independently. A composite material consists of two phases one is called reinforcement and other is called matrix. These two phases are separated by distinct interfaces. The most useful properties of composites are high specific strength and specific stiffness, good corrosion resistance and good fatigue resistance. [1]. A Bullet proof consist of a panel a vest shaped sheet of advanced plastic polymer that is composed of many layers of either Kevlar, spectra shield, twaron or dyneema, Boron.

II. PROPERTES OF FIBRE MATERIALS

A. Fibre Properties:

The properties of Kevlar149, Spectra900 and Boron fibres are listed as given in TABLE I.

TABLE I: FIBRE PROPERTIES

Fibre types	Elongation in %	Density in gms/cm^3	Strength in Gpa	Factor of safety	Poisson's ratio	Max Temp.
Kevlar149	1.5	1.47	2.3	2.3	0.36	250
Spectra900	3.5	0.97	2.6	1.6	0.32	100
Boron	1.0	2.5	2.55	2.4	0.3	200

B. Methodology:

At present, ANSYS software is widely used in finite element analysis, but its pre-process function is so complex that we must spend too much time and energy, especially for complex model. In our project we have used CATIA for modeling and ANSYS for meshing and analysis. The comprehensive application of various finite elements software can exert their corresponding advantages and makes the analysis more efficient.[3]

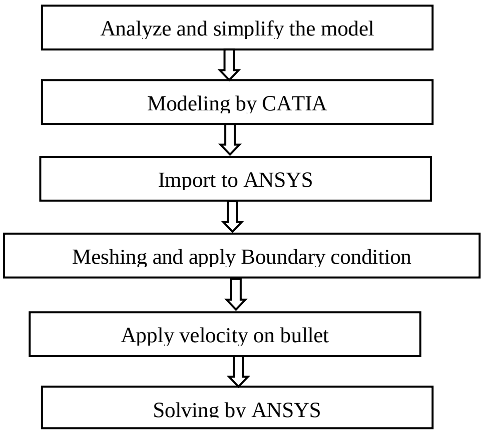

Fig 1: Steps Involved in Analysis

.Dimension of fiber materials:

Thickness of fiber material = 9mm

Dimension of bullet proof material = 100mm x 100mm

Boron, Kevlar149 and Spectra900 fiberes are taken for the analysis Dimension specification of bullet:

Diameter of bullet = 9mm

Velocity of bullet = 950m/sec

Calculations:

Thickness of the fibers = 9mm

Velocity of bullet = 950m/sec

End time = (thickness of plate) / (Velocity of bullet)

= 0.009/950

= 0.00000947sec

III. RESULTS AND DISCUSSIONS

A. Total Deformation:

Total Deformation of Boron fibre

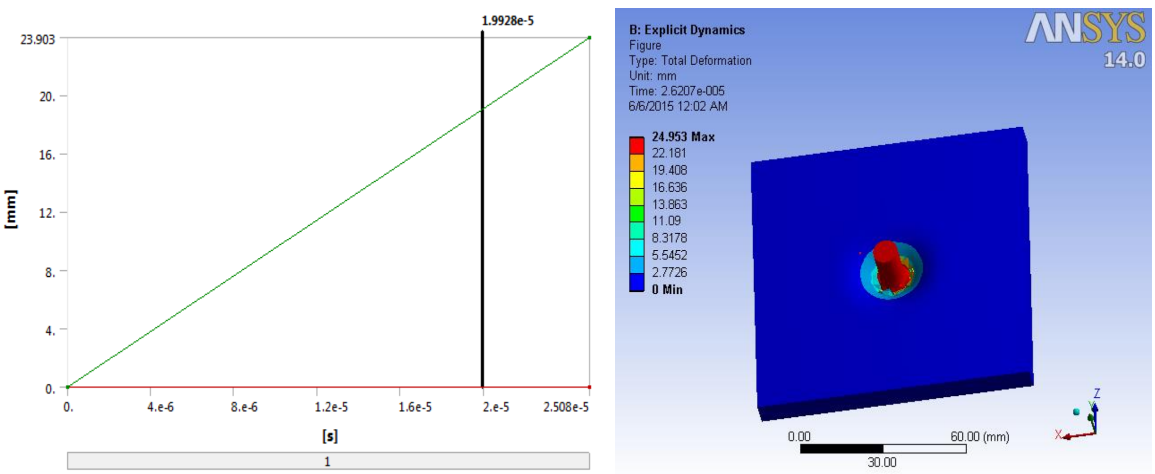

Fig .2

In dynamics analysis, the model has been extracted in IGES format. Here the material choosen is boron fibre which is subjected to boundary conditions such as the plate has been fixed and given a bullet velocity as 950 m/sec indented on a plate. The above Fig.2 shows the total deformation along Y-axis. It is found that maximum Deformation in the plate is 24.953mm.

Total Deformation of Kevlar149 fibre

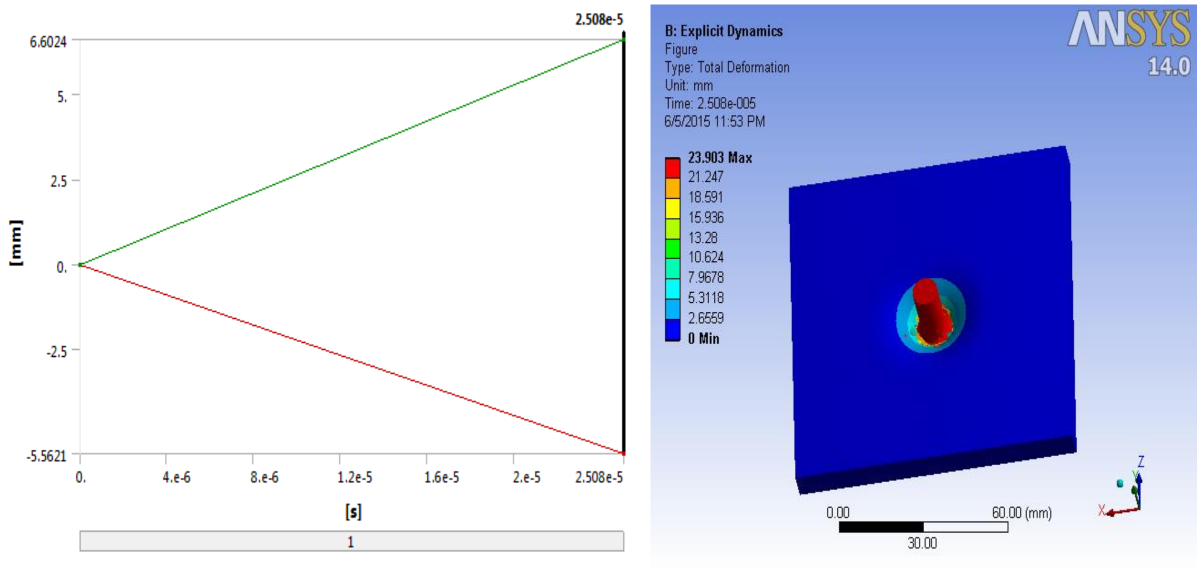

Fig .3

In dynamics analysis, the model has been extracted in IGES format. Here the material choosen is kevlar149 fibre which is subjected to boundary conditions such as the plate has been fixed and given a bullet velocity as 950 m/sec indented on a plate. The above Fig.3 shows the total deformation along Y-axis. It is found that maximum Deformation in the plate is 24.903mm.

Total Deformation of Spectra900 fibre

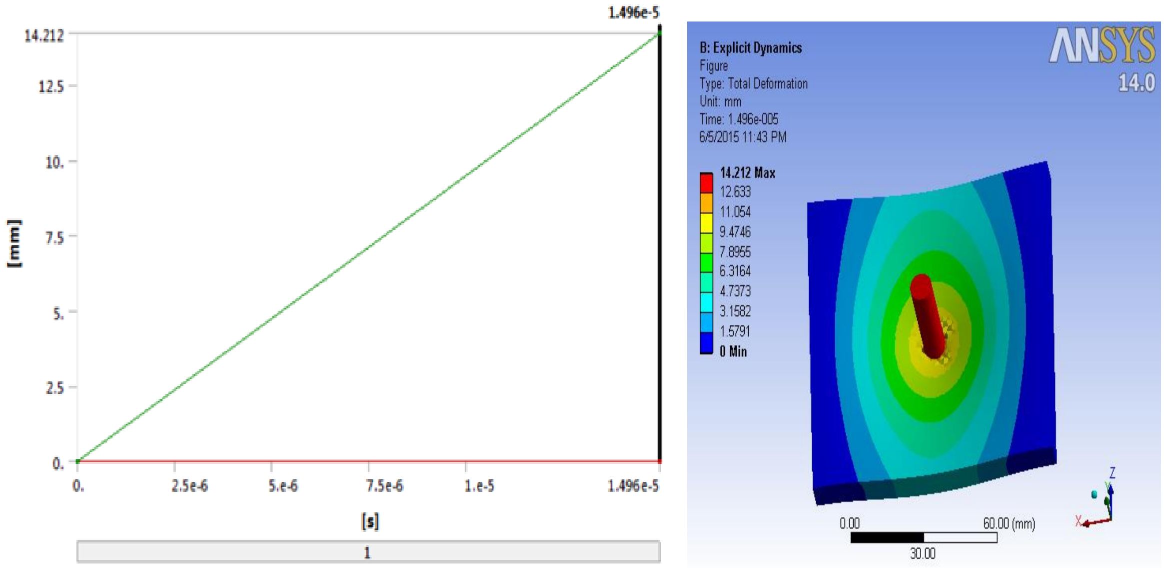

Fig .4

In dynamics analysis, the model has been extracted in IGES format. Here the material choosen is Spectra900 fibre which is subjected to boundary conditions such as the plate has been fixed and given a bullet velocity as 950 m/sec indented on a plate. The above Fig.4 shows the total deformation along Y-axis. It is found that maximum Deformation in the plate is 14.212 mm.

B. Maximum Principal Stress:

Maximum Principal Stress of boron fibre

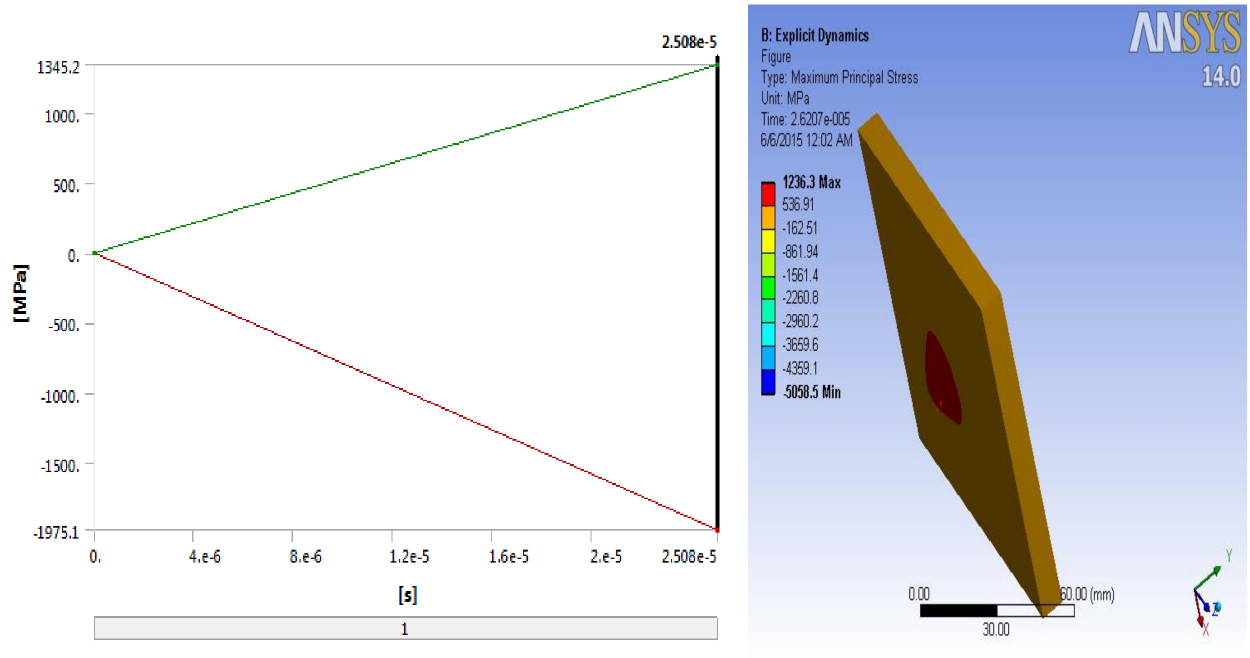

Fig .5

In dynamics analysis, the model has been extracted in IGES format. Here the material choosen is boron fibre which is subjected to boundary conditions such as the plate has been fixed and given a bullet velocity as 950 m/sec indented on a plate. The above Fig.5 shows the Maximum and Minimum Principal Stress. The maximum principal stress of the plate is 1236.3 Mpa and minimum principal stress is -5058.5 Mpa.

Maximum Principal Stress of Kevlar149 fibre

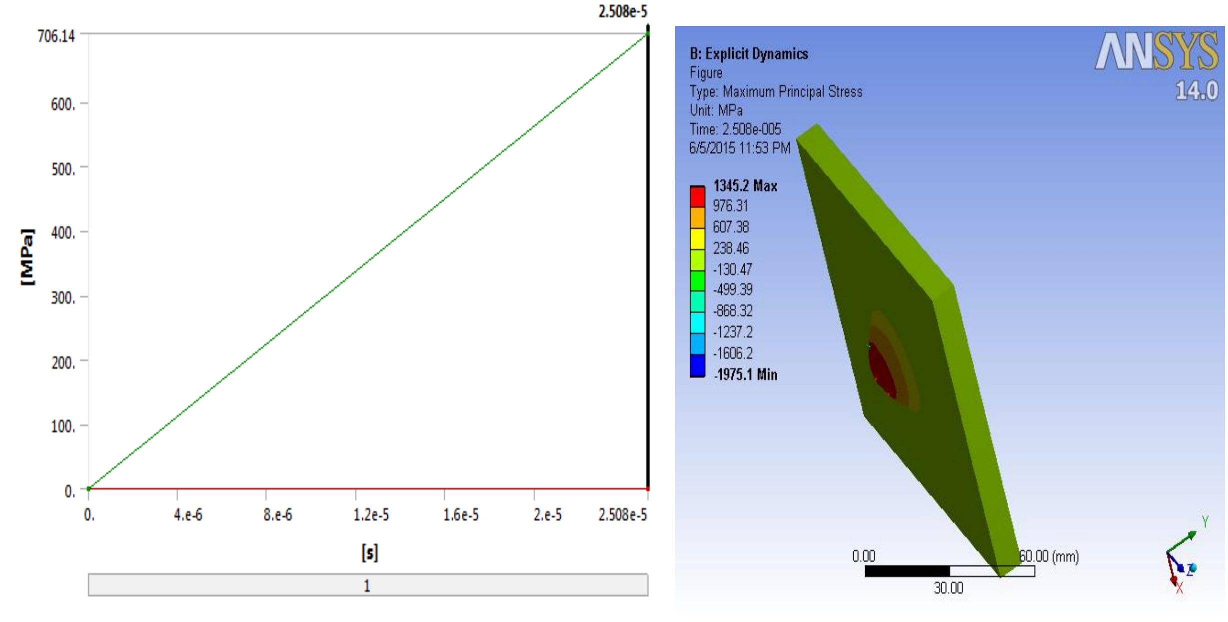

Fig .6

In dynamics analysis, the model has been extracted in IGES format. Here the material choosen is kevlar149 fibre which is subjected to boundary conditions such as the plate has been fixed and given a bullet velocity as 950 m/sec indented on a plate. The above Fig.6 shows the Maximum and Minimum Principal Stress. The maximum principal stress of the plate is 1345.2 Mpa and minimum principal stress is -1975.1 Mpa.

Maximum Principal Stress of Spectra900 fibre

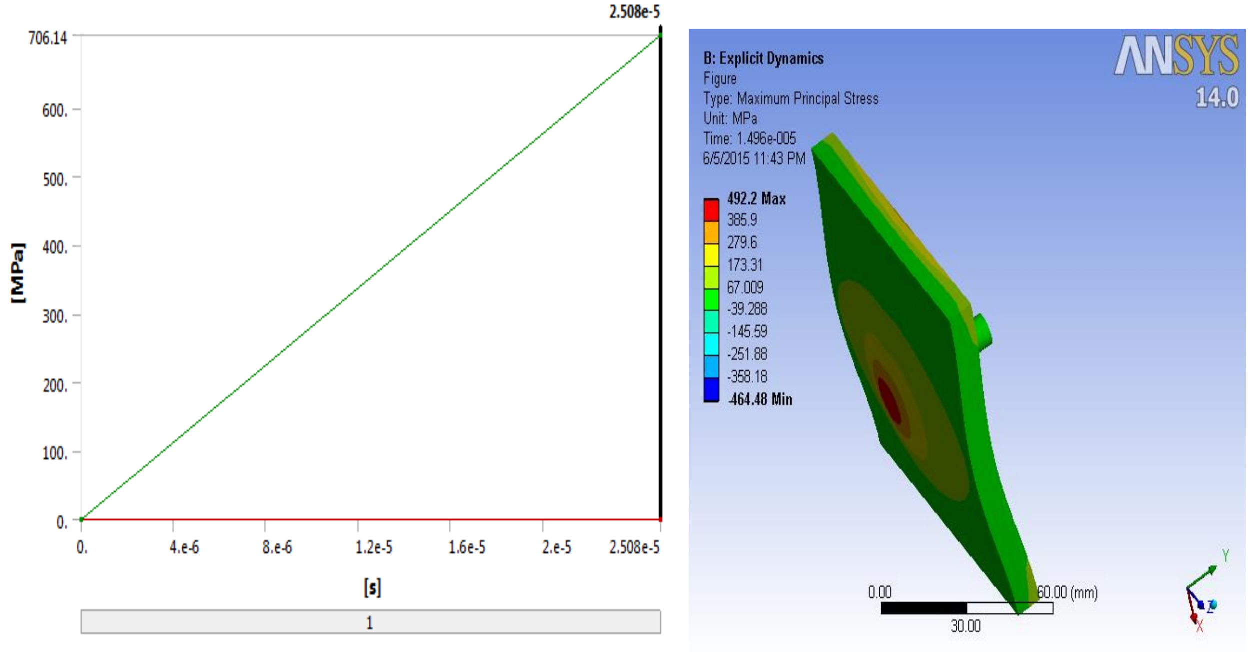

Fig .7

In dynamics analysis, the model has been extracted in IGES format. Here the material choosen is Spectra900 fibre which is subjected to boundary conditions such as the plate has been fixed and given a bullet velocity as 950 m/sec indented on a plate. The above Fig.7 shows the Maximum and Minimum Principal Stress. The maximum principal stress of the plate is 492.2 Mpa and minimum principal stress is -464.4 Mpa.

C. Directional Deformation Along Y Direction:

Directional Deformation of Boron fibre

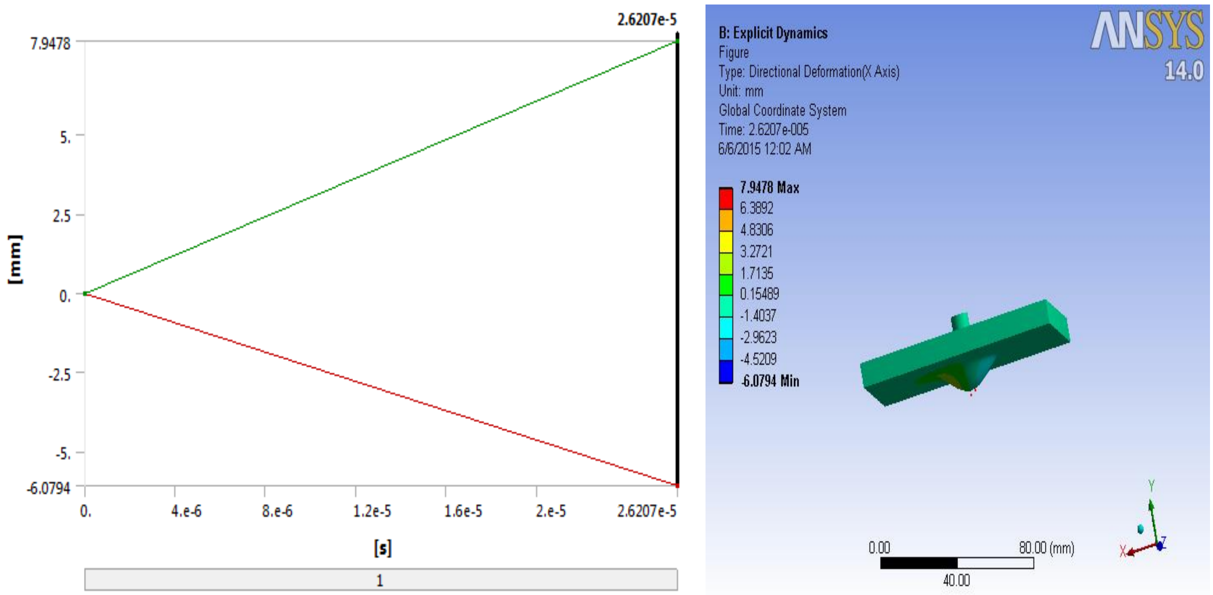

Fig .8

In dynamics analysis, the model has been extracted in IGES format. Here the material choosen is Boron fibre which is subjected to boundary conditions such as the plate has been fixed and given a bullet velocity as 950 m/sec indented on a plate. The above Fig.8 shows the directional deformation. Directional deformation along y direction of the plate is 7.9478 mm.

Directional Deformation of Kevlar149 fibre

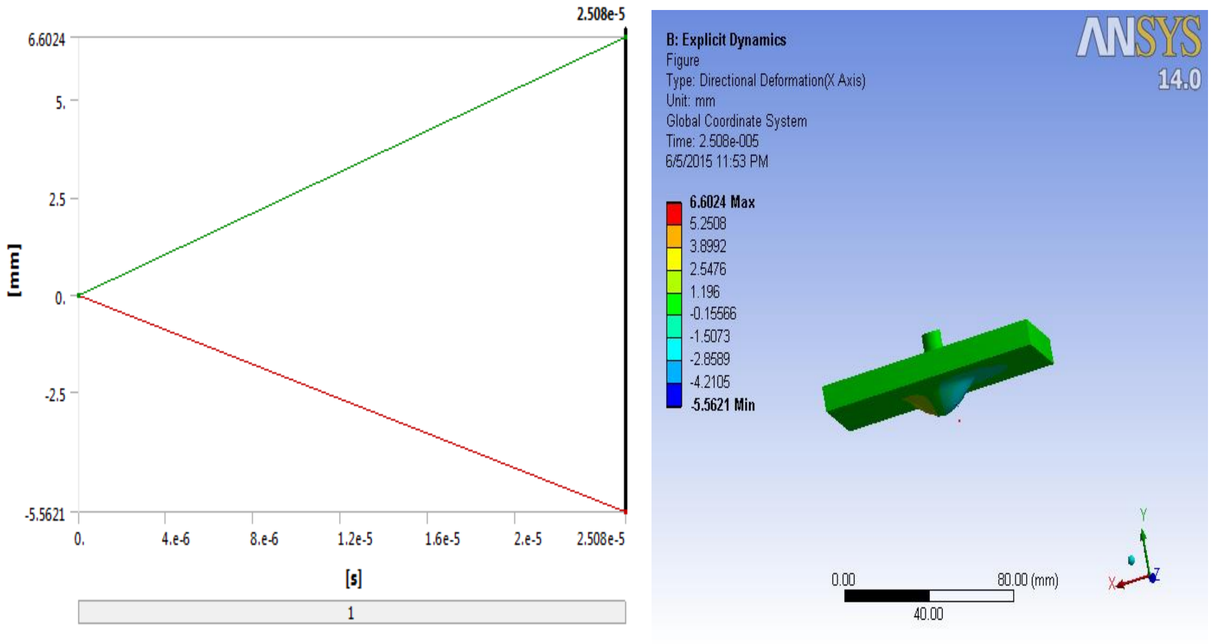

Fig .9

In dynamics analysis, the model has been extracted in IGES format. Here the material choosen is Kevlar149 fibre which is subjected to boundary conditions such as the plate has been fixed and given a bullet velocity as 950 m/sec indented on a plate. The above Fig.9 shows the directional deformation. Directional deformation along y direction of the plate is 6.6024 mm.

Directional Deformation of Spectra900 fibre

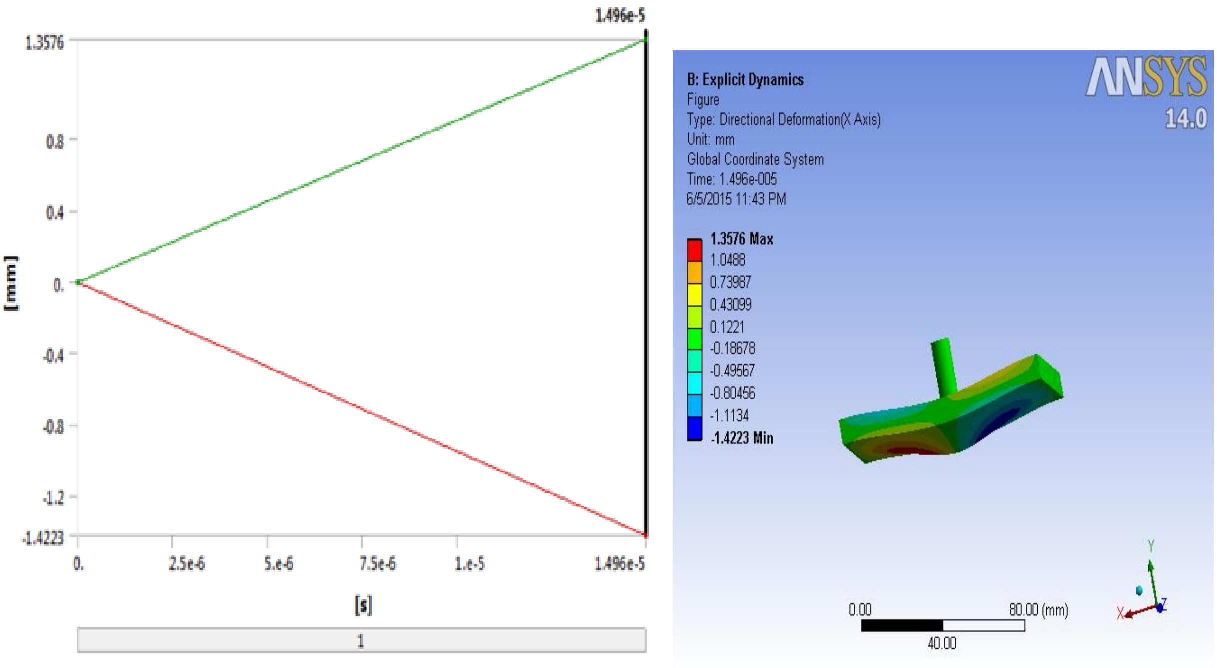

Fig .10

In dynamics analysis, the model has been extracted in IGES format. Here the material choosen is Spectra900 fibre which is subjected to boundary conditions such as the plate has been fixed and given a bullet velocity as 950 m/sec indented on a plate. The above Fig.10 shows the directional deformation. Directional deformation along y direction of the plate is 1.3576 mm.

D. Maximum Shear Stress:

Maximum Shear Stress of Boron fibre

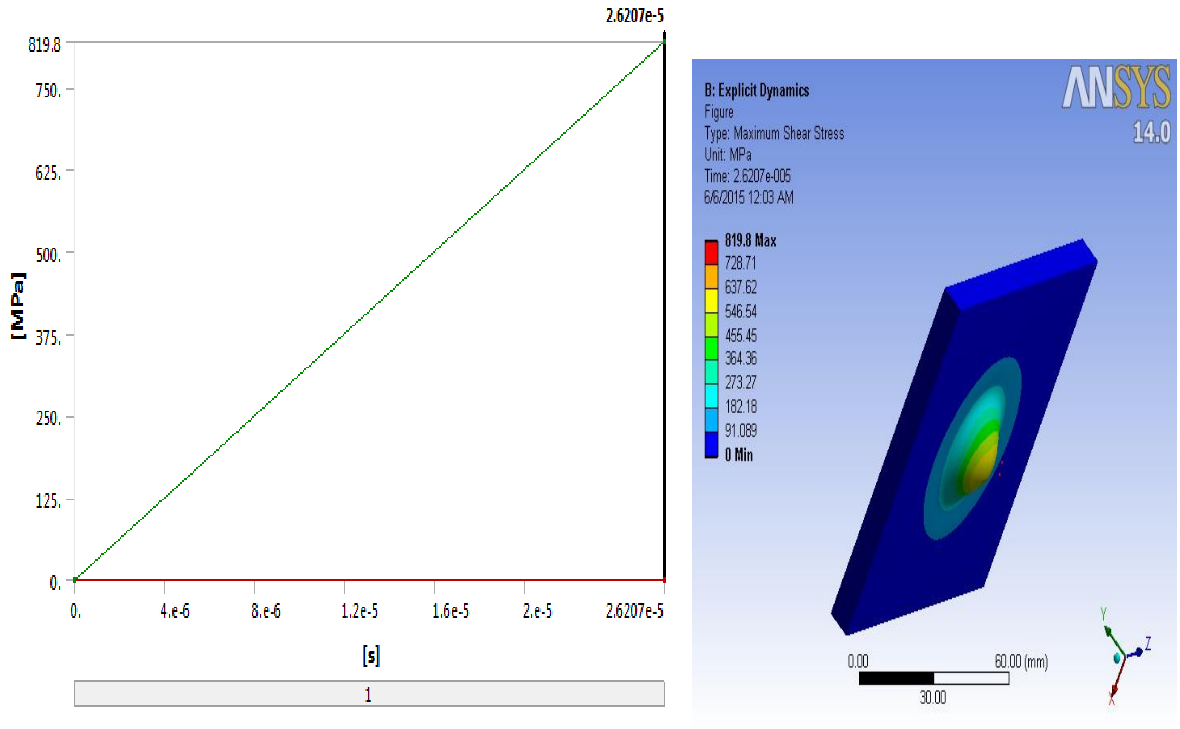

Fig .11

In dynamics analysis, the model has been extracted in IGES format. Here the material choosen is Boron fibre which is subjected to boundary conditions such as the plate has been fixed and given a bullet velocity as 950 m/sec indented on a plate. The above Fig. 11 shows the maximum shear stress. Maximum shear stress of the plate is 819.8 Mpa

Maximum Shear Stress of Kevlar149 fibre

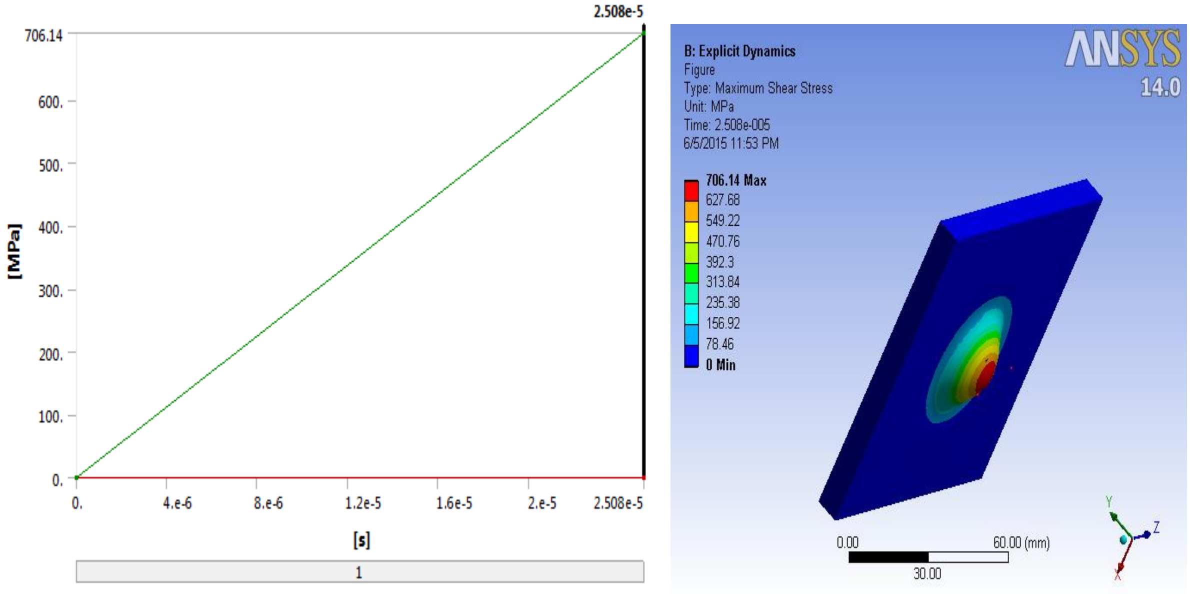

Fig .12

In dynamics analysis, the model has been extracted in IGES format. Here the material choosen is Kevlar149 fibre which is subjected to boundary conditions such as the plate has been fixed and given a bullet velocity as 950 m/sec indented on a plate. The above Fig. 12 shows the maximum shear stress. Maximum shear stress of the plate is 706.14 Mpa.

Maximum Shear Stress of Spectra 900 fibre

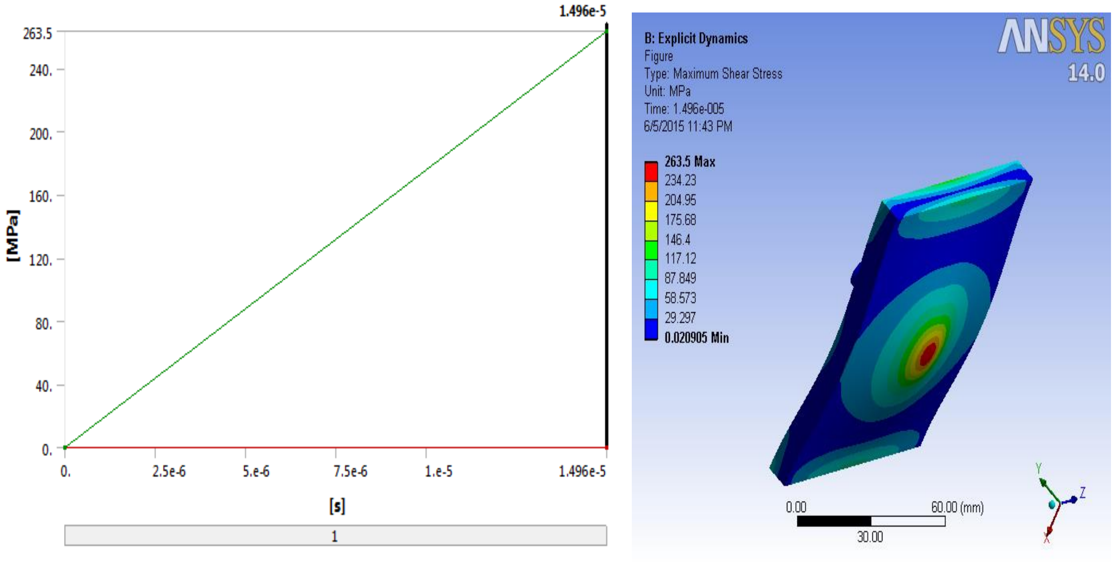

Fig .13

In dynamics analysis, the model has been extracted in IGES format. Here the material choosen is Spectra900 fibre which is subjected to boundary conditions such as the plate has been fixed and given a bullet velocity as 950 m/sec indented on a plate. The above Fig. 13 shows the maximum shear stress. Maximum shear stress of the plate is 263.5 Mpa.

III. CONCLUSION

Finite element analysis is carried out on three materials that is Boron fiber, Kevlar 149 and Spectra 900 to determine the deformations and stresses when it is striked with high bullet of velocity 950m/sec. From the results and tabulations it is evident that Spectra 900 fibers are the best when compared to Boron and Kevlar 149 with minimum deformation and stresses when subjected to bullet impact. Spectra 900 based composites are having the desired mechanical properties like higher strength, resistance to chemical reactions, negligible moisture sensitivity.

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