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Modelling and FE Analysis of Bumper Using Honeycomb Sandwich Structure

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ABSTRACT:

The study of energy-absorbing behaviour in sandwich beams under static loading has become the basis for the design of crashworthy structure in automobile applications. Unlike metals, composite sandwich materials display little or no plastic deformation. Research has shown that foam-cored sandwich beam has significantly higher energy absorption than low carbon/high carbon steel used in automobiles. This thesis is aimed at developing a structural component that provides better kinetic energy absorption, than the existing car front bumper. Occupants of motor vehicles are injured or killed in several different types of crash situations. These are frontal, side, rear, and rollover.

The most severe accident situations are frontal impact. The car front bumper is a major structural component, and it carries most of the impact load in crash events. Therefore, in order to improve the front bumper performance, an attempt is made in this study to use sandwich material in the front bumper. And for that, a study is carried out to arrive at a combination of core and face sheet that offers maximum energy absorption.In this thesis, design of a bumper used for Maruti Suzuki SX4 is modified with honeycomb structure and analyzed for its strength.

The original and modified models are designed in Pro/Engineer and Simulation using Finite Element Analysis software, which is COSMOS, is conducted. Presently used material for bumper is steel. In this thesis analysis is to be done by replacing the bumper material with Kevlar. Impact analysis is done by varying the speeds 75Km/hr, 100Km/hr and 150Km/hr.

KEYWORDS:

Modelling, Analysis, Sandwich Structure, Impact Analysis.

I.INTRODUCTION:

Honeycomb Sandwich Structure Basically consists of a core, which is basically sandwiched between the two face sheet upper and lower face sheet. In this structure we have option to select material for upper face sheet, lower face sheet, and for core material. This structures property depend upon the geometry of the core such as cell shape, which is basic unit of core, height of core, thickness of foil from which cell is prepared. Face sheet thicknessalso major contribute in properties. We can obtain desired effect by changing any one parameter. For pedestrian damage we have to focus on front side bumper of car .In Indian low cost car the material used for bumper is steel. Bumper is part which comes most in deformation zone, so crashworthiness of bumper should increase.The objective of this work is to identify, the best material for bumper reinforcement which will ensure passenger safety, with high strength to weight ratio through static impact analysis .Using different engineering materials like alloy steel and Kevlar.

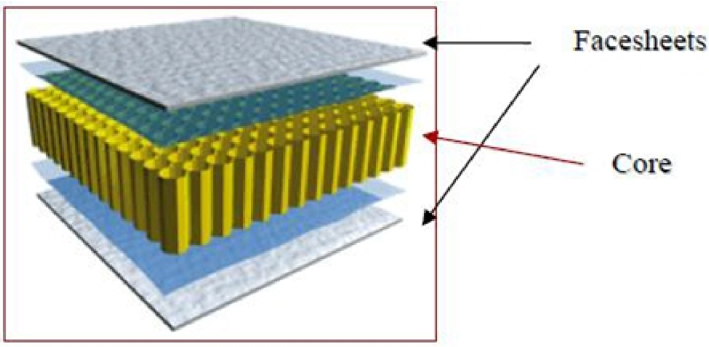

Fig 1. Honeycomb Sandwich Structure

II.METHADOLOGY:

The 3D model of bumper reinforcement is made in PROE. After this the same model is imported in to COSMOS workbench for impact analysis, stress and deformation is observed.

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We are applied here condition for impact is velocity condition which 75 km/hr (20.83 m/s), 100 km/hr (27.77 m/s), and 150 km/hr (41.66 m/s) and respective masses for two materials. Now by using Newton's second law, we calculated force value according to respected speeds for two materials. This point force applied centrally on Bumper beam.

III.MATERIAL SELECTION:

Two types of material are selected for bumper mainly following specification:

Table 1. Material Properties

Material Name	Yield Strength Modulus	Density	Elastic Modulus
Alloy Steel	620.422 $N.mm^2$	7700 g/cm^3	210 GPA
Kevlar	4000 N/mm^2	1400 g/cm^3	60GPA

IV.MODELLING OF A BUMPER:

In this Bumper for Maruti Suzuki Sx4 is taken as reference, and then optimized the shape for modified model. These Original and Modified models are modelled using parametric software Pro/Engineer. The thickness of original model is 10mm. In this thesis it is increase to 70mm.

A.ORIGINAL MODEL:

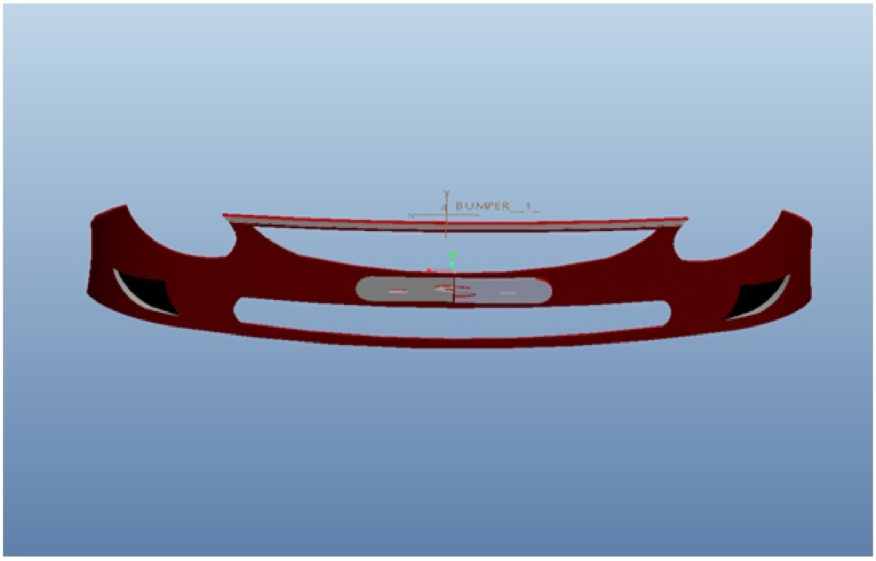

Fig2. 10mm Thickness Bumper

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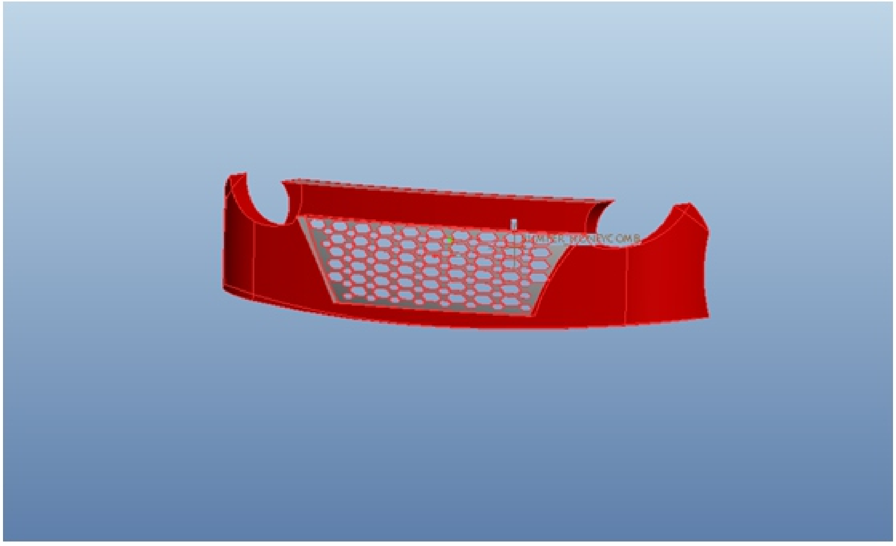

Fig2. 10mm Thickness Bumper

V.EXPERIMENTAL PROCEDURE:

a)DYNAMIC OR IMPACT ANALYSIS OF BUMPER FOR ALLOY STEEL AT 75 KMPH

Table2. STUDY RESULTS

Name	Type	Min	Max
Stress1	VON: Vanishes Stress	12.9153N/mm^2 Node: 13452	2374.92N/mm^2 Node: 17091

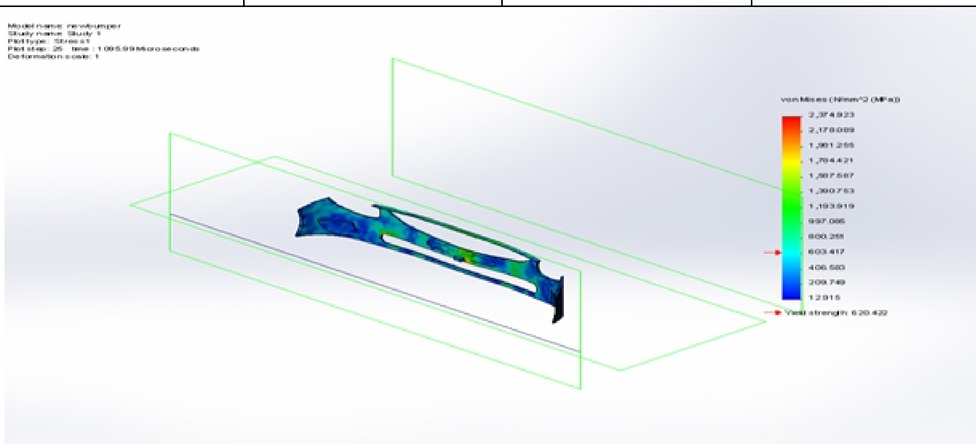

Fig4. Stress

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Name	Type	Min	Max
Displacement1	URES: Resultant Displacement	0.103437 mm Node: 13553	26.6413 mm Node: 14050

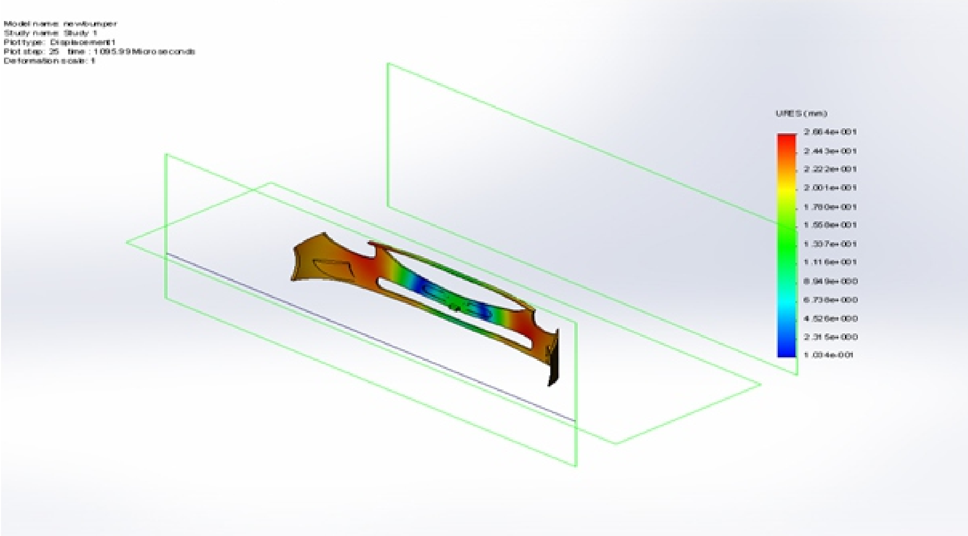

Fig5. Displacement

Name	Type	Min	Max
Strain1	ESTRN: Equivalent Strain	4.75622e-055 Element: 2956	0.00672196 Element: 4739

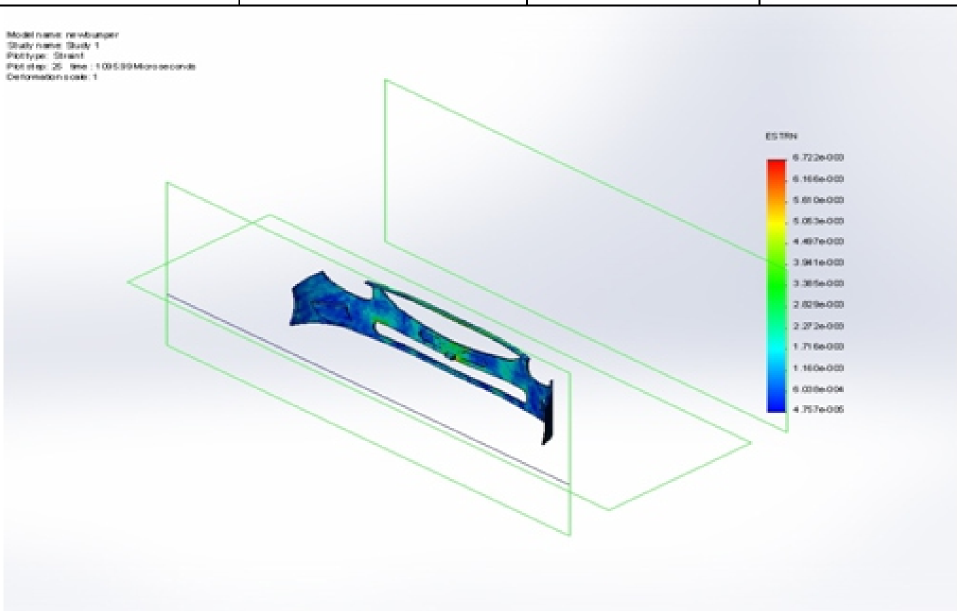

Fig6. Strain

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In the same way we find the results for alloy steel at 100kmph and 150kmph. For these speeds we have mentioned the results it in tabular column for two models.

Table3. Table and Graphs for Alloy Steel of Front Impact

SPEED	DISPLACEMENT		STRESS		STRAIN	
	Original	Modified	Original	Modified	Original	Modified
75	$2.790e^{+001}$	$3.207e^{+001}$	613.602	2345.996	$6.369e^{-003}$	$4.968e^{-003}$
100	$3.443e^{+001}$	$4.515e^{+001}$	1913.3	3333.513	$3.550e^{-003}$	$7.058e^{-003}$
150	$5.210e^{+001}$	$7.076e^{+001}$	2396.5	5433.480	$4.682e^{-003}$	$1.215e^{-002}$

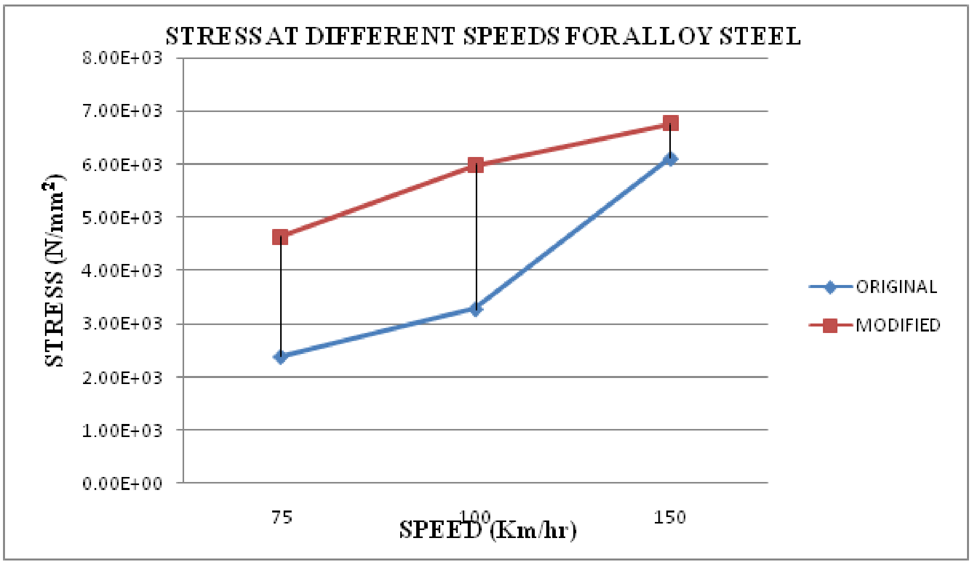
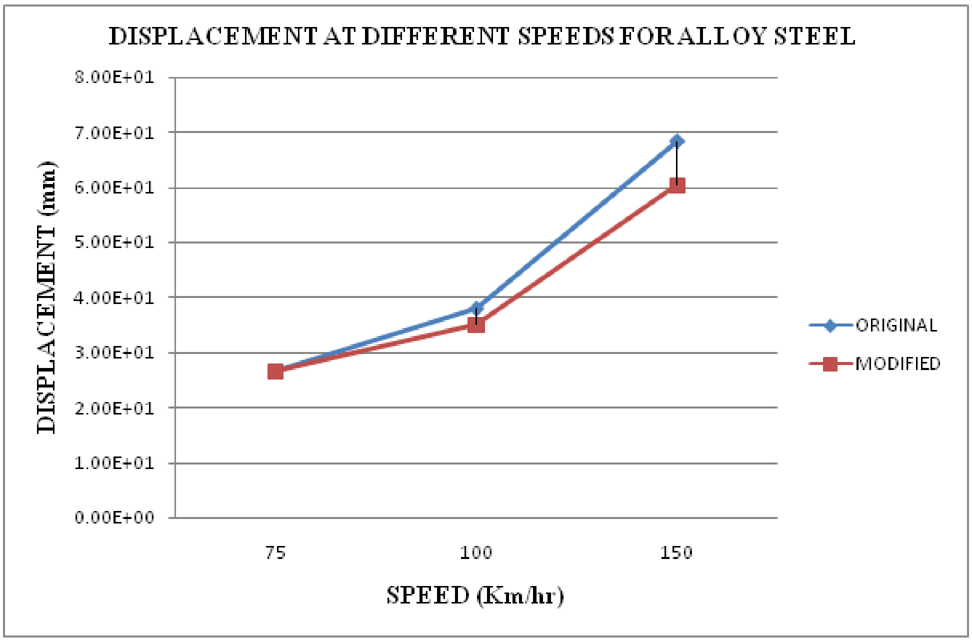


Fig7. Stress vs. Speed for Alloy Steel of Front Impact



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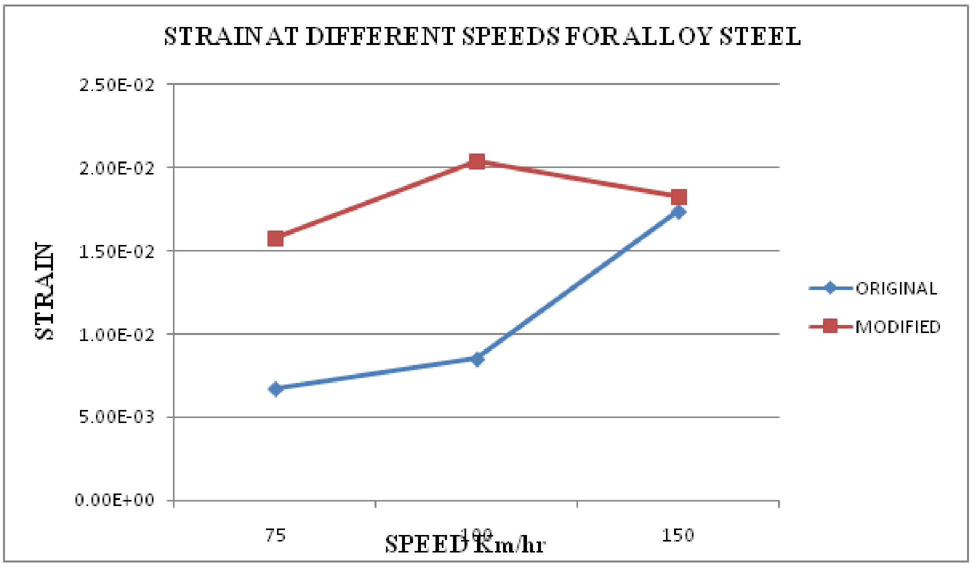

Fig9. Strain vs. Speed for Alloy Steel of Front Impact

b)DYNAMIC OR IMPACT ANALYSIS OF BUMPER FOR KEVLAR AT 75 KMPH

Table4. Study Results:

Name	Type	Min	Max
Stress1	VON:VonMises Stress	1.83293 N/mm² Node: 10252	613.602 N/mm² Node: 18140

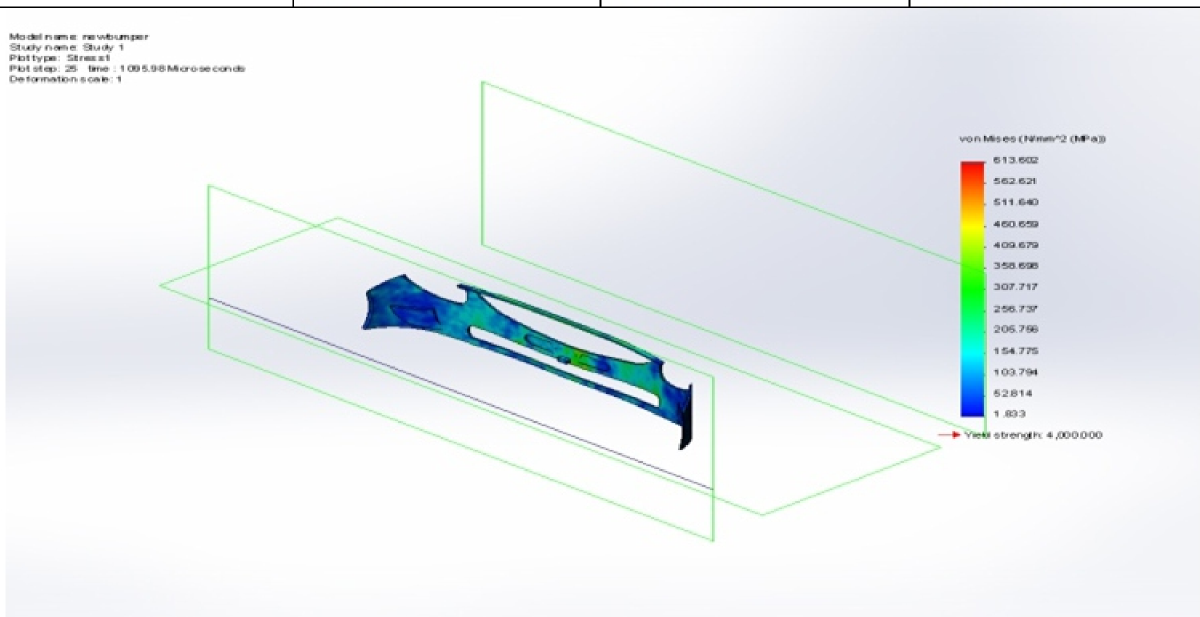

Fig10. Stress

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Name	Type	Min	Max
Displacement 1	URES: Resultant Displacement	0.244074 mm Node: 13848	27.9033 mm Node: 179

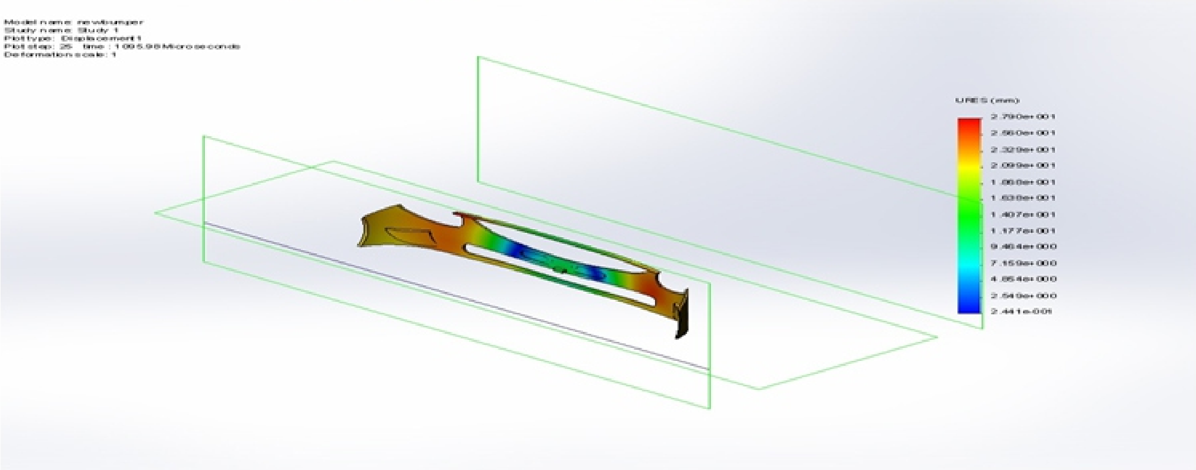

Fig11.Displacement

Name	Type	Min	Max
Strain 1	ESTRN: Equivalent Strain	5.62362e-005 Element: 7405	0.00636891 Element: 5065

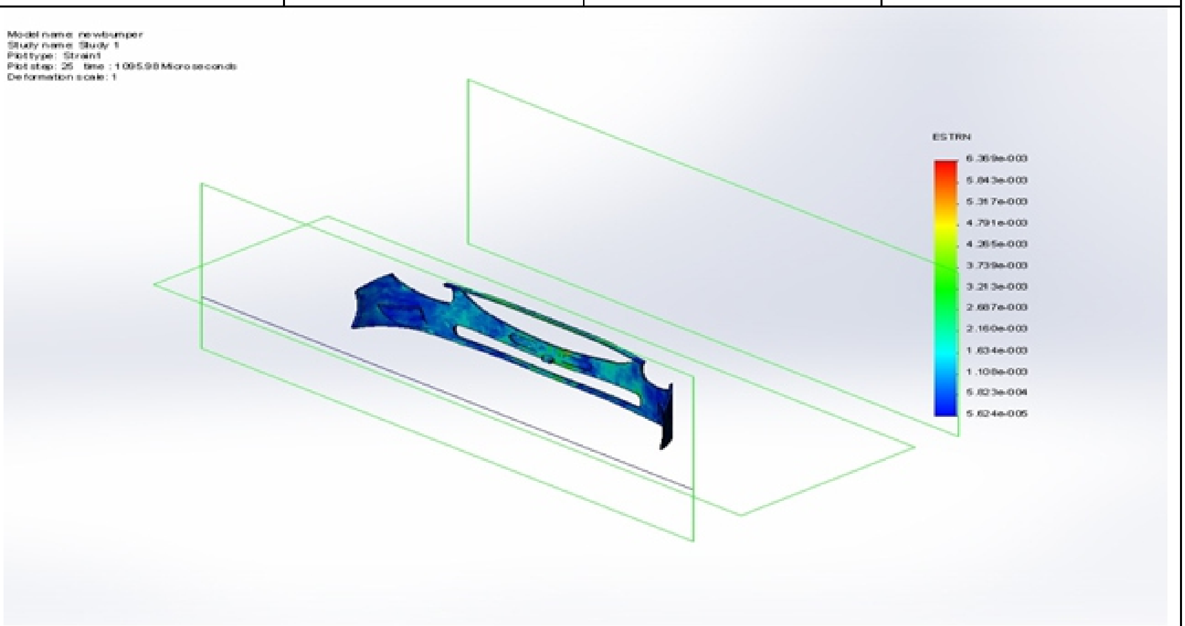

Fig12. Strain

In the same way we find the results for kevlar at 100kmph and 150kmph. For these speeds we have mentioned the results it in tabular column for two models.

Table5. TABLE AND GRAPHS FOR KEVLAR OF FRONT IMPACT

SPEED	DISPLACEMENT		STRESS		STRAIN	
	Original	Modified	Original	Modified	Original	Modified
75	2.790e+001	3.207e+001	613.602	2345.996	6.369e-003	4.968e-003
100	3.443e+001	4.515e+001	1913.3	3333.513	3.550e-003	7.058e-003
150	5.210e+001	7.076e+001	2396.5	5433.480	4.682e-003	1.215e-002

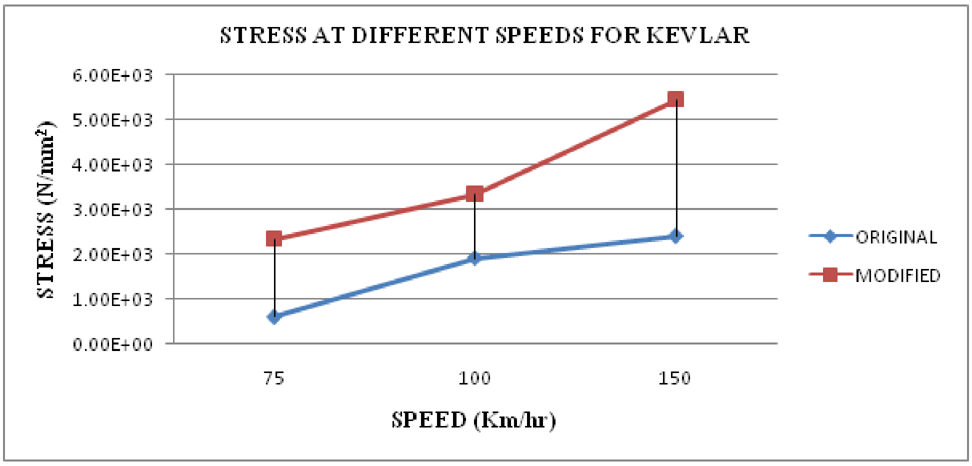

Fig13. Stress vs. Speed for Kevlar of Front Impact

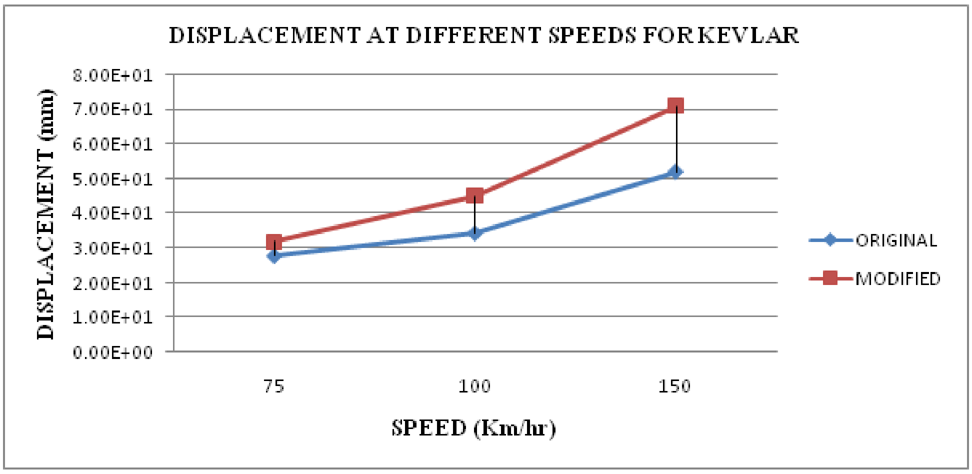

Fig14. Displacement vs. Speed for Kevlar of Front Impact

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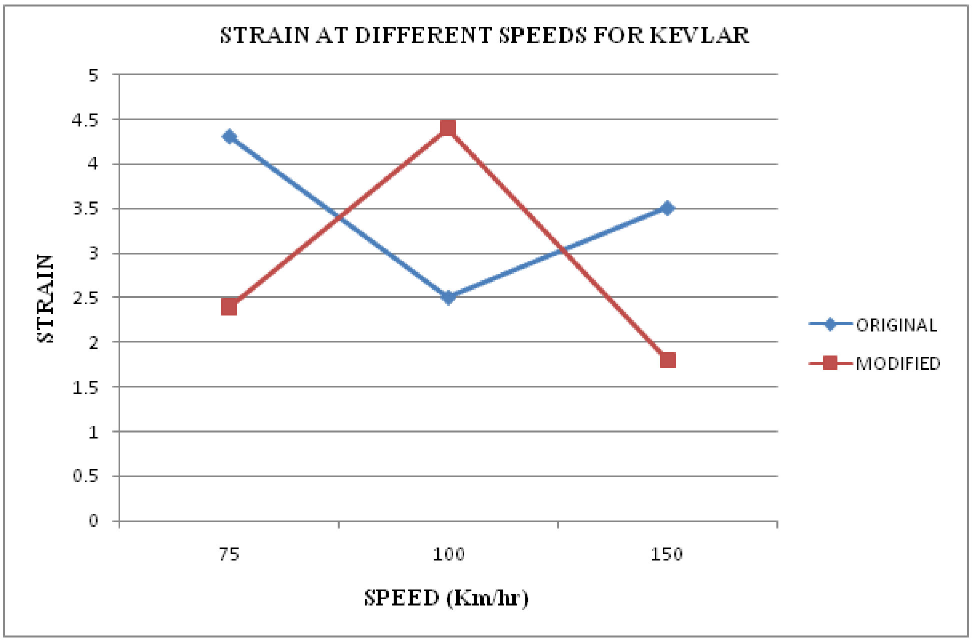

Fig15. Strain vs. Speed for Kevlar of Front Impact

VI.CONCLUSION:

The goal of this thesis was to investigate the use of composite sandwich panel as an alternative to the present automobile front bumper, and thus help in reducing the risk of injuries to the occupant. The composite sandwich beam model was computationally tested by simulation using Finite Element Analysis Software, which is COSMOS is conducted. In this thesis, modelling of a bumper used for Maruti SX4 is modified with honeycomb structure and analyzed for its strength. The following conclusions can be made from this study.

•Presently used material for the bumper is Steel. Analysis is to be done by replacing the bumper material with Kevlar. Impact Analysis is done by varying the speeds 75km/hr, 100km/hr, and 150km/hr.

•By observing analysis results for Alloy Steel the Original Model for Front impact of the Displacement is less and Stresses are more for Modified Model than Original.

•The uses of Alloy Steel for taken Speeds are failed, because the analyzed stress values are more than that of yield strength of steel.

•By Observing analysis results for Kevlar the Original Model for Front Impact of the Displacement and Stresses are more for Modified Model than Original Model.

•The use of Kevlar when the bumper is impacted at front, only at speeds of 75Km/hr and 100Km/hr is suitable for the both Original Model and Modified Model, and for 150Km/hr only Original Model is Suitable, because the analyzed stress values are less than that of strength of Kevlar.

•It can be concluded that the modified model is better with use of Kevlar at speeds of 75Km/hr and 100Km/hr.

VII.FUTURES SCOPE:

The Following recommendations are made for future work in this thesis:

•Improvement can be made in the design of the sandwich beam, by varying the core
Thickness and the orientation of the layers used in the laminate.

•A multiple-cored sandwich beam can be designed with two different foam coresBonded together by an adhesive material.

•In this present research, face sheet and foam are joined together rigidly, but still better Results can be obtained if the adhesive material properties are defined in detail while modelling the sandwich beam.

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