Impact Analysis of an Automobile Bumper Using Spring

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Abstract- *A bumper is a mechanical part which is attached to vehicle from front and rear end and it's used for absorb impact on vehicle. So design of bumper in such way that is absorbs impact (Purpose of Safety). Bumper is made from steel and many more. Bumper is important part and it is connected to directly to chassis so there is no linkage to drop that impact force, But in this paper we proposed new bumper with spring to absorb that impact force. Spring is used to absorb impact energy. A new bumper is designed in AutoCAD 3d and structural analysis is done in ANSYS Workbench. For structural analysis steel is used. In most commercial vehicle still steel bumper is used.*

Keywords- Bumper, Impact Force, AutoCAD 3d, ANSYS, Steel.

I. INTRODUCTION

A bumper is the structure connected to vehicle from front and rear side .the purpose of bumper is to absorb impact force in collision to minimize service cost. So design of bumper with economic and safety have been great challenge. And the safety of passenger is important so used right bumper is necessary. So bumper is places in such way that after collision it goes towards chassis and minimizes impact on vehicle. Material used for bumper is steel, aluminum and many others. At the time of design several factor considered the material, ability to absorb shocks, weight, Manufacturing Process Ability. Now a day's bumper is connected to directly chassis so there is no mechanism to absorb energy so design of new bumper is necessary to absorb that energy. So the designed spring bumper in which spring is used to break that linkage that is necessary to absorb energy and it does not allow transfer that energy as possible as to other part of vehicle.

II. LITERATURE REVIEW

1) **G.Ravikumar Reddy, M.Suneetha [1]** designed a bumper using spring to absorb impact forces. In this paper for analysis of the bumper, is carried on different material. The bumpers with springs and without spring's are designed and analysed. The stresses and deformation are calculated at different speeds. Frequency is less for GMT material and deformation is high as compare to other material.
2) **Maheshkumar V. Dange1, Dr. Rajesh al. [2]** has studied at the time design use material having high yield strength and high modulus of elasticity. Plastic deformation avoided. Material M220 is best material for bumper beam designed.
3) **Dharmateja Kruthiventi and M. Venkaiah [3]** has studied Modelling of a car bumper is done using 3D software.Forces analyzed on bumper for different speeds. The analysis of car bumper on different materials examined. At present material used for bumper is steel. Density of ABS Plastic, Polyetherimide, s2 glass and glass fibre composes is less compare to steel. By observing stress value is less for s2 glass than other material.
4) **Bilal Abdullah Baig and Hakimuddin. A. Hussain[4]** has studiedfrom the literature it can be stated that bumper is an important part of an automobile. Thus the analysis of bumper will help to increase the design and also for new size, shape and material.

III. METHODOLOGY

A.Material Selection

A bumper is used for absorbing shock or impact when accidental hitting. Selection of material for bumper design, the material required has high capability of absorb the impact either reduce effect of strike. So the bumper is manufactured by using material like steel.

Table 1: Properties Of material

SR	Material	Density (kg/m^3)	Poisson's ratio	Ultimate Tensile Strength(MPA)	Young Modulus(GPA)
1	Steel	7750	0.27	510	190

B.Problem Definition

Force Calculation for Bumper

Here Considered any vehicle for design i.e. bumper drawings
Mass of vehicle =1703 kg.
Mass of two passengers = 150kg i.e., 75kg each=150kg
Total Mass of vehicle in motion
m = 1703 +150
m = 1853 kg

Hence

Assumptions: 1. Initial Velocity = 0 m/s 2. Time = 1 s
Case 1 For V = 50kmph v= 13.5m/s
a= 0-13.5/1 a = 13.5 m/s^2
F= m×a F=1853 x 13.5
F=25015.5 N F =25015 N
Case 2 for v=90kmph v=24.3m/s
a=0-24.3/1 a=24.3 m/s^2
F=m×a F= 1853×24.3
F=45027.9 F=45027N

IV. MODELING

AutoCAD is used for bumper designed. It is computer aided design and drafting software and it is used to create precise 2D and 3D drawing. Here modeled Bumper for analysis are bumper without spring or Bumper with spring attachment.

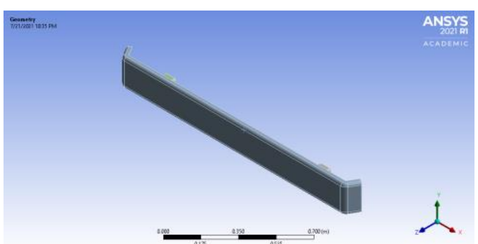

Figure 1: Bumper withoutspring

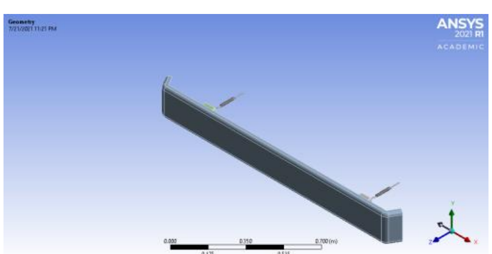

Figure 2: Bumper with spring

V. ANALYSIS

A. Introduction to ANSYS

ANSYS is finite element analysis software and it is a numerical method of deconstructing a complex geometry/system into very small pieces. This result can be presented in tabulated or graphical form

B. Structural Analysis

Structural Analysis involves determining behavior of material when it is subjected to load. In this structural analysis done at different speed like 50km/hr., 90km/hr. and different material like steel and aluminum B390 respectively

1. Bumper without spring

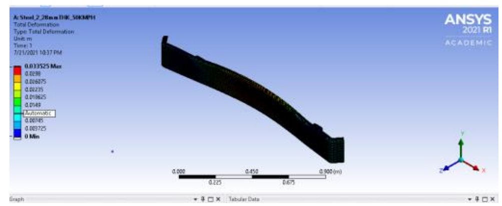

Figure 3. Total Deformation at 50km/hr.

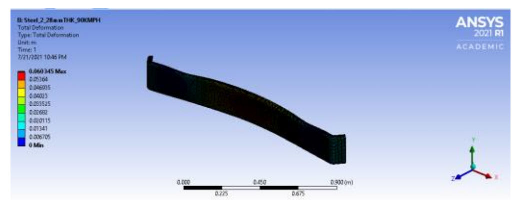

Figure 4. Total Deformation at 90km/hr.

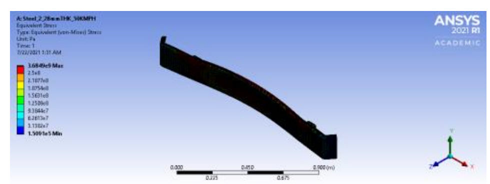

Figure 5. Equivalent Stress at 50km/hr.

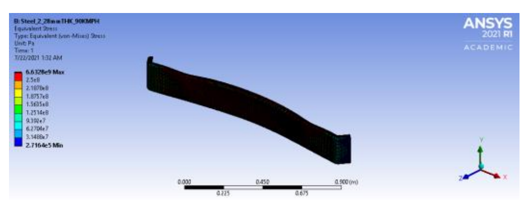

Figure 6. Equivalent Stress at 90km/hr.

The comparison result shown in in tabular column in result.

2. Bumper with spring

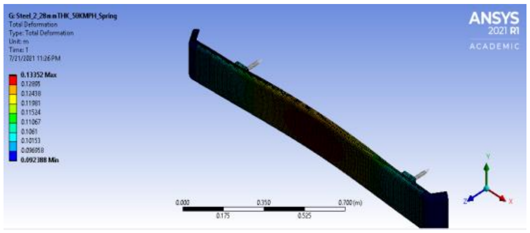

Figure 7. Total Deformation at 50km/hr.

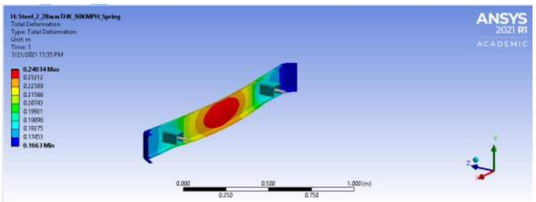

Figure 8. Total Deformation at 90km/hr.

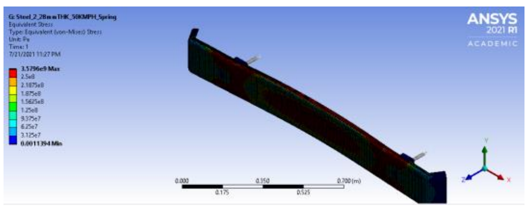

Figure 9. Equivalent Stress at 50km/hr.

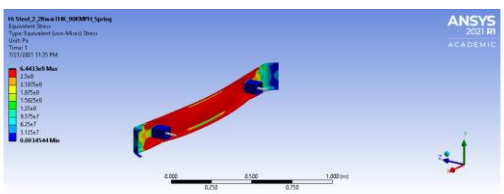

Figure 10. Equivalent Stress at 50km/hr.

C. Modal Analysis

A modal analysis is used to determine the vibration of a structure while it is being design.

1. Bumper without spring

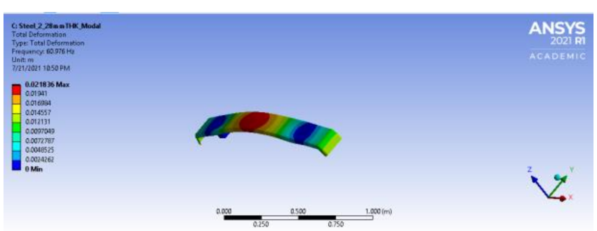

Figure 11. Total Deformation at node 1

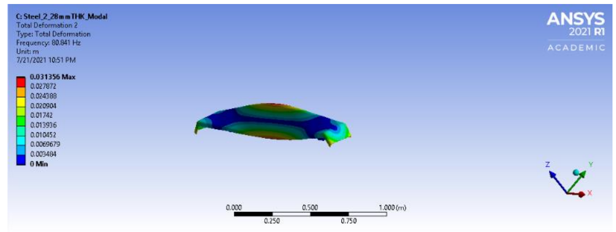

Figure 12. Total Deformation at node 2

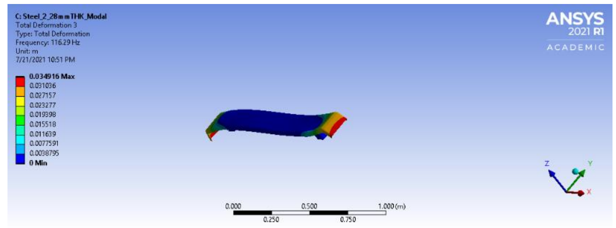

Figure 13. Total Deformation at node 3

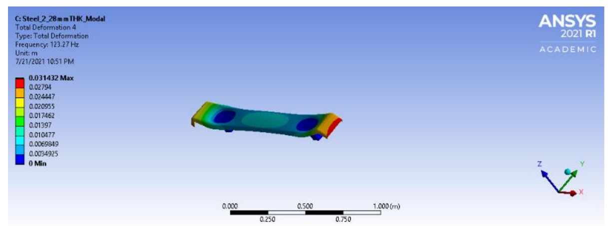

Figure 14. Total Deformation at node 4

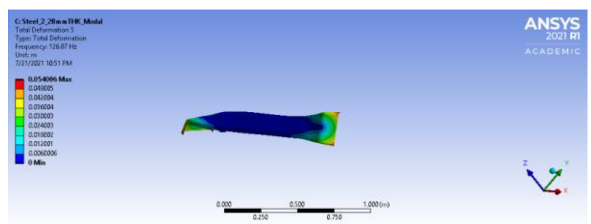

Figure 15. Total Deformation at node 5

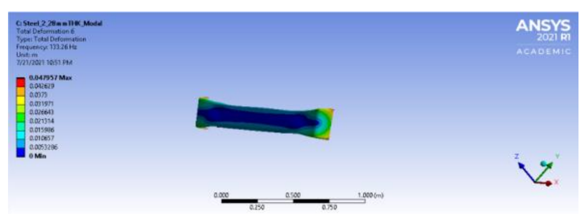

Figure 16. Total Deformation at node 6

2. Bumper with spring

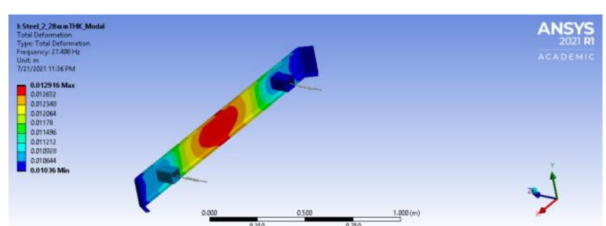

Figure 17. Total Deformation at node 1

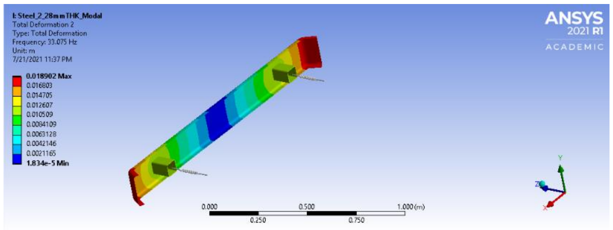

Figure 18. Total Deformation at node 2

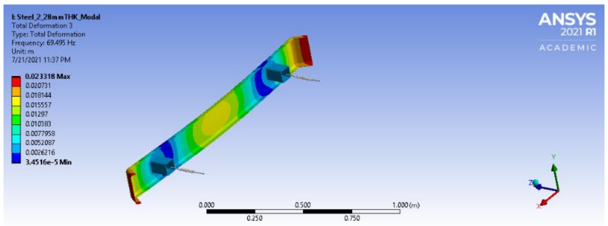

Figure 19. Total Deformation at node 3

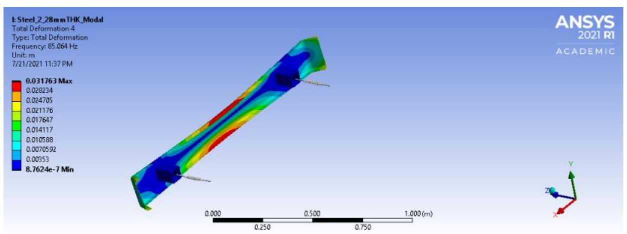

Figure 20. Total Deformation at node 4

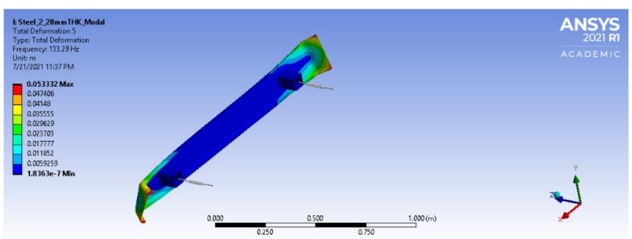

Figure 21. Total Deformation at node 5

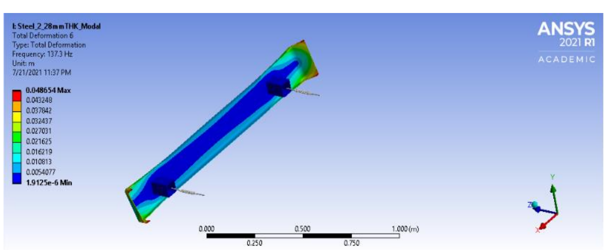

Figure 22. Total Deformation at node 6

Modal analysis for bumper without spring steel is done at different nodes. The comparison and deformation are done.

VI. RESULTS

Analysis of bumper with spring or without spring is done in structural analysis and modal analysis at different speed .Result is shown in below table.

Table 2 Comparison of Structural Analysis Deformation and stress of bumper in two cases

Material	Speed (km/hr)	Deformation(m)	Stress(pa)
Steel Bumper Without Spring	50	0.33	3.684
	90	0.060	6.632
Steel Bumper With Spring	50	0.133	3.57
	90	0.24	6.44

Table 3 Comparison of Modal Analysis of bumper Without Spring

Material	Node	Frequency(HZ)	Deformation(m)
Steel	1	60.97	0.021
	2	80.84	0.031
	3	116.29	0.034
	4	123.27	0.031
	5	126.87	0.054
	6	133.26	0.047

Table 3 Comparison of Modal Analysis of bumper With Spring

Material	Node	Frequency(HZ)	Deformation(m)
Steel	1	27.49	0.012
	2	33.07	0.018
	3	69.49	0.023
	4	85.06	0.031
	5	133.29	0.053
	6	137.3	0.048

VII. CONCLUSION

Bumper is important automobile part from the passenger safety point of view. The bumper With Spring and without spring is designed and analyzed. The Stresses, deformation, frequency are determined at different speed. Stresses and deformation is less in Bumper with spring as compared to Bumper without spring. In Modal Analysis frequency and deformation is less of Bumper with spring as compared to Bumper without spring. Steel bumper with spring absorb high impact as compared to steel bumper without spring.

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