International Journal of Research
Available at https://edupediapublications.org/journals

e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 05 Issue 04
February 2018

Impact Analysis on a Car Bumper by Varying Speed Using Composite Material through Simulation

Yellamelli Srinivas , G Satish , P.Chandhrasekhar

[1]**YELLAMELLI SRINIVAS received** the B.Tech degree in mechanical engineering from BONAM VENKATA CHALAMAYYA ENGINEERING COLLEGE, ODALAREVVU, JNTU, Kakinada, Andhra Pradesh, India, in 2012 year, and perusing M.Tech in CAD/CAM from Amalapuram Institute of management science & college of Engineering, Mummidivaram, , Andhra Pradesh, India.

[2]**Mr.G Satish, M.Tech, Assistant professor,**Amalapuram Institute of management science & college of Engineering, Mummidivaram, Andhra Pradesh, India

[3]**Mr. P.chandhrasekhar M Tech (Ph.D),** Associated professor, Amalapuram Institute of management science & college of Engineering, Mummidivaram, , Andhra Pradesh, India.

ABSTRACT

The simulation of a bumper is characterized by impact modelling using CATIA V5, impact analysis is done by ANSYS according to the speed that is 13.3 m sec-1 (48 km h-1) given in order to analyze the results. This speed is according to regulations of Federal Motor Vehicle Safety Standards, FMVSS 208- Occupant Crash Protection whereby the purpose and scope of this standard specifies requirements to afford impact protection for passengers.

In this research, analysis is done for speed according to regulations and also by changing the speeds. Simulation using Finite Element Analysis software, which is ANSYS, was conducted. The material used for bumper is FRP composites with different play combinations.

INTRODUCTION

Car accidents are happening every day. Most drivers are convinced that they can avoid such troublesome situations. Nevertheless, we must take into account the statistics – ten thousand dead and hundreds of thousands to million wounded each year. These numbers call for the necessity to improve the safety of automobiles during accidents. Automotive bumper beam is one of the key systems in passenger cars. Bumper beam designed to prevent or reduce physical damage to the front or rear ends of passenger motor vehicles in collision condition. They protect the hood, trunk, grill, fuel, exhaust and cooling system as well as safety related equipment such as parking lights, headlamps and taillights, etc. A good design of car bumper must provide safety for passengers and should have low weight. Different countries have different performance standards for bumpers. Under the International safety regulations originally developed as European standards and now adopted by most countries outside North America, a car's safety systems still function normally after a straighten

Pendulum or moving-barrier impact of 4 Kmph (2.5 mph) to the front and the rear, and to the front and rear corners of 2.5 Kmph (1.6 mph) at 445mm above the ground with the vehicle loaded or unloaded. In North America (FMSS: Federal Motor Vehicle Safety Standards), Canada (CMVSS: Canadian Motor Vehicle Safety Standards) and E.C.E. United Nations Agreement, Regulation No. 42, 1994. This regulation is accepted by ARAI India, so it is used for this study.

Regulatory effect on design

Cars for the US market were equipped with bulky, massive, heavy, protruding bumpers to comply with the 5-mile-per-hour bumper standard in effect from 1973 to 1982. This often meant additional overall vehicle length, as well as new front and rear designs to incorporate the stronger energy absorbing bumpers. Passenger cars featured gap-concealing flexible filler panels between the bumpers and the car's bodywork causing them to have a "massive, blockish look". A notable exception that year was the new AMC Matador coupe that featured "free standing" bumpers with rubber gaiters alone to conceal the retractable shock absorbers.

LITERATURE SURVEY

1. Davoodi et al. proposed conceptual design of fiber reinforced epoxy composite bumper absorber as a pedestrian energy absorber. The energy absorption capacity was sufficient for pedestrian impact and it could possible to use as substitute for the existing materials such as EPP foam for low impact collision.

2. Mohapatra Sdiscussed that automotive development cycles are getting shorter by the day. With increasing competition in the marketplace, the OEM's and suppliers main challenge is to come up with time-efficient design solutions. Researchers are trying to improve many of existing designs using novel approaches. Many times there is conflicting performance and cost requirements. This puts additional challenge for Research and Development units to come up with a number of alternative design solutions in less time and cost compared to existing designs. These best solutions are best achieved in a CAE environment using some of the modern CAD and FEM tools. Such tools are capable of effecting quick changes in the design within virtual environment.

3. Andersson R et.al emphasized that to increase crash performance in automotive vehicles it is necessary to use new techniques and materials. The components that are linked to crash safety should transmit or absorb energy. The energy absorbing capability of a specific component is a combination of geometry and material properties. The chosen material should have high yield strength and relatively high elongation to fracture. These demands lead to increase interest to use of high strength stainless steels.

4. Hosseinzadeh et al. studied the structure, shape, and impact condition of glass mat thermoplastic (GMT) bumper by using LS-DYNA pre solver and the results are compared with conventional metals like steel and Aluminium. GMT showed very good impact behavior compared with steel and Aluminium, which all failed and showed manufacturing difficulties due to strengthening ribs or weight increase due to use more dense materials.
5. Andersonet al. has discussed that to increase crash performance in automotive vehicles it is necessary to use new techniques such as use of energy absorber and materials. Components linked to crash safety should transmit or absorb energy. The energy absorbing capability of a specific component is a

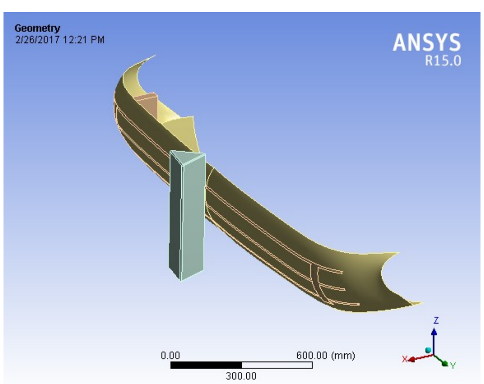
International Journal of Research
Available at https://edupediapublications.org/journals
e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 05 Issue 04
February 2018

combination of geometry and material properties.

6. Evans D and Morgan T have studied that as vehicle manufacturers continue to become more aggressive with the styling of new vehicles, bumper system technologies will be required to find new solutions that fit into the reduced package spaces while continuing to meet the vehicle performance and cost requirements. It was suggested to introduce new and innovative Expanded Polypropylene (EPP) foam technologies and techniques.
7. Bautista et al. studied the different impact standards and for the specific material they optimized the shape of bumper beam by performing the software simulation. They also studied the effect of metallic energy absorber in bumper system. Maximum stress and deformation were used as design criteria. They have complied many international standards for bumper beam design.

ANALYSIS

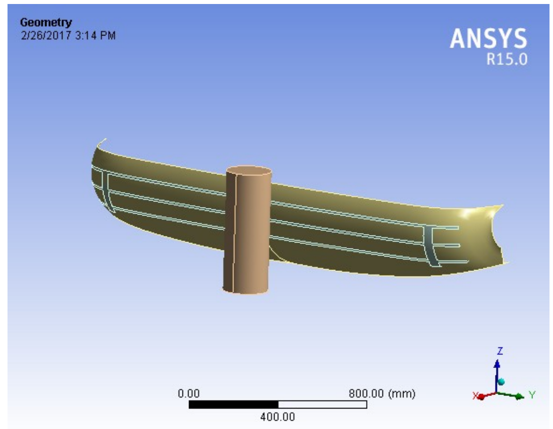
Structure of car bumper with a non-cylindrical obstacle case 1



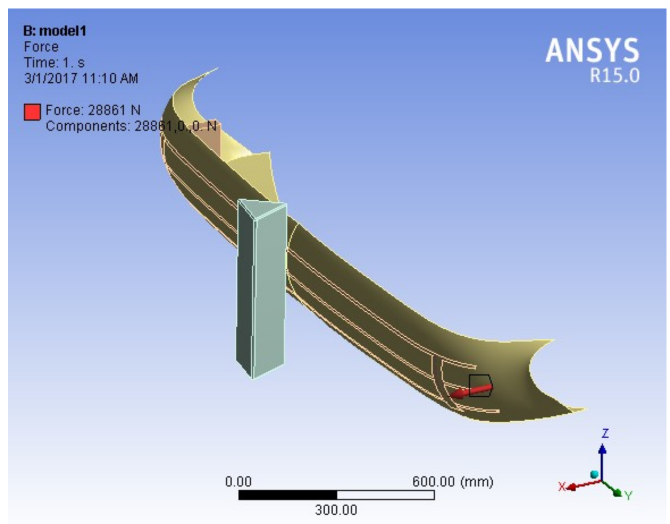
REPORT

Structural analysis of car bumper case 1

Structure analysis of car bumper with a cylindrical obstacle case 2



Boundary conditions



International Journal of Research
Available at https://edupediapublications.org/journals
e-ISSN: 2348-6848
p-ISSN: 2348-795X
Volume 05 Issue 04
February 2018

model 1	Total Deformation (mm)		Equivalent Elastic Strain (mm/mm)		Equivalent (von-Mises) Stress (Mpa)	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
ABS material	0	10.435	8.14E-10	2.43E-03	2.05E-05	118.28
carbon epoxy woven fabric cross ply 10 lamina	0	2.9389	3.05E-10	2.34E-03	2.75E-06	61.071
carbon epoxy woven fabric cross ply 20 lamina	0	2.9384	3.04E-10	2.34E-03	2.76E-06	61.086
carbon epoxy woven fabric angle ply 20 lamina	0	2.8256	4.03E-10	2.33E-03	1.10E-05	59.205
E-2 glass M10 E/3873 cross ply 10 lamina	0	5.5933	5.52E-10	2.54E-03	7.32E-06	84.961
E-2 glass M10 E/3873 cross ply 20 lamina	0	5.5934	5.52E-10	2.54E-03	7.32E-06	84.97
E-2 glass M10 E/3873 angle ply 20 lamina	0	5.614	6.33E-10	2.54E-03	1.46E-05	85.167
S-2 glass FGI-1800 cross ply 10 lamina	0	6.0378	5.90E-10	2.57E-03	8.34E-06	88.538
S-2 glass FGI-1800 cross ply 20 lamina	0	6.0382	5.90E-10	2.56E-03	8.36E-06	88.567
S-2 glass FGI-1800 angle ply 20 lamina	0	10.608	4.26E-10	6.88E-03	9.00E-06	174.06

Structural analysis of car bumper case 2

model 2	Total Deformation (mm)		Equivalent Elastic Strain (mm/mm)		Equivalent (von-Mises) Stress (Mpa)	
	Minimum	Maximum	Minimum	Maximum	Minimum	Maximum
ABS material	0	8.486	6.94E-09	1.80E-03	1.61E-04	87.34
carbon epoxy woven fabric cross ply 10 lamina	0	2.4014	1.33E-08	7.13E-04	1.93E-04	45.604
carbon epoxy woven fabric cross ply 20 lamina	0	2.4014	1.33E-08	7.13E-04	1.93E-04	45.606
carbon epoxy woven fabric angle ply 20 lamina	0	2.2708	7.26E-09	6.98E-04	2.04E-04	44.317
E-2 glass M10 E/3873 cross ply 10 lamina	0	4.4808	1.04E-08	9.76E-04	2.04E-04	62.164

E-2 glass M10 E/3873 cross ply 20 lamina	0	4.4808	1.04E-08	9.76E-04	2.04E-04	62.167
E-2 glass M10 E/3873 angle ply 20 lamina	0	4.4933	9.05E-09	1.08E-03	2.09E-04	62.221
S-2 glass FGI-1800 cross ply 10 lamina	0	4.8208	1.02E-08	1.06E-03	2.02E-04	63.887
S-2 glass FGI-1800 cross ply 20 lamina	0	4.8208	1.02E-08	1.06E-03	2.01E-04	63.895

Mass comparison of bumper made with various materials

	ABS materia l	carbon epoxy woven fabric cross ply 10 lamina	E-2 glass M10 E/3873 cross ply 10 lamina	S-2 glass FGI-1800 cross ply 10 lamina
Total Thickness (mm)	5	5	5	5
Total Mass (kg)	7.4707	11.04	17.94	15.18

CONCLUSION

From the results of this study, manufacturing car bumper with composites will add some wait to the car but the stress are greatly reduced, especially in case of Carbon fibre epoxy and E-glass epoxy composites the stress and deformations are reduced by 50% and 25 % (approximately) respectively.

- Also the modal behavior of bumper made with Carbon epoxy and E-glass are better than the others
- S-glass epoxy composites also performed similar to E-glass but angle play laminate is not preferable because stress generated are much high and are almost equal to that of ABS material
- Coming to carbon and E-glass composites performance is pronounceably same in all types of fiber orientations and no of plays for this particular application

FUTURE SCOPE

This project can be carried forward by developing prototype of bumper and conducting crash test etc.

REFERENCES

[1] J. M. Marzbanrad, M. Alijanpour, and M. S. Kiasat, “Design and analysis of automotive bumper beam in low speed frontal crashes,” Thin Walled Structures, vol. 47, pp. 902-911, 2009.

[2] S. S. Cheon, J. H. Choi, and D. G. Lee, “Development of the composite bumper beam for passenger cars,” Composite Structures, vol.32, pp. 491-499, 1995.

[3] S. R. Reid, and G. Zhou, “Impact behavior of fiber-reinforced composite materials and structures,” England: Woodhead Publishing, 2000.

[4] R. Maeda, S. Ueno , K. Uda, and T. Matsuoka, “Strength test of aluminum alloy bumper for automobile,” Furukawa Review, 13, 1994.

[5] S. S. Cheon, G. L Dai, and K. S. Jeong, “Composite side-door impact beam for passenger cars,” Composite Structures, vol.38, pp. 229–239, 1997.

[6] K. S. Cheon, T. S. Lim, and T. S. Lee, “Impact energy absorption of glass fiber hybrid composites,” Composite Structures, vol.46(3), pp. 267–278, 1999.

[7] Karol Bielefeldt, WładysławPapacz and JanuszWalkowiak “Environmentally friendly car plastics in automotive engineering”, University of ZielonaGóra, Institute of Mechanical Engineering and Machine Operation, 2007.

[8] A. Hambali1, S. M. Sapuan, N. Ismail and Y. Nukman, “Application of analytical hierarchy process in the design concept selection of automotive composite bumper beam during the conceptual design stage”, Scientific Research and Essay, April 2009, Vol. 4 (4) pp. 198-

[9] Umar R.. Update of road safety status in Malaysia. University Putra Malaysia. 2005.

[10] Hosseinzadeh RM, Shokrieh M, and Lessard LB, “Parametric study of automotive composite bumper beams subjected to low-velocity impacts”, Composite Structures 68 (2005) 419–427, Elsevier Ltd.

[11] Marzbanrad J M, Alijanpour M, and Kiasat MS, “Design and analysis of automotive bumper beam in low speed frontal crashes”, Thin-Walled Structures 47(2009) 902–911, Elsevier Ltd.

[12] United Nations agreement, Uniform provisions concerning the approval of vehicles with regards to their front and rear protective devices (bumpers, etc.), E.C.E., 1994.

[13] Andersson R, Schedin E, Magnusson C, Ocklund J, “The Applicability of Stainless Steel for Crash Absorbing Components”, SAE Technical Paper, 2002.