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Experimental Investigation on Elastic Deformation of Passenger Car Bumper Using Thermoplastic and Elastomeric Materials Blends

R. Arvinth¹, Dr.P.Suresh²

P.G. Scholar M.E. (Mechatronics), Department of Mechanical Engineering, Karpagam College of Engineering,
Coimbatore, Tamil Nadu, India¹

Professor and Dean, Department of Mechanical Engineering, Karpagam College of Engineering, Coimbatore,
Tamil Nadu, India²

ABSTRACT: Basically the bumpers are used for the protection of the cars . Today bumpers are made of composite materials. This research work proposes self deformation of the bumper within 15–20 minutes(tentative) after an impact on a bumper. A Frontal bumper and rear bumper system with implementation of elastic behaviour with smart blended composite material referred with existing materials used in the car bumpers . These materials are composed with high strength and stiffness to mass ratio and the ability to produce parts with required mechanical properties with the blended materials.

KEYWORDS: bumpers, blended materials, elastically deformed

I. INTRODUCTION

An automobile's bumper is the front-most or rear-most part that is apparently designed to allow the car, to sustain an impact without damage to the vehicle's safety systems. These car bumpers are used for the protection of the car and for the passengers. Natural fiber thermoplastic components in the automotive industry can provide the advantages of reduction in weight, cost, recyclability, renewability and eco-efficient compared to synthetic conventional materials. Natural fibers have recently become attractive to automotive industry as an alternative reinforcement for glass fiber reinforced thermoplastics. This research aim attention on development partially eco- friendly hybrid long fiber reinforced thermo plastics with natural kenaf fiber to enhance the desired mechanical properties for car bumper beams as automotive structural components.

The bumpers are designed and shaped in order to deform it and absorb the force (kinetic energy) during a collision.

II. EXISTING PROBLEM

Now a days car bumpers are plastically deformed which cannot retain to its original position after an impact is happened to it. According to this if the bumpers get dent or broken we want to replace to a new one; This will cost more and its not affordable to the users. So we should see to this and want to increase the impact and flexural strength of the car bumper. The existing materials used for the bumpers are as follows - Polypropylene (PP), Polyurethane (PU), Acrylonitrile butadiene styrene (ABS), Polystyrene (PS), Polycarbonate (PC), Polyethylene (PE) , polyoxymethylene (POM) ,etc.

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III. LITERATURE REVIEW

This literature review focuses on existing bumper materials in present scenario. In the journal “Analysis of composite car bumper reinforcement”[1], In this research, a front bumper and rear bumper beams made of three materials: aluminium, glass mat thermoplastic (GMT) and high-strength sheet moulding compound (SMC) were studied by impact modelling to determine the impact forces, stress distribution, deflection and energy-absorption behaviour. “Automotive Bodies And Structures

Chassis Materials Manufacturing”[2], we can use Polyethylene (PE), POM (polyoxymethylene), Polycarbonate (PC) materials composites can be used for the car bumpers.” A Comparative Study of the Pure and Nano-Filled Acrylonitrile Butadiene -Styrene Butadiene Rubber Blends”[3], Compatibilizer is used for the improvement of interfacial interaction, processability, mechanical & chemical properties of the investigated blends. In this study, the effect of acrylonitrile-butadiene-styrene (ABS) compatibilizer in vulcanizable compositions of mixed acrylonitrile butadiene rubber (NBR) and styrene butadiene rubber (SBR) is investigated. Silica and carbon black improve the properties the obtained blends. “Thermoplastic Elastomer Blends”[4], according to this patent they have used 1-olefin polymer and styrene butadiene rubber blended together and tested the physical and mechanical properties which has a good physical property and especially in tear strength and tensile strength, elongation at break, low temperature impact resistance and minimum creep at high temperature.” Polypropylene/ethylene-propylene rubber (PP/EPR) blends for the automotive industry: Basic correlations between EPR-design and shrinkage”[5], The morphology of the dispersed phase – in terms of size and shape of the rubber particles as determined from scanning electron microscopy (SEM) – was found to correlate fairly well with the shrinkage determined in the flow and transverse direction of injection molded plates. In this respect it turned out to be elementary to consider the anisotropy of the particles rather than their average size alone.” Some Mechanical and Thermal Properties of PC/ABS Blends”[6], A series of blends of Acrylonitrile-Butadiene-Styrene (ABS) and Polycarbonate (PC) were prepared and some of their thermal and mechanical properties were determined. The Young’s modulus changed gradually and monotonically with the polycarbonate content. The experimental values found for the impact strength were intermediate between those of the neat polymers, depending upon the dispersed rubber particles of butadiene in the matrix of SAN (Styrene-Acrylonitrile), and the dispersed PC particles which generally make the ABS more brittle.” Thermomechanical Properties Of Abs/Pa And Abs/Pc Blends”[7], This technique allows to obtain different morphologies of compatibilized ABS/PA or ABS/PC blends and the aim of this work is to evaluate the corresponding thermomechanical properties. Experimental results demonstrate in particular that fibrillar (A small slender fiber or filament) morphology is obtained with the new blending technique (only with ABS/PA blends), which could lead to a mechanical enhancement if the adhesion between ABS and PA is optimized.

IV. OBJECTIVES OF THE WORK

The aim of the work is to design and Improvement in front and rear bumpers of a passenger car in terms of material selection using crash Analysis.

1. To analyze the mechanical properties on rear and front part of car bumper by comparative speed impact analysis.
2. To analyze on mechanical properties focus on tensile, elongation, flexural and IZOD impact testing is analysis.
3. Experimentation is done by using the twin screw extruder and the injection moulding technique for manufacturing the sample specimens with the blended materials.

V. PROPOSED SYSTEM

The materials are chosen for this project are as follows,

- ABS (Acrylonitrile butadiene styrene)
- PC (Polycarbonate)
- SBR (styrene-butadiene rubber)

ABS (Acrylonitrile butadiene styrene): Acrylonitrile butadiene styrene (ABS) (chemical formula $(C_8H_8)_x \cdot (C_4H_6)_y \cdot (C_3H_3N)_z$) is a common thermoplastic polymer. Its glass transition temperature is approximately 105 °C

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(221 °F).ABS is amorphous and therefore has no true melting point.ABS is a terpolymer made by polymerizing styrene and acrylonitrile in the presence of polybutadiene . The proportions can vary from 15 to 35% acrylonitrile, 5 to 30% butadiene and 40 to 60% styrene. The result is a long chain of polybutadiene criss -crossed with shorter chains of poly(styrene-co-acrylonitrile). Youngs modulus of ABS is 1.4 - 3.1 (10^9 N/m², GPa)

PC (Polycarbonate): Polycarbonates (PC) are a group of thermoplastic polymers containing carbonate groups in their chemical structures. Polycarbonates used in engineering are strong, tough materials, and some grades are optically transparent. They are easily worked, molded , and thermoformed . Because of these properties, polycarbonates find many applications. Polycarbonates received their name because they are polymers containing carbonate groups (–O–(C=O)–O–). A balance of useful features including temperature resistance, impact resistance and optical properties position polycarbonates is between commodity plastics and engineering plastics. Youngs modulus of PC is 2.6 (10^9 N/m², GPa)

styrene-butadiene-rubber (SBR): Styrene-butadiene or styrene-butadiene rubber (SBR) describe families of synthetic rubbers derived from styrene and butadiene (the version developed by Goodyear is called Neolite). These materials have good abrasion resistance and good aging stability when protected by additives. About 50% of car tires are made from various types of SBR. The styrene/butadiene ratio influences the properties of the polymer: with high styrene content, the rubbers are harder and less rubbery.SBR is not to be confused with a thermoplastic elastomer made from the same monomers, styrene-butadiene block copolymer.

The formulation are as follows in percentage

S.NO.	PC(%)	ABS(%)	SBR(%)
1	70	30	0
2	65	30	5
3	60	30	10
4	62.5	30	2.5

VI. METHODOLOGY

There are some of the process for manufacturing the polymer specimen .They are as follows

- **DRYING :** The raw materials are spreaded in a plate and kept in the oven for about 2-3 hrs for drying the moisture at the temperature of about 60°C - 80 °c .
- **WEIGHING :** the raw materials are weighed according to the formulation and mixed well.
- **COMPOUNDING(mixing, heating and melting) :** the mixed materials are then put into the twin screw extruder for mixing and melting the materials well at the temperature of about 240 ° c – 280 ° c.
- In this twin screw extruder ,there will be a two screws rotating in opposite direction for grinding and mixing the materials with constant temperature.
- **COOLING :** the mixed materials will came out as two thick threads and which is cooled in a water tub .This will strengthen the liquid state into solid state.
- **CUTTING :** the mixed materials are then cut into small pellets with the help of the cutter machine.
- **INJECTION MOULDING :** There will be five heaters which is connected in series at different temperature (240,230,220,210,50) ° c. the pellets are poured in to the holes which travels through the heaters for melting and ASTM moulds are attached in to the mould for specimen preparation. Injection pressure is 500kg/cm² , speed is 20%, clamping force is 90 tones and specimen position is 40mm.

VII. TESTING RESULTS FOR THE SAMPLE SPECIMEN BY ASTM STANDARD

Three test are tensile, flexural, and IZOD impact. The results as follows

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TENSILE TEST:

Sno.	Specimen label	Maximum Load (N)	Tensile strength(MPA)
1	s-1	825.52	-----
2		1,283.99	31.39654
3		1,319.64	32.2683
4		1,043.63	25.51905
5		1,002.15	24.5048
6	s-2	305.12	7.46079
7		423.81	10.36307
8		390.5	9.54855
9		460.09	11.25035
10		440.16	10.76296
11	s-3	457.76	11.19338
12		544.39	13.31161
13		554.67	13.56284
14		520.43	12.72559
15		554.78	13.5656
Maximum		1,319.64	32.2683
Mean		675.11	16.24524
Median		544.39	13.0186
Minimum		305.12	7.46079

FLEXURAL TEST

Name		Max_Force	Max_Stress	Max_Strain
Parameter				
Pass/Fail				
Units		N	N/mm2	%
sample--1	58.7344	33.687	1.34477	
1 -- 2		56.8594	32.6116	1.27411
1 -- 3		57.3438	32.8894	1.30944
1 -- 4		77.9219	44.692	1.73645
1 -- 5		65.4375	37.5316	1.46842
Mean		63.2594	36.2823	1.42664
sample--2	47.1719	27.0342	1.17658	
2 -- 2		29.8906	17.1303	0.768
2 -- 3		55.6719	31.9056	1.40698
2 -- 4		46.9844	26.9267	1.16275
2 -- 5		53.2344	30.5086	1.31251
Mean		46.5906	26.7011	1.16536
sample--3	31.1563	17.8556	0.90701	
3 -- 2		39.9688	22.9061	1.18118
3 -- 3		36.4063	20.8644	1.0967
3 -- 4		40.25	23.0673	1.16659
3 -- 5	39.9844	22.915	1.1689	
Mean		37.5532	21.5217	1.10408

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IZOD – IMPACT NOTCHED TEST:

s.no.	samples	length(mm)	width(mm)	thickness(mm)	J	KJ/m ²
	s1					
1		63	10.24	3.15	0.0323	1.0036
2		63	10.24	3.15	0.0352	1.094
3		63	10.24	3.15	0.0382	1.1846
4		63	10.24	3.15	0.0374	1.1619
5		63	10.24	3.15	0.0411	1.2753
					average	1.1438
	s2					
1		63	10.22	3.15	0.0411	1.2778
2		63	10.22	3.15	0.0323	1.0056
3		63	10.22	3.15	0.0309	0.96045
4		63	10.22	3.15	0.0382	1.1869
5		63	10.22	3.15	0.0338	1.0508
					average	1.0963
	s3					
1		63	10.21	3.15	0.0396	1.2335
2		63	10.21	3.15	0.0331	1.02929
3		63	10.21	3.15	0.0367	1.1426
4		63	10.21	3.15	0.0418	1.3018
5		63	10.21	3.15	0.0331	1.0292
					average	1.1472

VIII. CONCLUSION

The expected result for this project is not satisfied because of the values obtained is less in flexural strength and on IZOD impact notched test. The expected value of flexural strength should be above 6.0% to 8.0% and for impact test value should be above 2.3 ft-lb/in (imperial value) and in metric its about 123 J/a or m².kg.s⁻².A⁻¹. The tensile strength value should be above 4,000 psi or 30.0 Mpa. Thus, this want to be improved by adding some Compatibilizers with this blends by changing the formulations to get the expected result of elastic deformation material.

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