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"Modification of A pillar by composite materials"

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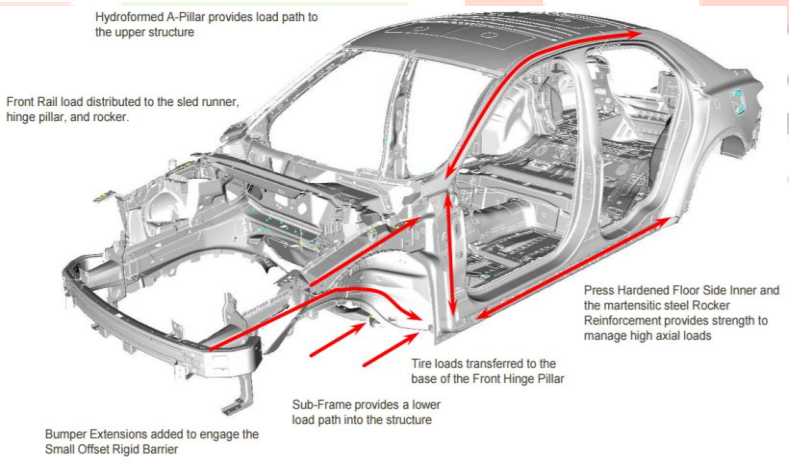
Abstract— In current scenario the world of Automobile has been grew vast, and in connection with that so does the increase in user of Automobile. Due to that the road accidents are happening more frequently than it used to be. Mostly the cause of the accident is unable to see or judge an object while driving. There are many blind spots in a car, which can cause accidents. Most irritating and bugging one is A pillar of car. This paper suggests ideology to overcome this obstructing scenario, by replacing conventional aluminum A pillar by polymer, spring steel and non-Newtonian fluid.

Keywords: Polymers, Spring steel, non-Newtonian fluid.

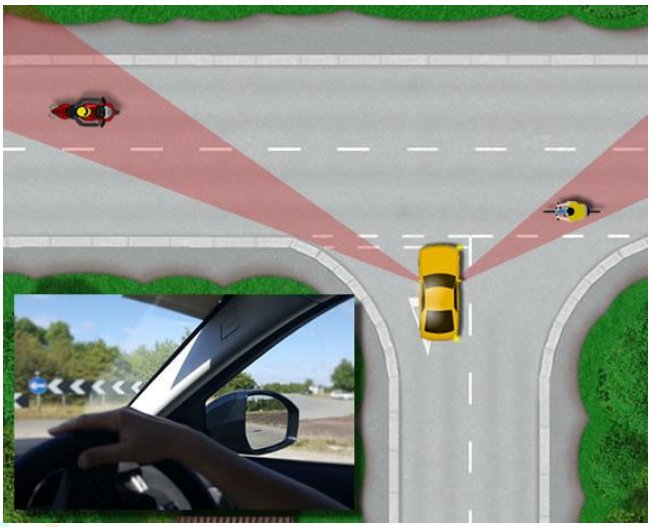
***Index Terms*—Modification of a pillar by composite materials**

Introduction

A pillar is a structural requirement for any car to resist this sudden impact load during accidents. current legal laws for car manufacturers also includes many safety factors, such as while body roll or in any dangerous incidents a vehicle roof must withstand a force equal to four times of its weight before the roof crushes 5 inches. An A pillar performs many tasks other than supporting the venture windshield to fulfill the requirements, manufacturers help adapted to which widened a pillar which causes obstruction in eyesight of user.



Many other attempts have been also conducted to reduce the risk such as mounting the display in A pillar, providing cameras on both side mirror and proximity sensors which gives constant feedback to the central console of the vehicle. So that driver could have been warned when any objects arrive in the preprogrammed area around the vehicle. These are some pictures which shows perception of a user.



The specific objectives of the experimental study are as following.

1. Reduction in obstruction angle of driver.
2. enhancing the visibility of drivers
3. enhancing the safety of vehicles.
4. Making a pillar sturdier and stress resistance.

I. LITERATURE REVIEW

Development of a detection road users system in vehicle A-pillar blind spots - P O Beresnev, A V Tumasov, D V Zeziulin, D M Porubov, L N Orlov. Road detection system has been proven most inevitable system for the vehicle to overcome the risk of an accident by the blind spot created by A pillar. In this system cameras, displays, sensors and on-board computer is used to identify objects around the vehicle and enhancing the ability of ADAS-advanced driver assistance system. The results show improved decision capabilities because of more information is provided to the user. Ultimately less chances of occurring an accident.

Design and Development of a Composite A-Pillar to Reduce Obstruction Angle in Passenger Cars - Sajiree Vaidya and Naga Sai Chakravart Velamakuri, Piyush Agarwal, Srikanth Pilla, David Schmueser. Blind spot of an A pillar has caught much attention of the designers to improvise it. This paper is a perfect redesigning of internal structure of the A pillar by using composite material. A CFRP-carbon fiber reinforced pillar which can reduce the obstruction angle and improves the safety of the vehicle to an extent. The carbon fiber reinforced pillar has proven to be more stress resistance and lighter in weight as compared to the conventional A pillar. There are further chances to reduce this blind spot by combining it with this paper's ideology of optical grade polymers and non-newtonian fluid.

Non-Newtonian Fluids: An Introduction- R.P. Chhabra non-newtonian fluid is a vast field of opportunities by which has caught many scientists and higher intellectual's attention towards it. The use of non-newtonian fluid is also nowadays one of the safety equipment for the armed forces. It because the properties of non-newtonian fluid differs from the regular newtonian fluid under certain pressure, temperatures, and stress condition. These valuable characteristics can also be used in improving vehicle's safety in scenario as accidents. it also helps to improve vehicle weight management to some extent.

Critical Review of Literature for Computational Investigation of Mechanical Properties of CNT Reinforced Bulk Metallic Glasses- Manish Dhawan, Sankalp Sinha. Bulk metallic glass is first founded in 1960 and later the development of this material has been done. The bulk metallic glass promises the peak in higher tensile strength. Producing bulk metallic glass with reinforcing carbon nanotubes can improve the characteristics of the composite material in many aspects such as thermal, mechanical as well as electrical properties. However, the mess embedded inside of bulk metallic glass will help to achieve even more structural and tensile strength which can be utilized in manufacturing shatterproof windscreens and A pillar also could be designed in a way to utilize this ability.

III PROBLEM CREATED BY CURRENT A PILLAR DESIGN

Problem by using Conventional A pillar

1. Broad Design
2. Obstruction in driver's view
3. Zero opacity in A pillar
4. Dependency on single material

Problem minimizes by using Composite A pillar

1. Increase in driver's field of view
2. Enhanced safety measurements
3. Provide aesthetic appearance
4. Less costly as compared to aluminum

In the present work the ideology is proposed for A pillar structure construction by using different materials such as optical grade polymer, spring steel and non-newtonian fluid. However, it can be more improvise by using the bulk metallic glass reinforced with the CNT-carbon nanotube and CFRP-carbon fiber reinforced pillar. The current limitations of this project is lack of resources to make a prototype and test it in real environment.

IV A PILLAR SPECIFICATION AND PROPOSED DESIGN

A Pillar specifications

1. Types of materials: Optical grade polymers, Spring steel, Non-newtonian fluid

Proposed design

The present experimentation is carried out based on near to actual dimensions of A pillar. The designing task is performed in 3D modeling software Solidworks. The outer most layer is materialized as optical grade polymer, the second layer is spring steel pipe which is later filled with non-newtonian fluid.

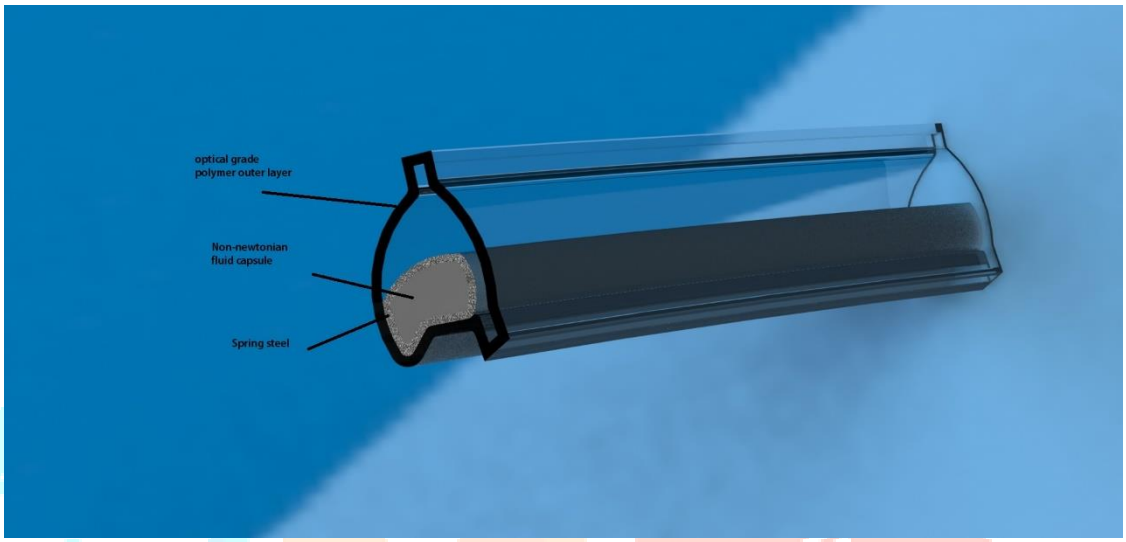
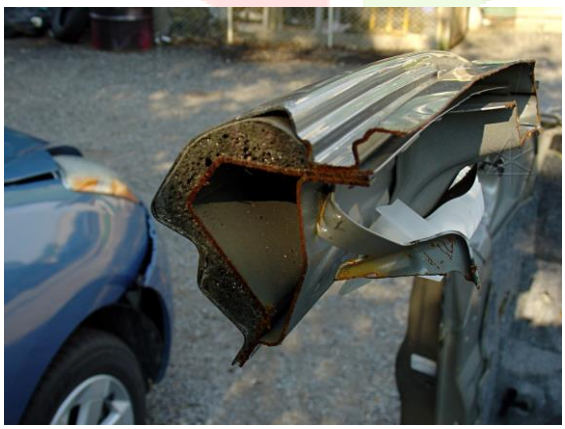


Fig. Proposed Design

(1) Optical grade polymer
(2) Spring steel
(3) Non-newtonian fluid capsule

Aluminum is used nowadays in manufacturing of most of the components in car chassis and body. Aluminum alloy with Magnesium 5000 series, Al-Mg 5022 GC45 and GC150 are currently in use for body components. It provides high strength, high formability. This is cross section of the A pillar. Replacing the aluminum pillar by using different material such as optical grade polymers, spring steel special purpose designed support and non-Newtonian fluid as a shock absorber. Below given datasheet suggests characteristics of various optical grade polymers available in the market.



SPECIFICATIONS OF OPTICAL GRADE POLYMERS DIVERSEOPTICS

Common Trade Names	Acrylic (PMMA) LUCITE, PLEXIGLASS, POLYCAST	Polycarbonate (PC) LEXAN, MERLON	Polystyrene (PS) DYLENE, STYRON, LUSTREX	Cyclic Olefin Copolymer (COC) TOPAS	Cyclic Olefin Polymer (COP) ZEONEX, ZEONOR	PolyEtherImide (PEI) ULTEM	Thermo-plastic Polyimide EXTEM	AL-6261 OKP4	AL-6263 OKP4HT
Refractive Index:									
n_F(486.1nm)	1.498	1.599	1.604	1.540	1.537	1.689	1.685	1.623	1.653
n_d (587.6nm)	1.492	1.585	1.590	1.534	-	-	1.660	1.607	1.632
n_D (589.3nm)	1.492	1.585	1.590	1.534	1.530	1.682	-	1.607	1.632
n_C (656.3nm)	1.489	1.580	1.585	1.531	1.527	1.653	1.650	1.601	1.625
Rate of Index change w/Temp									
dn_{abs}/dT X 10^{-5} /°C	-8.5	-11.8 to -14.3	-12	-10.1	-8	-	-9.1	-13	-11
Abbe Value (V_d)	55 to 57	30	31	56	56	19	19	27	23
Transmission %									
Visible Spectrum through 3.174mm	92	85-91	87-92	92	92	36-82	-	85-92	85-92
ΔHaze (%)	0.5 to 2	1 to 2	2 to 3	1 to 2	1 to 2	2	-	1	1
CTE: Coeff. of Linear Exp.									
X 10^{-5} cm/cm/°C @ 70°C	6.74	6.6 to 7.0	6.0 to 8.0	6.0 to 7.0	6.0 to 7.0	4.7 to 5.6	5.0	7.2	6.9
Max Continuous Service Temp	140°F to 158°F	255°F	180°F	266°F	266°F	338°F	446°F	-	-
$T_{10}^{13.0}$	60°C to 70°C	124°C	82°C	130°C	130°C	170°C	230°C	-	-
HDT: Heat Deflection Temp									
3.6°F/min @66psi [0.455MPa; annealed]	214°F/101°C VS-100 177°F	295°F/146°C	230°F/110°C	266°F/130°C	266°F/130°C	410°F/210°C	482°F/250°C Unannealed	222°F/106°C @1.8 Mpa	253°F /123°C @1.8 Mpa
3.6°F/min @264psi [1.82 Mpa; annealed]	198°F/92°C VS-100 169°F	288°F/142°C	180°F/82°C	253°F/123°C	263°F/123°C	394°F/201°C	455°F/235°C Unannealed	-	-
Specific Gravity									
[water @ 72.5°F]	1.16 to 1.19	1.20 to 1.25	1.05 to 1.06	1.02 to 1.03	0.95 to 1.01	1.27	1.31	1.22	1.26
Hardness	Rockwell M97	Rockwell M70	Rockwell M90	Rockwell M89	Rockwell M89	Rockwell M109	-	-	-
Impact Strength									
Notched Izod @ 73°/23°C (ft-Lbs/in notch)	0.3 to 0.5	12.0 to 17.0	0.35	0.5	0.5	0.6	0.8	0.75	1.24
Key Advantages	Scratch Resistance Chemical Resistance High Abbe # Excellent for Diamond Turning	Impact Strength Temperature Resistance	Clarity Low Cost	Low Moisture Absorption High Modulus Good Electrical Properties	Low Birefringence Chemical Resistance Completely Amorphous	Impact Resistance Thermal Resistance Chemical Resistance High Index	High Fluidity High Thermal Resistance Chemical Resistance Low Abbe #	High Index Low Birefringence Low Abbe # High Fluidity	High Index Low Birefringence Low Abbe # High Fluidity

Manufacturing pillar only by glass will weaken the body structure and to withstand the impact from the roof and side cannot be prevented, so in solution adding spring steel special purpose designed portion will enhance the load carrying capacity. It also works as a shock absorber and returns the force applied to itself because of better stiffness.

Non newtonian fluid is basically a fluid which disobey the rules of Newton for fluid. When a sudden force is applied to the non-newtonian liquid it behaves differently than the other liquids. Such as fluid made from starch reacts to the sudden force applied to it with making change in its characteristics of fluid and behaves like a solid, some of the solid research and experiments have proven that it may help to stop the bullet from piercing the bulletproof jacket.

That is the reason to add this fluid into the A pillar. With the help of that during a roof accident or rolldown of car it can be a liable asset to ensure the safety.

V EXPERIMENT RESULT OF COMPOSITE A PILLAR

Below given table is comparison between conventional aluminum structure against proposed structure and given data is extracted from different online prices on different websites such as Alibaba.com for the price of optical grade polymers. As the result suggests it is feasible to accommodate this design into current, in addition it also works as a styling element as the current requirement of modern designing and esthetic appearance. The wights of the different elements are calculated by the modeling software.

Material	Weight	Cost (In Rupees)
Aluminum	10.43 kg.	2830
Spring Steel	7.00 kg.	700
Optical grade polymer	3.44 kg.	910

Optical grade polymer + Spring steel + Non-newtonian fluid	[12,15] kg.	1610+N.N.F.[100,500] =2110 max

VI CONCLUSION

Based on the investigation the following conclusions are drawn:

1. Proposed design can resolve the current blind spot problem in automobiles
2. More safety features can be added to the current structure
3. Composition of material is affordable as compared to the conventional aluminum.

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