Design & Development of A Transparent A-Pillar for Vehicle Driving Safety

Abstract

In vehicle transport, driver visibility is the maximum distance at which the driver of a vehicle can see and identify prominent objects around the vehicle. Visibility is primarily determined by weather conditions and by a vehicle design. The parts of a vehicle that influence visibility include windshield, dash board and pillars. Good driver visibility is essential for safe road traffic. A blind spot in a vehicle is an area around the vehicle that cannot be directly observed by the driver while at the controls, under existing circumstances. Blind spots exist in a wide range of vehicles: cars, trucks, motorboats, sailboats and aircraft. Proper adjustment of mirrors and use of other technical solutions can eliminate or alleviate vehicle blind spots. Blind spots may occur in the front of the driver when the A-pillar (also called the windshield pillar), side view mirror, and interior rear view mirror block a driver's view of the road. Behind the driver, there are additional pillars, headrests, passengers, and cargo that may reduce visibility. As vehicles are increasing, chances of accidents also increases. One of the leading causes of accident owes to the blind spot of the vehicles. Many of the drivers including those with heavy duty vehicles complain of reduced visibility due to the presence of A-pillar. A-pillar directly hides the driver’s vision, which in many case leads to road accidents, especially while taking sharp curves. The proposed project aims at making the A-pillar transparent so that the driver could see what is happening on the other side of the road through the pillar. By replacing the conventional A-pillar by using a suitable transparent composite material, so that we can enhance the vision of the driver and hence make driving safe.

Keywords: Blind Spot, Transparent, A- Pillar, Composite Material, Visibility, Design

I. INTRODUCTION

The A-pillar is an important load carrying component of any automobile body. It is a primary support structure for the roof, and is typically a thin-walled, spot-welded, closed-section structure made from high strength aluminium alloy.

As part of the validation process, the A-pillar can be experimentally loaded at quasi-static rates until failure. The force and displacement of the impactor are measured to get valuable insight into the stiffness characteristics of the structure. During the past two decades, crashworthiness simulation of automotive structures has proven to be remarkably good, largely because the finite element codes being used can accurately predict the plastic bending and stretching deformation mechanisms that occur in stamped metal parts. Vehicle accidents have become one of the major causes for increasing death rates of humans worldwide. Hence, stringent norms on vehicle safety have been imposed on automobile industries. According to IIHS nearly 60 % of the deaths in side crash are due to brain injury [1]. The brain injury is mainly due to the intrusion of A-Pillar inside the passenger cabin and overlap of the head of the occupant over A-piller. In side impact of a car, the impacting vehicle slows down due to the reaction force generated by different structural members like car doors, side impact beams, roof bow, A-Pillar etc. As these structural members plastically deform and absorb energy, the impacting vehicle decelerates. Of the many components, because of its size and location in the structure, A-Pillar has to absorb substantial energy with least amount of deformation in order to limit its intrusion in the passenger compartment.
II. RELEVANCE OF TOPIC

The project undertaken precisely aims at improving blind spot visibility. We basically concentrated our research on A-piller of the car chassis over the driver side which tends to block away sizable vehicles, when one’s car reaches an intersection. Thus we came up with a solution of TRANSPARENT A-PILLARS using suitable material which may effectively enhance visibility issues thereby not compromising its function of providing support to the car frame as well.

The material we plan to implement for this task is Aluminium oxynitride (ALON), which shows excellent characteristic properties for this job. This concept will also lead to better design aesthetics so that a driver does not feel his connection to the surrounding being compromised as has been the ritual for past years. The material in use would be suitably fabricated via ceramic processes of forming it to the required component and then joining the piece using effective joining methods like brazing or soldering which produces excellent result in term of pressure bearing ability etc. The project also keeps in view the daily need of one’s driving experience, so as to minimize the cause of blind spot as a reason for road accidents.

III. ANALYSIS USING ANSYS SOFTWARE

A. ALON

Aluminium oxynitride or ALON is a ceramic composed of aluminium, oxygen and nitrogen. It is marketed under the name ALON by Surmet Corporation. ALON is optically transparent (≥80%) in the near-ultraviolet, visible and midwave-infrared regions of the electromagnetic spectrum. It is 4 times harder than fused silica glass, 85% as hard as sapphire, and nearly 15% harder than magnesium aluminate spinel. Since it has a cubic spinel structure, it can be fabricated to transparent windows, plates, domes, rods, tubes and other forms using conventional ceramic powder processing techniques. ALON is the hardest polycrystalline transparent ceramic available commercially. Combination of optical and mechanical properties makes this material a leading candidate for lightweight high-performance transparent armour applications such as bulletproof and blast-resistant windows and for many military infrared optics. ALON-based armor has been shown to stop multiple armour-piercing projectiles of up to 50 cal. It is commercially available in sizes as big as 18x35-inch monolithic windows.

In addition to being used as a transparent armour material, ALON is used as infrared-optical windows. As such it has applications as a sensor component, specialty IR domes, windows for laser communications, and in some semiconductor-related applications.

B. Mechanical Properties

- Young's modulus 334 GPa
- Shear modulus 135 GPa
- Poisson ratio 0.24
- Fracture toughness 2.0 MPa·m1/2
- Flexural strength 0.38–0.7 GPa
- Compressive strength 2.68 GPa
- Specific heat 0.781 J/(g·°C)
- Thermal conductivity 12.3 W/(m·°C)
- Thermal expansion coefficient ~4.7×10⁻⁶/°C
- Transparency range 200–5000 nm

ALON also appears to be radiation-resistant and resistant to damage from various acids, bases, and water.

![Deformation plot-material ALON](image-url)
IV. COMPARISON OF RESULTS

Along with ALON other materials like POLYPROPYLENE, POLETHELENE, ABS PLASTIC were selected and analysed using ansys software. we applied a load of 1000 N. Following were the results obtained for each individual material. By tabulation of results we obtain that the deformation was found to be maximum for polypropolyne while the minimum was found to be for ALON. Another parameter which was Von Mises Stress was also compared for the following materials. The results obtained are tabulated as below:

A. Comparison of Results

<table>
<thead>
<tr>
<th>MATERIAL</th>
<th>DEFORMATION(mm)</th>
<th>VON MISES STRESS(MPa)</th>
</tr>
</thead>
<tbody>
<tr>
<td>POLYPROPYLENE</td>
<td>0.86279</td>
<td>0.55447</td>
</tr>
<tr>
<td>POLYETHELENE</td>
<td>0.61771</td>
<td>0.55555</td>
</tr>
<tr>
<td>ABS PLASTIC</td>
<td>0.67235</td>
<td>0.55747</td>
</tr>
<tr>
<td>ALON</td>
<td>0.00011</td>
<td>0.1059</td>
</tr>
</tbody>
</table>

V. CONCLUSION

Use of acrylic materials for A-Pillar enhances the energy absorption and its provide better mechanical strength.

After analyzing the car with different materials like PP, PE and ABS Plastic, ALON, the ALON was suitable material for the automotive A-Pillar.

Based on the analysis done the material ALON was found to be the most suitable one to be used as a transparent A-pillar considering its strength and transparency.

REFERENCES