iJETRM
International Journal of Engineering Technology Research & Management

MODELLING AND 3D PRINTING OF CAR BUMPER

G. Sanjeevkumar[1], D. Aravind[2], B. Prakash[3], K. Suman[4]
[1]Assistant Professor, Department of Mechanical Engineering, GNITC, Hyderabad, Telangana.
[2,3,4,] UG Scholars Department of Mechanical Engineering, GNITC, Hyderabad, Telangana.

ABSTRACT
This abstract provides a concise overview of the modeling and 3D printing processes employed for car bumpers. This bumper is re-modification from the existingone which has less strength to bear the opposite force. In this project, the bumper offers more strength by placing slides on the inner side. Materials used for these are Aluminum B390 alloy, Chromium coated mild steel, and Glass Mat Thermoplastic (GMT) materials. Integrating advanced modeling techniques, such as computer-aided design (CAD), and designing in solid works software enables the precise representationof bumper geometry. Subsequently, 3D printing technology transforms these virtual models into tangible prototypes. Using additive manufacturing techniques allows for customization, improved material efficiency, and rapid prototyping in the automotive industry. The study explores the implications of this methodology on design flexibility, cost-effectiveness, and the overall manufacturing landscape of car bumpers. The synergy between advanced modeling and 3D printing showcases a promising approachfor optimizing the production and performance of automotive components.

INTRODUCTION

A car bumper is a crucial component of an automobile designed to absorb and mitigate the impact of collisions, thereby minimizing damage to the vehicle and protecting its occupants. Positioned at the front and rear ends of a vehicle, the primary purpose of a bumper is to absorb and distribute the kinetic energy generated during a collision, reducing the force transferred to the rest of the vehicle. The evolution of car bumper design has been driven by safety standards, aerodynamics, and aesthetic considerations. Bumpers are today often integrated into the vehicle's overall design, contributing to its aesthetics while maintaining their crucial safety functions. Some vehicles also feature advanced technologies such as sensors and cameras embedded within the bumpers, enhancing the overall safety features of the vehicle.
.

OBJECTIVES

The main objective of the study is to customize and design a composite car bumper by using solid works and complex geometries of car bumper and also propose a suitable composite material for the car bumper.
The re-design of the bumper by adding slides (supports) on the inner side of the bumper.

LITERATURE SURVEY

Nurhalida Shahrubudin, Te Chuan Lee, and RJPM Ramlan presented in their paper that an overview of the types of 3D printing technologies, the application of 3D printing technology and lastly, the materials used for 3D printing technology in manufacturing industry. This paper is to overview the types of 3D printing technologies, materials used for 3D printing technology in the manufacturing industryand lastly, the applications of 3D printing technology. He expected that in the future, researchers can do some study on the type of 3D printing machines and the suitable materials to be used by every type of machine.[1]
Janarthanan Gopinathan and Insup Noh presented in their paper about polymer- based bioinks used in 3D printing for applications in tissue engineering and regenerative medicine. He performed using different bioink materials and their properties related to biocompatibility, printability, and mechanical properties. Heconcluded that many bioinks formulations have been reported from cell-biomaterials- based bioinks to cell-based bioinks such as cell aggregates and tissue spheroids for tissue engineering and regenerative medicine applications. Interestingly, more tunable bioinks, which are biocompatible for live cells, printable and mechanically stable after printing are emerging with the help of functional polymeric biomaterials, their modifications, and the blending of cells and hydrogels. These approaches show the immense potential of these bioinks to produce more complex tissue/ organ structures using 3D bioprinting in the future.[2]
Jian-Yuan Lee, Jia An, and Chee Kai Chua presented in their paper this review provides a basic understanding of the fundamentals of 3D printing processes and the recent development of novel 3D printing

iJETRM
International Journal of Engineering Technology Research & Management

materials such as smart materials, ceramic materials, electronic materials, biomaterials, and composites. He concluded that the fundamental aspects of AM processes in terms of speed, resolution and specific energybased on the ASTM standard. On the other hand, 3D printing is versatile in terms of materials and the versatility of 3D printing material comes from system variety but for each specific applications such as bio prinitng, the biocompatible materials are still limited and further development of novel materials are still required.[3]

Thomas Campbell et al presented in his paper a new technology is emerging that could change the world. 3D Printing/Additive Manufacturing (AM) is a revolutionary technology that could profoundly alter the geopolitical, economic, social, demographic,environmental, and security landscape of the international system. This potential revolution in manufacturing may take a decade or more to mature and become ubiquitous, but it could profoundly change our world in the next ten to twenty years.[4]

Amanda Su and Subhi J. Al'Aref presented in his paper about 3D printing
technology has progressed at a rapid pace, with significant impact in both the industrial and commercial world. Stereolithography, selective laser sintering, and fused deposition modeling were among the first widely successful methods of 3D printing, initially used for industrial prototyping. 3D printing technology was soon developed foruse in a variety of fields, for large-scale manufacturing, engineering of highly complexparts, and even for personal use.[5]

Brian Evans presented in his paper about 3D Printing builds parts in layers by spreading a layer of powder and then selectively joining the powder in the layer by ink-jet printing of a binder material. After all layers are printed, the layer loose of powder is removed to reveal the finished part. Application areas include ceramic molds for metal castings, directly printed parts for end-use and for use as tooling, ceramic preforms for metal matrix composites, structural ceramic parts, and others.[6]

Helena N. Chia and Benjamin M. Wu presented in their paper about 3D Printing promises to produce complex biomedical devices according to computer design using patient-specific anatomical data. In this review, the major materials and technology advances within the last five years for each of the common 3D Printing technologies. He concluded that this review article is on the fabrication techniques and biomaterials used in 3DP, the degradation kinetics and byproducts of the materials are in fact a very significant problem in 3D scaffolds due to mass transport limitations within thick scaffolds. This is a moving boundary diffusion-reaction problem that even without biodegradable biomaterials can result in hypoxia and acidosis within the scaffolds andrelease of acidic degradation products is expected to worsen the acidosis which may harm the seeded cells and/or the surrounding cells".[7]

M. M. Davoodi presented in his paper this study critically reviews the related literature on bumper design to come up with the optimal bumper beam design process.It particularly focuses on the effective parameters in the design of bumper beam and their most suitable values or ranges of values. The results can help designers and researchers in performing functional analysis of the bumper beam determinant variables. He concluded that the new safety regulations concerning bumper system specifications besides the automaker environmental legislations (end-of-life vehicle) make it quite complicated and costly for the design of this structure to fulfill all broad requirements.[8]

Nitin S. Motegi, S. B. Naik, and P. R. Kulkarni presented in their paper the design of the bumper will increase the performance of the bumper, improve absorbing capacityduring impact load, and increase the protection of the front car component. This research aims towards improvement in the design of the front bumper of passenger cars and gives an economical solution for the front bumper material by emphasizing the cost-reducing aspect. The methodology employed includes the study of the front bumper system, and the design and analysis of the improved front bumper using CAD/CAE software. He concluded that the stress pattern within the bumper system has been studied. Depending on the outcome, metallic and composite bumper facia are selected for impact strength assessment. Finally, it is found that composite facia is suitable from the impact point of view and is common now.[9]

Seung Ki Moon presented in his more specifically, the research seeks to identify onetruss lattice with the optimal elastic performance. He proposed three lattice designs - a3D Kagome structure, a 3D pyramidal structure, and a hexagonal diamond structure. In this paper, he extended the concepts of compliant mechanisms into inflatable wing design for small and deployable UAVs. 3D Kagome lattice, hexagonal diamond, and Cross pyramidal structures were used to compare the compressive strength of their lattice structures that have high values in elastic performance. The results confirmed that the 3D Kagome has the highest load capacity although it has also been noted that the hexagonal diamond exhibited the ideal properties of energy absorbers. To demonstrate and validate the usefulness of the proposed inflatable design, we developeda prototype wing segment for UAVs using 3D printing technologies.[10]

iJETRM
International Journal of Engineering Technology Research & Management

Wenbin Hou presented in his paper that the current study presents an investigationof a novel crash box, which consists of an Al shell and a 3D-printed lattice core. Givenobtaining a good lightweight and energy absorption, the lattice structures are fabricatedby fused filament fabrication (FFF) technology using carbon fiber reinforced polyamide6 (PA6/CF) composites. In this paper, he concluded that a novel crash box consisting of Al tube with a 3D-printed lattice core is investigated through experimental and numerical methods. The PA6/CF composite filaments are fabricated and successfully 3D-printed via FFF technology. The correlations between fiber content and elastic modulus, maximum stress, and fracture strain are successfully established via the least square method.[11]
Lorenzo Olivieri presented in his paper that in the framework of the EU H2020 REDSHIFT project, new 3D printed shields were developed for microsatellite protection. In this framework of the REDSHIFT project, novel shielding concepts manufactured with 3D-printed aluminum are in development. He concludes that the hypervelocity tests are presented and discussed focusing on the geometrical and physical parameters of the manufactured prototypes and preliminary results of their hypervelocity impact tests were presented. In particular, thin plates, single corrugated bumper panels, multi-shock panels, and a hybrid configuration were evaluated.[12]
Ramin Hosseinzadeh present in his paper a commercial front bumper beam made of glass mat thermoplastic (GMT) is studied and characterized by impact modeling using LS-DYNA ANSYS 5.7. Finally, the aforementioned factors are characterized by proposing a high strength SMC (Composite and metallic crash performance), bumper instead of the current GMT. Then he concluded that research tries to draw attention to materials whose manufacturing costs are lower than currently used materials, depictingthat 8% of today cars are made from plastic and composite materials. However, the authors strongly believe more practical tests should be done to verify the stability and advantages of the proposed structure.[13]
Javad Marzbanrad in his paper that in this research, a front bumper beam made of three materials: aluminum, glass mat thermoplastic (GMT), and high-strength sheet molding compound (SMC) is studied by impact modeling to determine the deflection, impact force, stress distribution, and energy-absorption behavior. He concluded that inthe design of the automobile bumper, two constraint conditions are usually considered.First, the deflection of the bumper beam should be kept below a certain value; 50 mm is taken in this study. Second, any plastic deformation should not be noticed to protectthe assembly of the vehicle such as the engine, fuel units, cooling units, ant, etc., fromdamage. The maximum stress of the bumper must be below the yield stress.[14]
M.J Cima, E. Sachs presented in their paper that the process involves spreading thepowder in thin layers and then selective binding of the powder using a technology similar to ink-jet printing. Layers are added sequentially until a part is completed. We envision cases where computer-delivered microstructures can be created by appropriate control of the printing particles. Thus, one can build components with the desired microstructure independent of the complexity of the desired shape. He concluded that this belief report represents SOlne of the first experiment to exploit the unusual capabilities of solid-free fabrication methods. He had already demonstrated unprecedented control of microstructure and local composition using the 3DP method, but other SFF technologies will undoubtedly be used along similar lines. MultiJet printing is now possible on 3DP machines as has been demonstrated at Soligen 26l andat MIT. This has dramatically increased the production rate of the 3DP process. C0l11lnerciai ink-jet print heads are available with thousands of individually controlled jets. Thus, future 3DP machines may be closer to production tools rather than tools forprototyping.
l health activities like Blindness Screening, Eye Care, Cataract Extraction, Hi-5 Impact Caravan and Ligation are now reached in Southern Barangays. However, due to long distance and transportation problems, these are irregularly conducted with interval of 4-5 years.[15]

ACKNOWLEDGEMENT

We wish to express our sincere thanks to **Dr. H.S SAINI,** Managing Director, Guru Nanak Institutions, and **Dr. KODUGANTI VENKATA RAO,** Director, Guru Nanak Institutions Technical Campus, School of Engineering and Technology, for providing us with all the necessary facilities and their support. We place on record, our sincere thanks to **Dr. A. RAJ KUMAR**, Professor and Head of the Department, of Mechanical Engineering for their wholehearted cooperation, providing excellent lab facility, constant encouragement, and unfailing inspiration.We would like to say sincere thanks to **Mr. V. SHYAMU**, Assistant Professor,Department of Mechanical Engineering for coordinating Projects.We would like to say sincere thanks to our guide **Mr. G. SANJEEVKUMAR,** Assistant Professor, Department of Mechanical Engineering for Coordinating Projects for the suggestions and constant guidance in every stage of the project. We would also like to thank all our lecturers

iJETRM
International Journal of Engineering Technology Research & Management

for helping us in every possible way.On a more personal note, we thank our beloved parents and friends for their moral support during our project.

CONCLUSION

In this work, this bumper is re-designed from the existing one which has less strength to bear the opposite force. In this project, we offer more strength to the bumper by placing slides on the inner side. This bumper has good stability and is cost-effective.The materials used for these designs are Glass Mat Thermoplastic (GMT) such as polycarbonate materials. By comparing thermoplastics designing properties are better in polycarbonates compared to glass mat thermoplastic material. So, using polycarbonate is better for car bumpers.

REFERENCES

[1] Nurhalida Shahrubudin, Te Chuan Lee, and RJPM Ramlan, "An Overview on 3D Printing Technology: Technological, Materials, and Applications," *Procedia Manufacturing* 35 (2019): 1286–96.
[2] Janarthanan Gopinathan and Insup Noh, "Recent Trends in Bioinks for 3D Printing,"
Biomaterials Research 22, no. 1 (2018): 11.
[3] Jian-Yuan Lee, Jia An, and Chee Kai Chua, "Fundamentals and Applications of 3D Printing for Novel Materials," *Applied Materials Today* 7 (2017): 120–33.
[4] Thomas Campbell et al., "Could 3D Printing Change the World," *Technologies, Potential, and Implications of Additive Manufacturing, Atlantic Council, Washington,DC* 3, no. 1 (2011): 18.
[5] Amanda Su and Subhi J. Al'Aref, "History of 3D Printing," in *3D PrintingApplications in Cardiovascular Medicine* (Elsevier, 2018), 1–10.
[6] Brian Evans, *Practical 3D Printers: The Science and Art of 3D Printing* (Apress,2012).
[7] Helena N. Chia and Benjamin M. Wu, "Recent Advances in 3D Printing ofBiomaterials," *Journal of Biological Engineering* 9 (2015): 1–14.
[8] M. M. Davoodi et al., "Development Process of New Bumper Beam for Passenger Car: A Review," *Materials & Design* 40 (2012): 304–13.
[9] Nitin S. Motgi, S. B. Naik, and P. R. Kulkarin, "Impact Analysis of Front Bumper,"
Int. J. Eng. Trends Technol 6 (2013): 287–91.
[10] Seung Ki Moon et al., "Application of 3D Printing Technology for Designing Light-Weight Unmanned Aerial Vehicle Wing Structures," *International Journal of PrecisionEngineering and Manufacturing-Green Technology* 1 (2014): 223–28.
[11] Wenbin Hou et al., "Crashworthiness Optimization of Crash Box with 3D-Printed Lattice Structures," *International Journal of Mechanical Sciences* 247 (2023): 108198.
[12] Lorenzo Olivieri et al., "Experimental Characterization of Multi-Layer 3D-Printed Shields for Microsatellites," *Journal of Space Safety Engineering* 7, no. 2 (2020): 125–36.
[13] Ramin HosseinzadehIn present in their paper ("Parametric study of automotivecomposite bumper beams subjected to low-velocity impacts"R. Hosseinzadeh et al. /Composite Structures 68 (2005) 419–427
[14]Javad Marzbanrad ("Design and analysis of an automotive bumper beam in low- speed frontal crashes") J. Marzbanrad et al. / Thin-Walled Structures 47 (2009) 902–911
[15] Cima MJ, Sachs E, Cima LG, Yoo J, Khanuja S, Borland SW, et al. Computerderived microstructures by 3D printing: bio-and structural materials. Solid Freeform Fabr Symp Proc: DTIC Document; 1994. p. 181-90