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MODELLING AND 3D-PRINTING OF CAR BUMPER

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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 representation of 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. Thesynergy between advanced modeling and 3D printing showcases a promising approach for 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 primarypurpose 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 andcameras embedded within the bumpers, enhancing the overall safety features of the vehicle.

Fig 1.1 Car Bumper

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 inmanufacturing industry. This paper is to overview the types of 3D printing technologies, materials used for 3D printing technology in the manufacturing industry and 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. He concluded 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 afterprinting 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 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]

METHODOLGY

A bumper structure is modeled and the same is considered for the design. It acts as a shock-absorbing structure. For a comparative study, an existing bumper design of a passenger vehicle is taken into consideration. Considering the basic design modifications are then made in the original design such that the front bumper is replaced with slides in the inner side of model designs. Crash analysis is carried out according to NCAP

regulations and safety standards. Design is carried out using Solid Works. Accordingly, different shock-absorbing structures are used in modern-day frontal car bumpers to meet these requirements.

- Car bumper design process using the Solid Works software after part file converted into the IGS file.
- Analysis using various materials like ABS Material, Carbon fiber, AL B 390, and Glass mat thermoplastic.
- Finally find out the material is suitable based on the deformation, shear stress, and Strain.

PROBLEM STATEMENT

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. Due to the kinetic impact energy. There will be some deformation takes place in bumpers because of their design, stability, and material used. The design a new bumper from the existing one by placing slides in the inner side of the bumper. Due to this, it acquires more strength and stability. Thermoplastic materials are used which reduce weight and increase stability and performance.

SKETCH OF CAR BUMPER IN SOLID WORKS

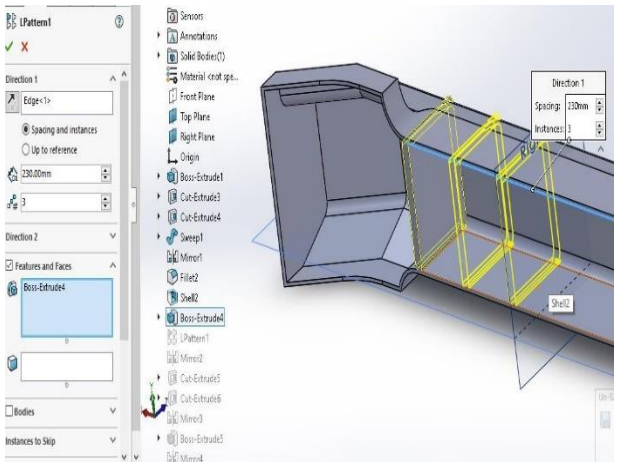

Fig 1.2 Extrude part 1

Selecting the right mid plane, then start drawing by selecting sketch plane and extrude the part after completion of diagram

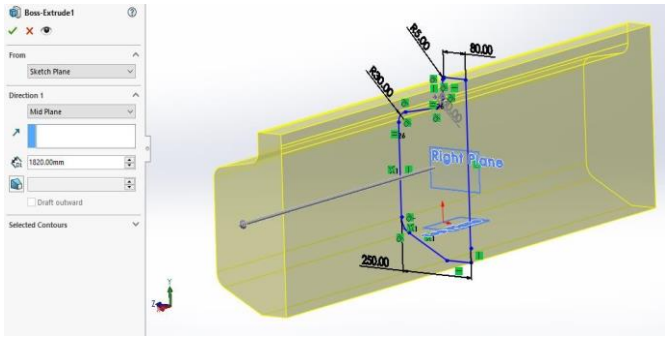

Fig 1.3 Extrude Part 2

Selecting the right and top plane by taking blind direction with length of 710mm and then extrude.

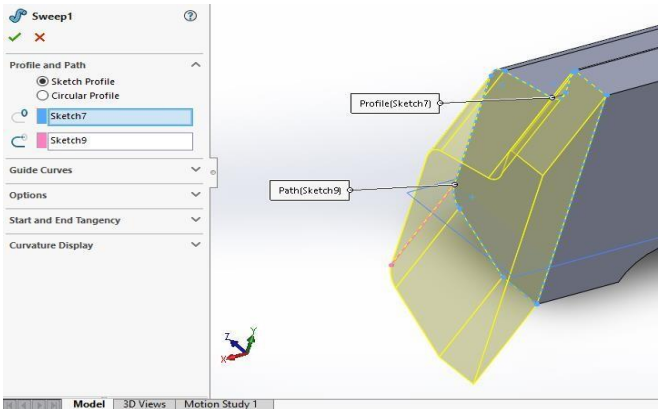

Fig 1.4 Sweep 1

Combination of both path and profile for sketch profile to design the sides of bumper numbering sketch 7 and sketch 9

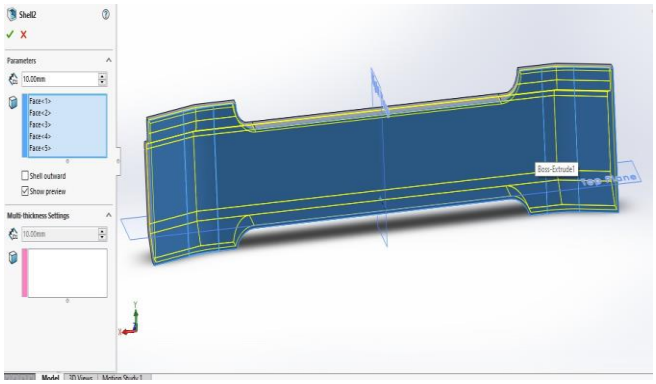

Fig 1.5 Shell 2

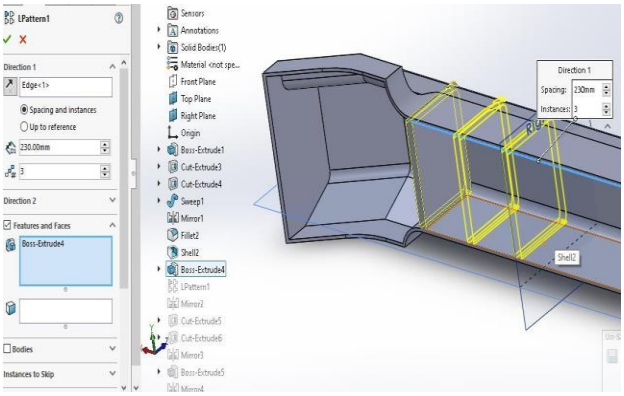

Fig 1.6 Fill pattern 1

Next step after sweep is the shell that is to make a part inside of bumper and make thin-walled edges

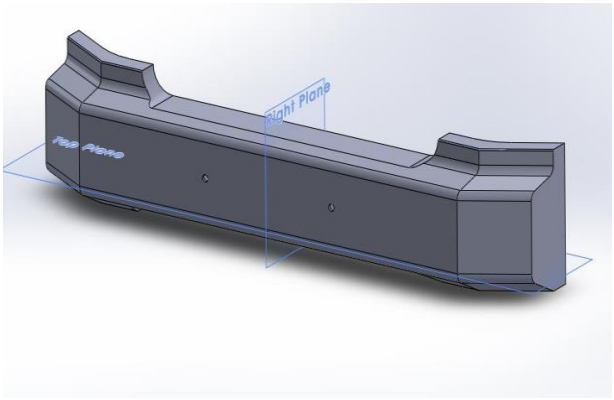

Fig 1.7 Final design of bumper

Here in the pattern, we cover the hallow part with slide plates which helps to increase stability and strength.

FUSED DEPOSITION MODELLING

Fused Deposition Modelling sometimes called Fused Filament Fabrication (FFF) is a 3D printing technology that uses a process called Material Extrusion. Material Extrusion devices are the most widely available and inexpensive of the types of 3D printing technology in the world today.They work by a process where a spool of filament of solid thermoplastic material (PLA, ABS, PET) is loaded into the 3D printer. It is then pushed by a motor through a heated nozzle, where it melts. The printer's extrusion head then moves along specific coordinates, depositing the 3D printing material on a build platform where the printer filament cools and solidifies, forming a solid object.

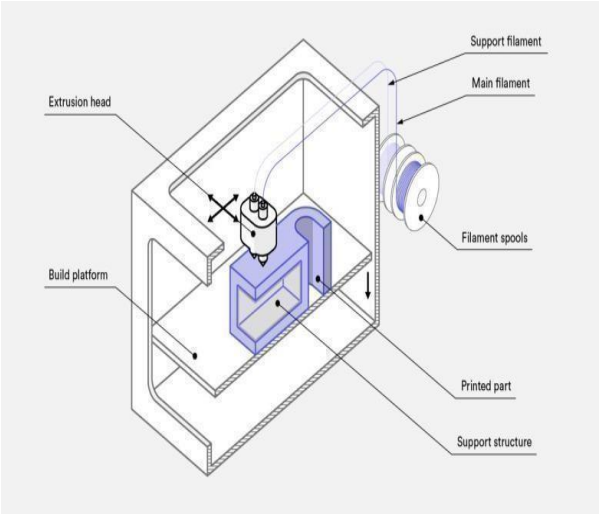

Fig 1.8 Schematic diagram of FDM printer

Once the layer is complete, the printer lays down another layer, repeating the process until the object is fully formed. Depending on the object's complexity and geometry, support structures are sometimes added, for example, if the object has steep overhanging parts. Common applications for FDM include electrical housings, form and fit testing, jigs and fixtures, and investment casting patterns. The strengths of FDM are that it offers the best surface finish plus full color along with the fact there are multiple materials available for its use.

DESIGN EXECUTION OF CARBUMPER IN 3-D PRINTING SOFTWARE

Design execution in Flash frobe software where this software is used to print the prototype with required dimensions and parameters. Selecting machine type and resolution.

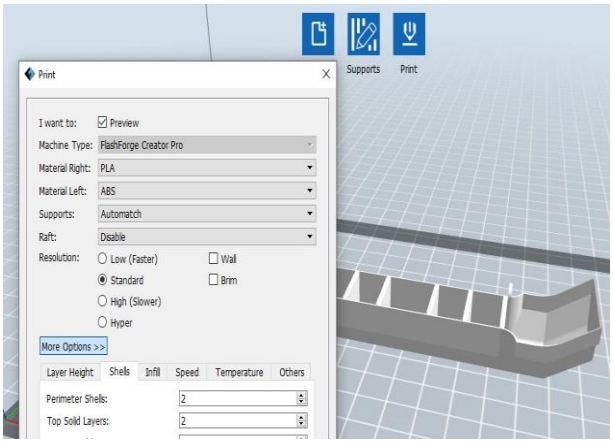

Fig 1.9 Selecting all the parameters

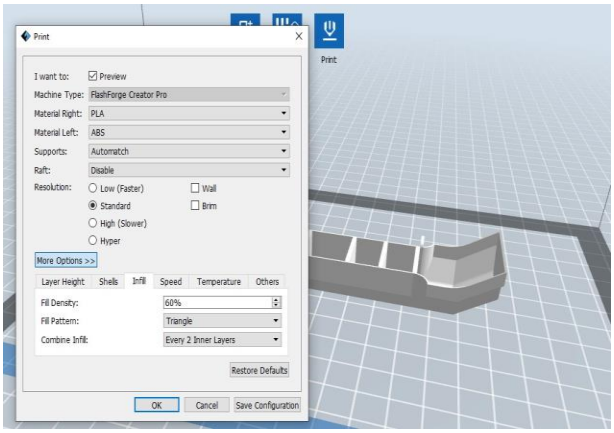

Fig 1.10 Selecting fill density and pattern

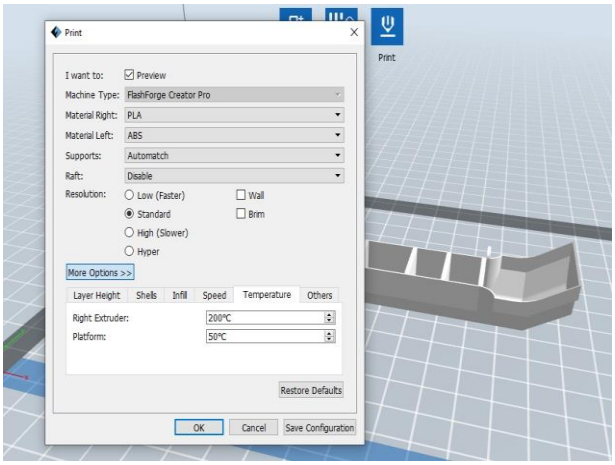

Fig 1.11 Selecting Temperatures

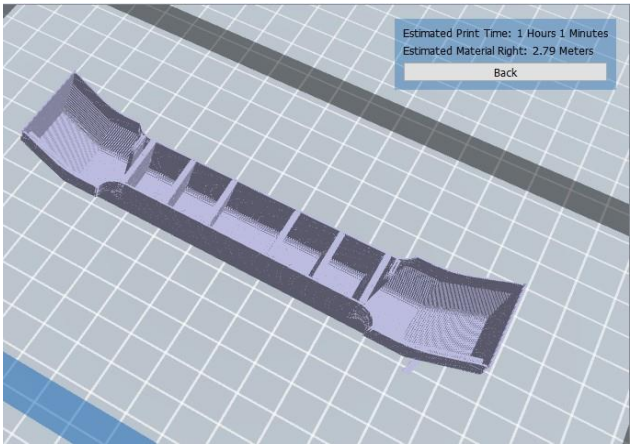

Fig 1.12 Estimated time for result

Total time taken to complete print time is 1 hour 1 minute and materialestimated is 2.79 meters

SELECTION OF MATERIAL

A thermoplastic, or thermos-softening plastic, is any plastic polymer material that becomes pliable or moldable at a certain elevated temperature and solidifies upon cooling. Most thermoplastics have a high molecular weight. The polymer chains are associated by intermolecular forces, which weaken rapidly with increased temperature, yielding a viscous liquid. In this state, thermoplastics may be reshaped, and are typically used to produce parts by various polymer processing techniques such as injection molding, compression molding, calendaring, and extrusion. Thermoplastics differ from thermosetting polymers which form irreversible chemical bonds during the curing process. Thermosets do not melt when heated, but typically decompose and do not reform upon cooling. 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. Products made from polycarbonate can contain the precursor monomer bisphenol A (BPA).

PROPERTIES OF POLYCARBONATE MATERIAL

Polycarbonate is a durable material. Although it has high impact resistance, it has low scratch resistance. Therefore, a hard coating is applied to polycarbonate eyewear lenses and polycarbonate exterior automotive components. The characteristics of polycarbonate compare to those of polymethyl methacrylate (PMMA, acrylic), but polycarbonate is stronger and will hold up longer to extreme temperatures. The thermally processed material is usually totally amorphous, and as a result is highly transparent to visible light, with better light transmission than many kinds of glass. Polycarbonate has a glass transition temperature of about 147 °C (297 °F), so it softens gradually above this point and flows above about 155 °C (311 °F). Tools mustbe held at high temperatures, generally above 80 °C (176 °F) to make strain-free and stress-free products. Low molecular mass grades are easier to mold than higher grades, but their strength is lower as a result. The toughest grades have the highest molecular mass but are more difficult to process. Unlike most thermoplastics, polycarbonate can undergo large plastic deformations without cracking or breaking. As a result, it can be processed and formed at room temperature using sheet metal techniques, such as bending on a brake. Even forsharp angle bends with a tight radius, heating may not be necessary.

ADVANTAGES

Collision Protection: These bumpers are designed to absorb impact in low- speed collisions, protecting both the vehicle's occupants and the vehicle itself from damage. They help minimize the force of impact transferred to the main structure of the car.

Pedestrian Safety: These bumpers are designed with pedestrian safety in mind, incorporating features such as energy-absorbing materials and space between the bumper and the vehicle's body to reduce injury in case of a pedestrian impact.

Functionality: These bumpers can also use parking sensors, fog lights, and license plate mounts, providing functionality beyond just impact protection. They can also include aerodynamic features to improve fuel efficiency and reduce wind noise.

Cost Savings: By absorbing impact and protecting more expensive components of the vehicle, such as the engine or body panels, bumpers can help reduce repair costs in the event of a collision.

DISADVANTAGES

Incompatibility with off-Road Driving: These bumpers are not more suitable for off-road driving and irregular surfaces.

Limited Protection: These bumpers are primarily designed for low-speed impacts. In high-speed collisions or accidents involving large objects, such as trees or guardrails, bumpers may offer limited protection, and the force of the impact can still cause significant damage to the vehicle and its occupants.

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 bumperby 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.

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