MODELING AND 3D PRINTING OF TWO WHEELER CRASH GUARDS

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ABSTRACT
The crash guard is a protective device installed on vehicles to minimize damage in case of accidents. It helps to protect the front or rear of the vehicle from collisions.3D printing is designing crash guards for two-wheelers, aiming to enhance safety and customization. By employing solid works software and simulations, complex geometries are optimized for impact resistance. Advanced materials with high strength-to-weight ratios are selected to ensure performance and lightweight characteristics. This delves into novel materials and ergonomic considerations for rider comfort. The optimizing crash guard structures for impact resistance but also on ensuring economic feasibility and scalability for mass production. It explores the potential for widespread adoption within the automotive industry. Additionally, it emphasizes the importance of comprehensive real-world crash simulations to validate the effectiveness of the proposed approach. By considering a holistic approach that blends advanced numerical analyses, sophisticated 3D printing methodologies, and user experience factors, the research aims to pave the way for a new era in two-wheeler crash guard design and manufacturing.
Keywords: Solidworks, Ansys, Flash Forge Pro

INTRODUCTION

Crash guards, also known as bumpers or bull bars, serve as crucial components in vehicle safety and protection. They are designed to absorb and mitigate the impact of collisions, whether with obstacles on the road or other vehicles. Crash guards are typically installed on the front or rear of vehicles, depending on the intended use and design specifications.

The primary function of crash guards is to minimize damage to the vehicle and its occupants in the event of a collision, by absorbing and redistributing the impact forces. They are constructed from durable materials such as steel, aluminum, or composite plastics, chosen for their ability to withstand high-energy impacts.

Beyond vehicle protection, crash guards also play a role in enhancing pedestrian safety by reducing the severity of injuries in case of accidents involving pedestrians. However, there is ongoing debate regarding their effectiveness in this regard, as poorly designed or improperly installed crash guards can potentially increase the severity of injuries.

While crash guards offer significant benefits in terms of vehicle protection, there are also concerns regarding their impact on fuel efficiency, pedestrian safety, and compatibility with advanced driver assistance systems (ADAS). As such, the design, regulation, and usage of crash guards continue to be topics of discussion and research within the automotive industry and regulatory bodies worldwide.

LITERATURE REVIEW

[1] **J.P.Badgujar & R.B.Barjibhe** studied increased motorcycle speeds leading to higher risks of frontal impact injuries, particularly to the knees and lower legs/feet. It focuses on enhancing vehicle safety during such impacts, specifically frontal and fixed-object collisions. Numerical simulations were conducted on the top five commercially available motorcycle leg guard designs in India using the ANSYS 19 explicit dynamics module. Following simulation results, the optimal design was selected and experimentally tested. The diamond-shaped guard exhibited minimal deformation, and strain rates were measured via drop tests using a Piezoelectric test rig. The numerical predictions closely matched experimental results, with a deviation of 9.04%.
[2] **R.Balamurugan & S. Mohamed Abdul Sukkoor, S.Madhankumar & A.Tamilselvan,** done research that focuses on addressing bike accidents by designing and analyzing a safety guard for scooters. With the increasing use of lightweight materials in automobile bodies for environmental and weight reduction purposes, the study aims to enhance scooter safety. The designed safety guard features S-shaped longitudinal members, chosen for their superior crash behavior and energy absorption compared to existing guards. The project utilized Creo 2.0 software for modeling and ANSYS 16.0 for crash simulations using Explicit Dynamics. The goal was to determine the impact energy absorption capabilities of the guard and investigate its stiffness in crash scenarios.
[3] **Javad Marzbanrad, Masoud Alijanpour & Mahdi Saeid Kiasat**, studied about importance of balancing passenger safety with the need for lightweight design to comply with fuel efficiency and emission regulations. Various characteristics, including deflection, impact force, stress distribution, and energy absorption, are analyzed to determine the optimal material, shape, and thickness for the bumper beam. The results indicate that a modified high-strength sheet molding compound (SMC) bumper beam exhibits minimized deflection, impact force, and stress distribution while maximizing elastic strain energy.
[4]**Miki N, Martimbianco AL, Hira LT, Lahoz GL, Fernandes HJ & Dos Reis FB** studied retrospective and observational, covering the period from January 2008 to December 2009. Data from medical records were analyzed, including age, gender, type of collision, type and location of the fracture, treatment (conservative or surgical), type of surgery, cost of synthesis material and hospitalization, length of hospital stay, and postoperative complications.

METHODOLOGY

The project begins with conceptualization, defining its purpose, size, and intended use, followed by sketching and research for inspiration. Designing entails choosing appropriate 3D modeling software, creating a rough outline, and refining the design with attention to measurements and functionality. Refinement involves critical review, seeking feedback, and iterative adjustments for improvement. Exporting the finalized 3D model in suitable file formats for printing is crucial. Slicing the model involves configuring settings for optimal print quality and efficiency, with careful previewing for potential issues. Printing requires transferring the sliced file, preparing the printer, and monitoring the process, troubleshooting as needed. Post-processing involves cleaning, removing supports, and additional steps like sanding or painting. Finally, testing the printed object for functionality and appearance, iterating based on feedback, completes the process.

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MODELING OF CRASH GUARDS

Crash guards, also known as bumper guards or bull bars, are structures installed on vehicles to protect them from collisions. They are typically made of strong materials like steel or aluminum and are designed to absorb impact energy in the event of a crash. Crash guards are often shaped to deflect objects away from the vehicle's body, reducing damage. Engineers use simulations and modeling software to design crash guards that meet safety standards while minimizing weight and cost. Advanced techniques like finite element analysis (FEA) help optimize crash guard designs for maximum effectiveness..

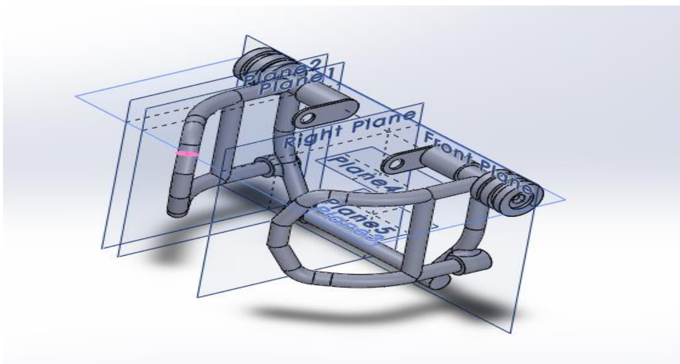

Fig .1 3D Model of crash guard

3D PRINTING OF CRASH GUARDS

3D printing offers an innovative solution for crafting crash guards, leveraging its versatility and rapid prototyping capabilities. Utilizing materials like ABS or nylon, 3D printers can produce robust crash guards with intricate designs to meet specific requirements. Through Solidworks software, engineers can tailor crashguard geometries for optimal performance and durability. The layer-by-layer printing process ensures precise construction, enabling customization for various vehicle models and sizes. With 3D printing, manufacturers can quickly iterate designs, test prototypes, and refine performance, reducing time-to-market and enhancing product quality. This technology revolutionizes crash guard production, offering cost-effective and efficient solutions for vehicle safety and protection.

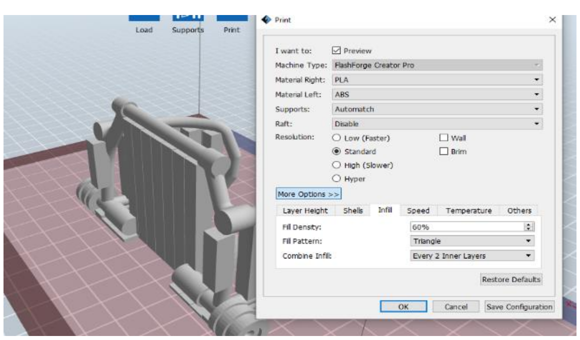

Fig .2 Infill

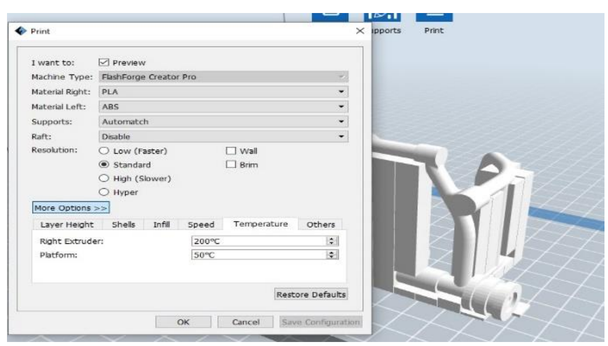

Fig .3 Temperature

EXPERIMENTAL ANALYSIS

Structural static analysis of crash guards involves simulating the application of static loads to evaluate their strength and performance. Using finite element analysis (FEA) software, engineers model the crash guard geometry and material properties to simulate real-world conditions. The analysis assesses factors like stress distribution, deformation, and structural integrity under different loading scenarios. By analyzing these factors, engineers can optimize the crash guard design for maximum strength and impact resistance. This process helps in identifying potential weak points and areas for improvement, leading to the development of safer and more effective crash guards.

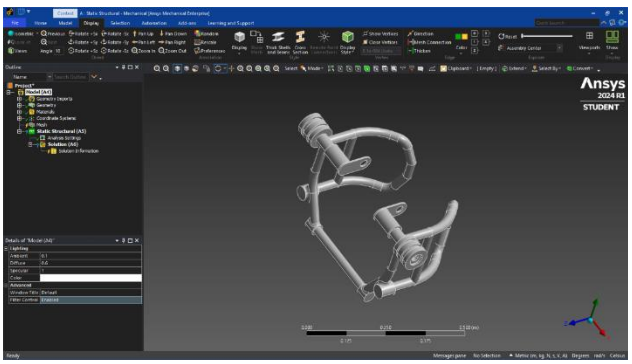

Fig. 4 Model with analysis tool

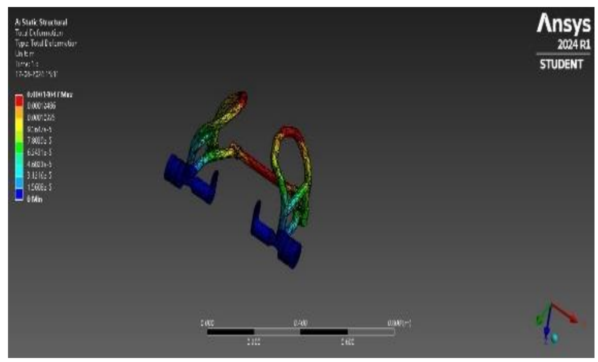

Fig .5 Total deformation of stainless steel.

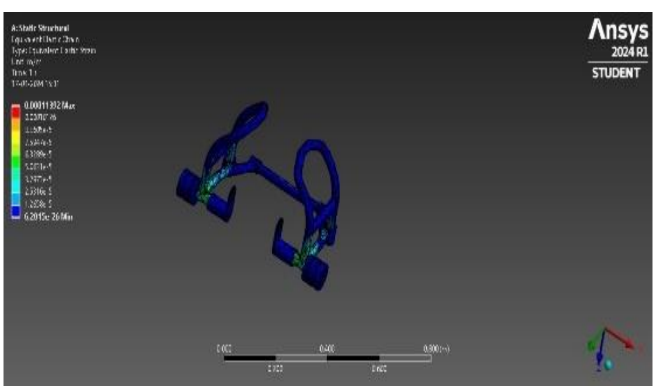

Fig. 6 Equivalent Elastic Strain of stainless steel.

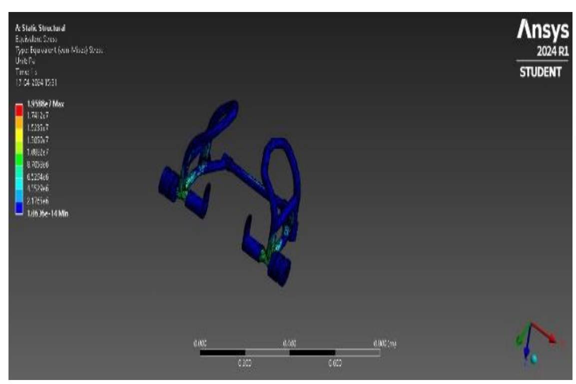

Fig .7 Equivalent(von-Mises) Stress stainless steel

RESULTS

The Final Printed Model

The traditional method of manufacturing R15 V3 crash guards involves more human efforts, time, and resources. But by using 3d printing technology we can manufacture the crash guards with minimal effort, time, and resources. The designer will have much liberty in designing the crash guards.

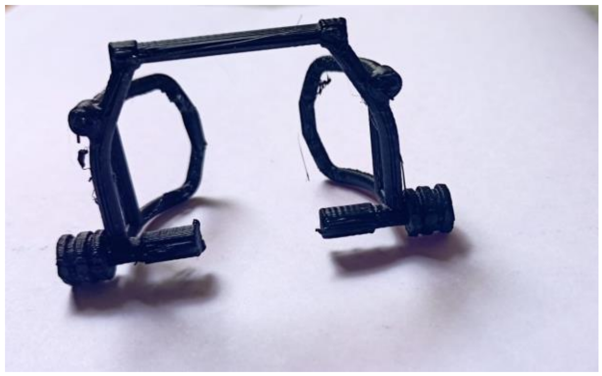

Fig Final product

Analysis Of Crash Guard

By using Ansys software total deformation, equivalent strain, and equivalent stress, are done for the designed crash guard. Analysis was done by using two different materials stainless steel and structural steel. By applying a 1500N load the structural steel has less deformation than stainless steel.

Total deformation results for both stainless steel and structure steel are given in the below table

Table 1: Total deformation

Material	Maximum	Minimum
Stainless steel	0.00014047	1.5608e-5
Structure steel	0.00013521	1.5023e-5

Equivalent Elastic strain results for both stainless steel and structure steel are given in the below table

Table 2: Equivalent Elastic Strain

Material	Maximum	Minimum
Stainless steel	0.00011392	6.2015e-26
Structure steel	0.00011008	4.0724e-26

Equivalent (von Mises) stress results for both stainless steel and structure steel are given in the below table

Table 3: Equivalent (von-Mises) stress

Material	Maximum	Minimum
Stainless steel	1.9588e7	1.0636E-14
Structure steel	1.9624e7	5.7848e-15

CONCLUSION

In this project, the modeling of the R15 V3 crash guards by using one of the most advanced 3-Dimensional software mostly known as Solidworks software designed the R15 V3 crash guards by using different types of tools and features that can be seen in the modeling of R15 V3 crash guards. Later file is saved in the format as an STP or IGES file to analyze the component.

The analysis is done by ANSYS software one of the most practical meshing accurate analysis software to find the result over the component. Structural Steel has less deformation than Stainless steel. Structural steel also has less stress and strain induced compared to stainless steel. Structural Steel provides better safety to the driver than Stainless steel.

In this, we made a comparison analysis between stainless steel and structure steel. Compared to stainless steel structure steel has less Deformation, less Equivalent Elastic Strain, and Equivalent (von Mises) stress.

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