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Optimization and Analysis of Car Door Handle Using 3 Point Bending Test and 3D Printing.

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A B S T R A C T

One of the important piece of hardware that people use every day is a door. Doors are utilised to provide us a sense of security. The door handle is the most crucial component of a door since it allows us to open and close it. Door handles are used to open and close a door quickly and easily. various door handles, including lever handles and doorknobs. The various handles we encountered in daily life include and pull handles. Since there are so many different door handle designs to choose from, we are unsure of the door handle selection criteria. The purpose of this effort is to investigate various materials and inside handle designs for automobile doors. To do this, we used FEA software to identify which materials and shapes had greater strength and to optimise design. In this project, the inside component of the automobile door inside handle was constructed using two separate structures: a honeycomb structure and an auxetic structure. Utilising 3D printing technology, an improved interior car door handle will be produced.

Keywords: Optimization of car door handle, door handle

INTRODUCTION

The only hardware used to open and close doors is door handles. Everyone uses doors, and door knobs are necessary for their functionality. Doors are employed to protect our possessions from theft. There are numerous different types of doors, including closet, false, and passage doors. similar to that, there are numerous types of door handles. The types of doors and how they work. Doors have handles built so that you may easily open and close the door with the least amount of effort.A door handle is used to open and close the doors of cars, as its name suggests. It can be found on the inner and outside sides of car doors, albeit it serves a different purpose on each panel. The inner door handle is used to unlock the door latch before you can push the door open to let yourself exit whereas the outside handle is used to open the automobile door. This proposal takes into account inside door handles.Car interior door handles are ergonomically created for the driver and passengers' comfort.The interior car door knobs are therefore both aesthetically pleasing and functionally sound.Designing with Ergonomics in Mind Ergonomics is the study of the interaction between people and machines and the application of anatomical, physiological, and psychological concepts to problems that arise in this setting.Durable plastic and metals like aluminium, zinc, and magnesium alloys can be used to create door handles.

2. Problem Statement

Vehicle interior door handles are frequently made of different materials. The material used on the internal side of the vehicle door, in contrast to the materials used on the exterior side, has uses beyond aesthetics. The purpose of this effort is to investigate various materials and inside handle designs for automobile doors. To do this, we employed Finite Element Analysis (FEA) software to identify which shapes and materials are more robust and to optimise the design. For the interior of the car door handle, we used two different structures in this project: a honeycomb structure and an auxetic structure. The construction of an improved inside car door handle will be done utilising 3D printing. Utilising a universal testing machine (UTM), the three-point bending behaviour of these structures was studied.

3. Objectives

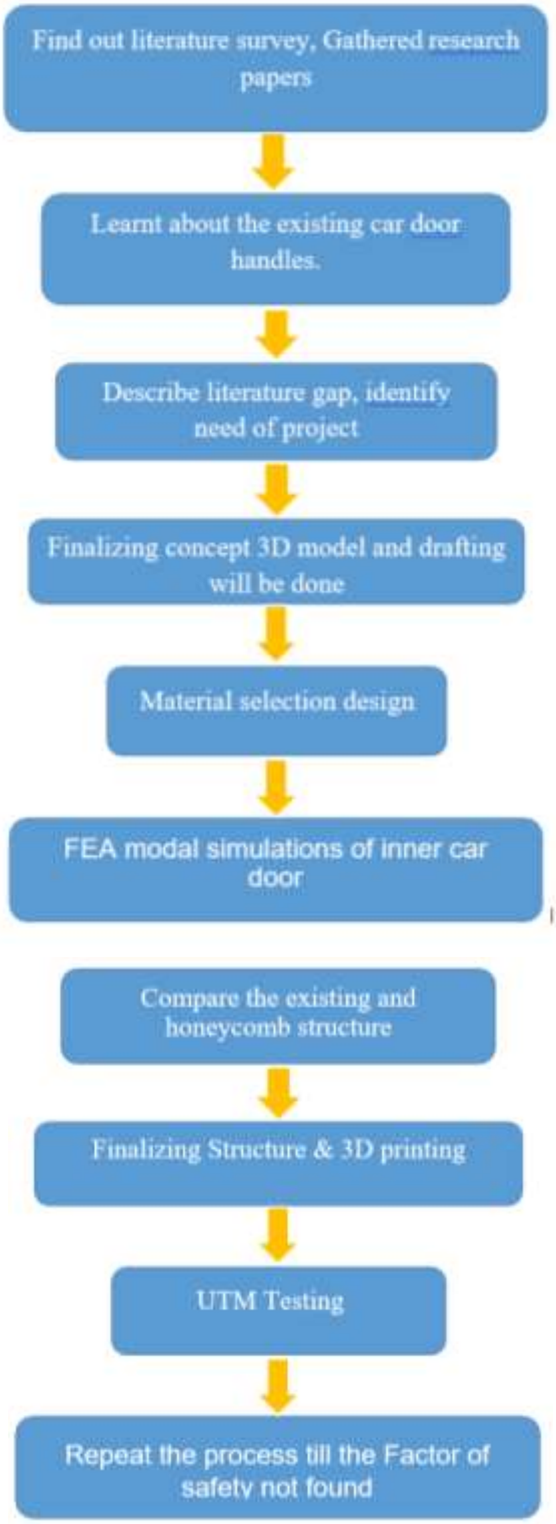
3.1Analyzing for stresses and deformation in car door interior handle of vehicle using ANSYS 19 software.

3.2 To manufacturing of car door interior handle of vehicle using 3D printing technology.

3.3 The behaviors of car door interior handle under three-point bending were investigated by using UTM.

3.4 Experimental testing and correlating results.

4. Methodology



5. Design and Analysis

5.1 CAD

Using computer systems (or workstations) to help with the creation, revision, analysis, or optimisation of a design is known as computer-aided design (CAD). CAD software is used to develop databases for manufacturing, boost designer efficiency, enhance design quality, and improve communications through documentation. Electronic files for printing, machining, or other manufacturing processes are frequently the CAD output. Another word used is CADD, which stands for computer-aided design and drafting

Here we use Solidwo5rks CAD software to design the honeycomb structure, which helps in reducing the material used in existing handle.

Fig. 5.1 Car Door Model

5.2 Finite Element Analysis

A method for solving practical (engineering) problems is finite element analysis (FEA). Prior to solving, the issues are transformed into matrices and partial differential equations. In order to solve the problem, partial differential and integral equations must eventually be solved. Since the volume of the equations to be solved is typically so large, it is nearly impossible to reach a solution without a computer. It is for this reason that the demand for several FEA packages is felt. Various FEA packages are available for various applications. FEA software programmes include Pro Mechanica, ANSYS, NASTRAN, and Gambit, among others.

Steps in FEA:

1. Pre-processing

The structure is modelled using a CAD programme, either one that is included with the FEA software or one that is purchased separately and includes 3D CAD modelling tools like Pro-E, Catia, and solid Edge. Several components make up the final FEA model, which together represents the overall structure. The components simulate the mechanical behaviour and qualities of the structure in addition to representing different parts of it.

2. Solution

This stage involves applying the geometry, restrictions, mechanical characteristics, and loads to each element to produce matrix equations, which are then combined to provide a global matrix equation for the structure.

$$\{F\} = [K]\{u\}$$

Where, $\{F\}$ = External force matrix,

$[K]$ = Global stiffness matrix,

$\{u\}$ = Displacement matrix.

3. Post processing

The finite element analysis ends with this step. Results from step 2 are typically obtained as raw data, which is challenging to interpret. A CAD programme is used to alter the data during post-analysis to produce deflected shapes for the structure, stress graphs, animation, etc. Understanding the behaviour of the structure is greatly aided by a graphical representation of the results.

We used ANSYS software to analyze both the handles we designed previously.

6. Existed Car Door Haldle

6.1 Geometry

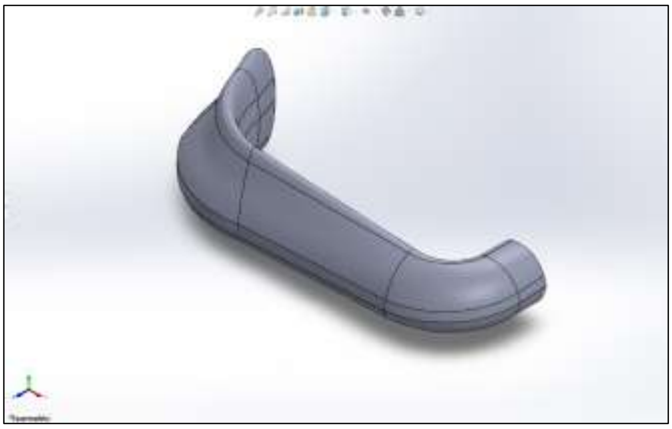
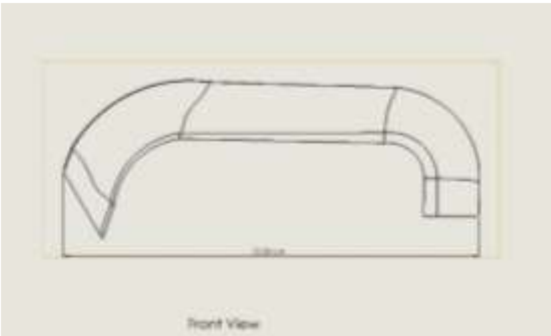


Fig. 6.1 Basic Geometry



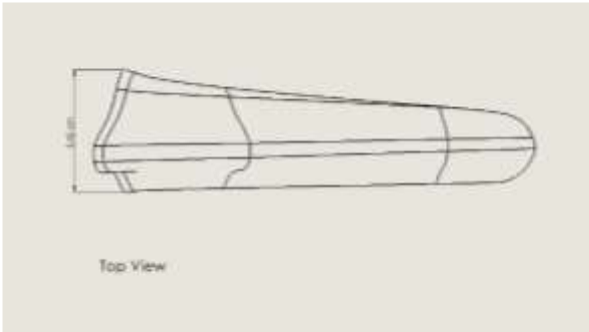


Fig. 6.2 Front view dimension

Fig. 6.3 Top view dimension

6.2 Material Properties

Properties of Outline Row 3: Polyethylene

	A	B	C	D	E
1	Property	Value	Unit		
2	Material Field Variables	Table			
3	Density	950	kg m^-3		
4	Isotropic Secant Coefficient of Thermal Expansion				
6	Isotropic Elasticity				
7	Derive from	Young's Modul...			
8	Young's Modulus	1.1E+09	Pa		
9	Poisson's Ratio	0.42			
10	Bulk Modulus	2.2917E+09	Pa		
11	Shear Modulus	3.8732E+08	Pa		
12	Tensile Yield Strength	25	MPa		
13	Compressive Yield Strength	0	Pa		
14	Tensile Ultimate Strength	3.3E+07	Pa		
15	Compressive Ultimate Strength	0	Pa		

Fig. 6.4 Material Properties

6.3 Meshing

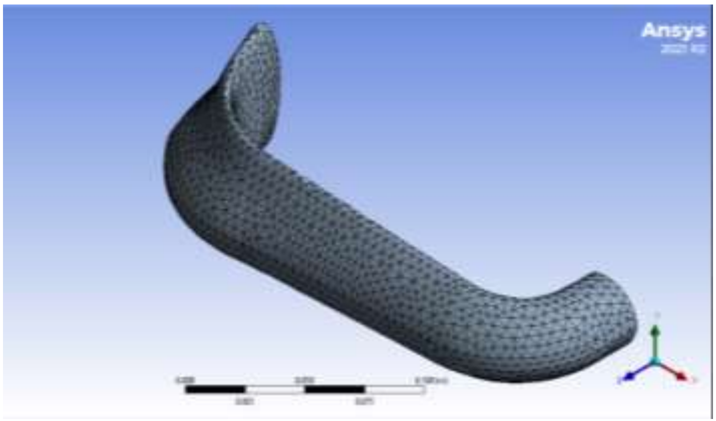


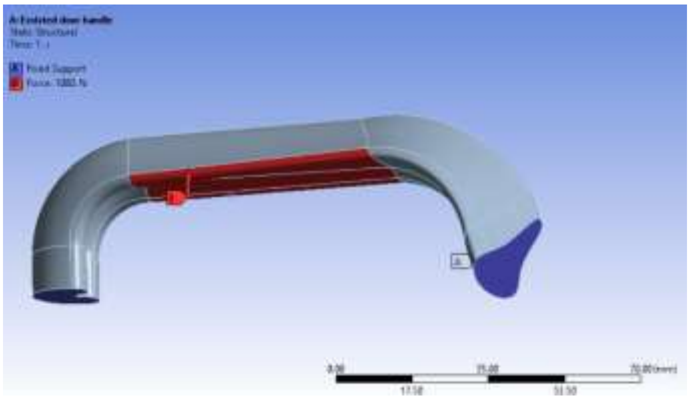
Fig. 6.5 Meshing

Details of "Body Sizing" - Sizing

Scope	
Scoping Method	Geometry Selection
Geometry	1 Body
Definition	
Suppressed	No
Type	Element Size
Element Size	5.e-003 m
Advanced	
Defeature Size	Default
Behavior	Soft

Tab. 6.1

6.4 Boundary Conditions



The weight of a person is the maximum weight that can be applied to a door handle. We therefore estimate that a human being weighs 100 kg while taking safety into account.

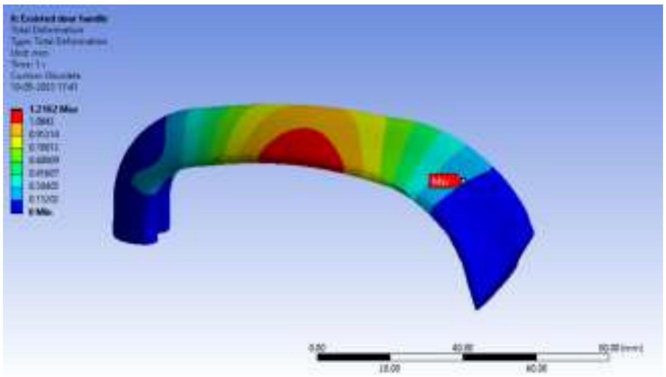
Thus, the maximum force apply on car door is 100*9.81=1000N.

We applied 1000N load on car door and fixed both end of the car door.

6.5 Analysis Result

1. Total Deformation

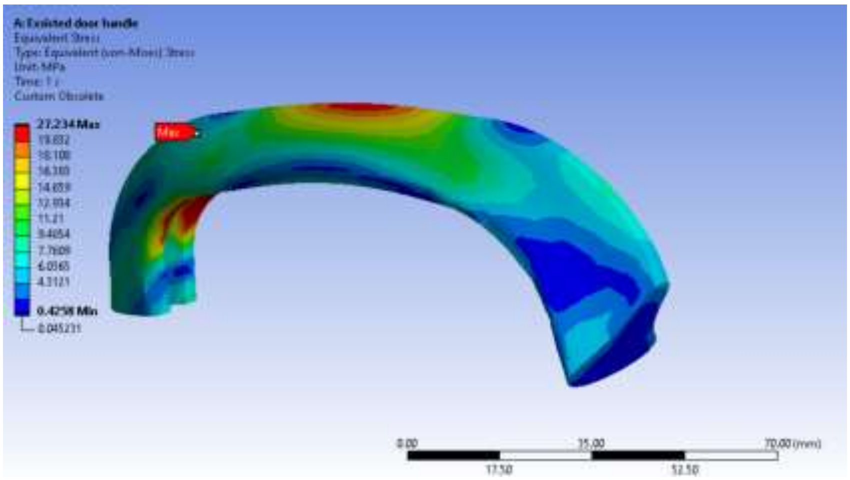
Regardless of the programme being utilised, the phrases "total deformation" and "directional deformation" are general concepts in finite element methods.The displacement of the system in a certain axis or user-defined direction is referred to as directional deformation. The vector sum of all the systems' directional displacements is the total deformation.



The Maximum deformation of 1.216mm is seen.

2. Equivalent Stress

Since equivalent stress (also known as von Misses stress) enables the representation of any arbitrary three-dimensional stress state as a single positive stress value, it is frequently used in design work. The maximum equivalent stress failure theory, which is used to forecast yielding in a ductile material, includes equivalent stress.



Maximum Stress of 27.234 MPa was observed.

7. Modified Car Door Handle

7.1 Geometry

Modified Honeycomb structure was designed using solidworks software.

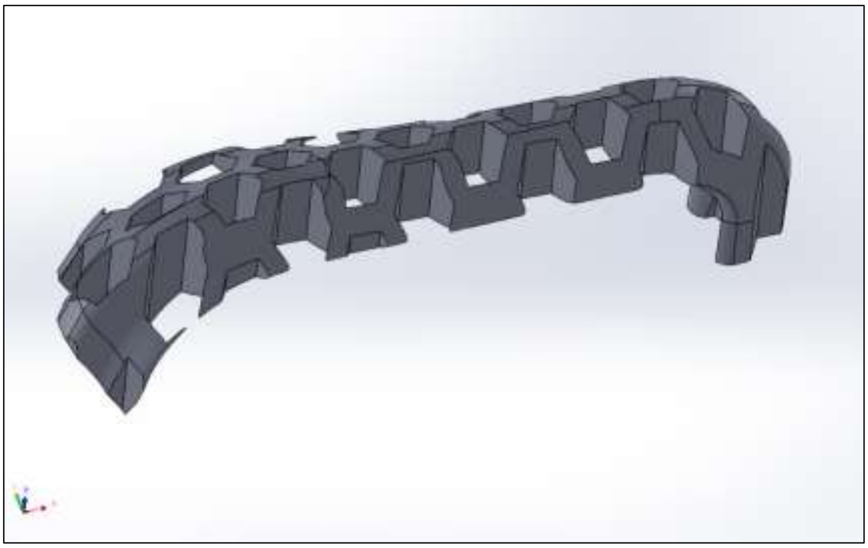


Fig. 7.1

Honeycomb structures are natural or man-made structures that have the geometry of a honeycomb to allow the minimization of the amount of used material to reach minimal weight and minimal material cost. The geometry of honeycomb structures can vary widely but the common feature of all such structures is an array of hollow cells formed between thin vertical walls. The cells are often columnar and hexagonal in shape. A honeycomb shaped structure provides a material with minimal density and relatively high out-of-plane compression properties and out-of-plane shear properties.

Man-made honeycomb structural materials are commonly made by layering a honeycomb material between two thin layers that provide strength in tension. This forms a plate-like assembly. Honeycomb materials are widely used where flat or slightly curved surfaces are needed and their high specific strength is valuable. They are widely used in the aerospace industry for this reason, and honeycomb materials in aluminum, fiberglass and advanced composite materials have been featured in aircraft and rockets since the 1950s. They can also be found in many other fields, from packaging materials in the form of paper-based honeycomb cardboard, to sporting goods like skis and snowboards.

7.2 Material Properties

ABS or Acrylonitrile or Acrylonitrile butadiene styrene is a common thermoplastic polymer typically used for injection molding applications.

This engineering plastic is popular due to its low production cost and the ease with which the material is machined by plastic manufacturers. Tensile strength of ABS is 46 Mpa (Greater than Polyethylene, which was previously used has 11 MPa)

Properties of Outline Row 19: Plastic, ABS (high-impact)

	A	B	C
1	Property	Value	Unit
2	Density	1030	kg m^-3
3	Isotropic Secant Coefficient of Thermal Expansion		
5	Isotropic Elasticity		
6	Derive from	Young's Modulus...	
7	Young's Modulus	1.628E+09	Pa
8	Poisson's Ratio	0.4089	
9	Bulk Modulus	2.9784E+09	Pa
10	Shear Modulus	5.7776E+08	Pa
11	Tensile Yield Strength	Tabular	
12	Tensile Ultimate Strength	Tabular	
13	Isotropic Thermal Conductivity	0.1997	W m^-1 C^-1
14	Specific Heat Constant Pressure, C_p	1400	J kg^-1 C^-1

The same boundary conditions were applied and the structure was analyzed.

7.3 Analysis Results

1. Total Deformation

The maximum deformation of 0.85133 mm was noted.

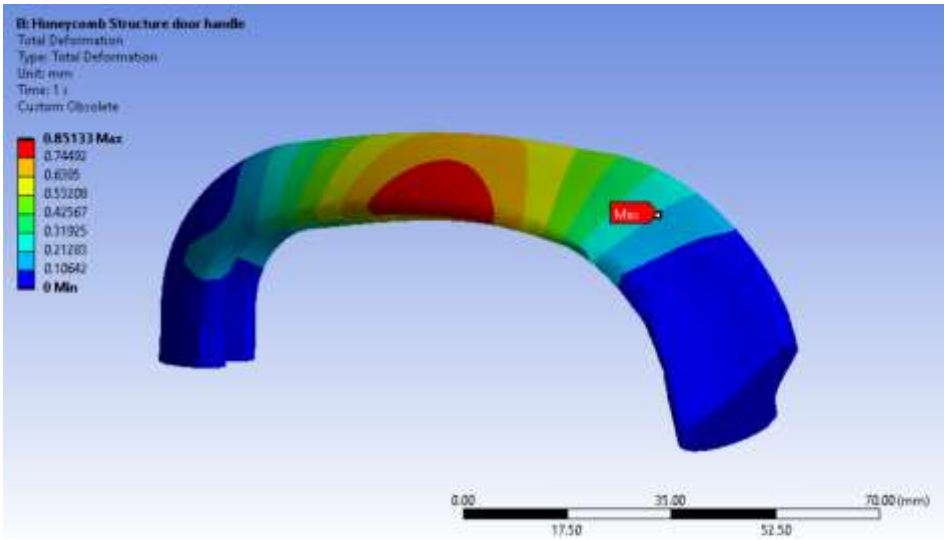


Fig. 7.3

Equivalent Stress

The maximum stress of 19.064 MPa was observed.

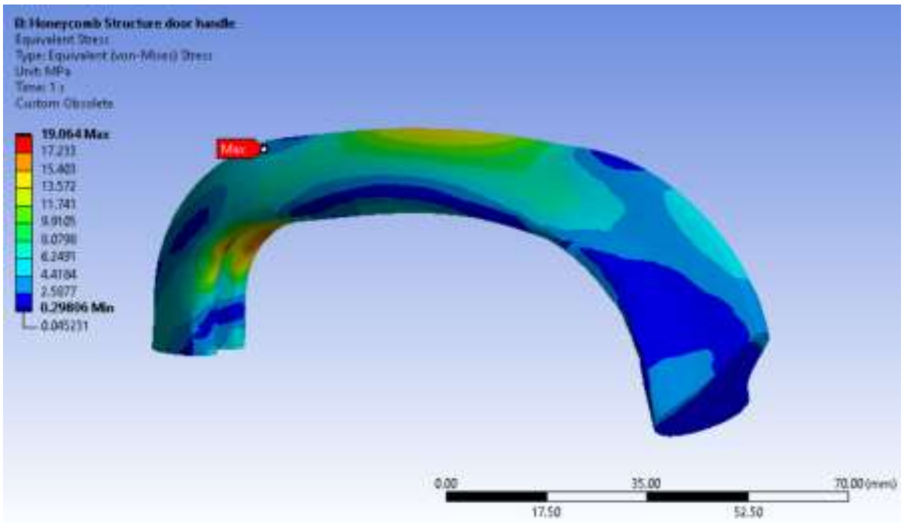


Fig. 7.4

8. Results Comparison Table

Tab. 8.1

REFERANCE	**EXISTING MODEL**	**HONEYCOMB MODEL**
MATERIAL	Polythelene	ABS
MAXIMUM DEFORMATION	1.2612 mm	0.85133 mm
DIRECTIONAL DEFORMATION	0.1489 mm	0.1042 mm
MAXIMUM STRESS	27.234 MPa	19.064 MPa
DENSITY	0.940 g/cm^3	1.05 g/cm^3
VOLUME	40.425 cubic cm	25.71 cubic cm
MASS	38gm	27gm

9. Conclusion

As the project's goal is to make the car door handle stronger while reducing weight. ABS is the material used in 3D printing when employing this technique. ANSYS software, which makes use of finite element technique technology, is used to analyze the car door handle.

- In this project, the maximum deformation and corresponding equivalent stress are determined using a FEA analysis on an existing automobile door handle.
- To determine deformation and equivalent stress, a static structural study of the car door handle is conducted. It has been noted that the equivalent stress is 27.234 MPa and the maximum deformation is 1.2612 mm.
- To reduce the weight of the model, we used an ABS material and honeycomb construction. As a result, we create a 3D cad model of an improved door handle.
- To calculate deformation and equivalent stress, a static structural analysis of a redesigned honeycomb car door handle made of ABS material is carried out. Maximum deformation is reported to be 0.85133 mm, with an equivalent stress of 19.064 MPa.
- We utilize 3D printing to create a replica of a car door handle and incorporate a honeycomb structure into the handle to make it lighter than existing models.
- The optimized door handle weighs 27 g as opposed to the existing door handle's 38 g. Therefore, this project's weight optimization is 28.9%.

- After applying pressure on door handle, after deformation, it regains its original shape.

References

1. Girish Naresh Raut and Prof. V.P. Mali -"Optimization of inner car door handle in automobiles using composite material" Volume: 04 Issue: 05 | May -2017
2. Enguang Zhang and Xin Zhang - "Finite element analysis and Topology optimization design for automobile door-handle" 2018 IOP Conf. Ser.: Mater. Sci. Eng. 392 062072.
3. Investigation of ergonomics design for the vehicle door handle for PROTON (BLM) and PERODUA (VIVA) KA Shamsuddin, NI Mokhtar, MMAMM Aris, TA Abdul Razak. IJESRT September, 2015.