DESIGN AND WEIGHT OPTIMIZATION OF 4 WHEELER ROCKER PANEL USING FEA AND THREE-POINT BENDING TEST

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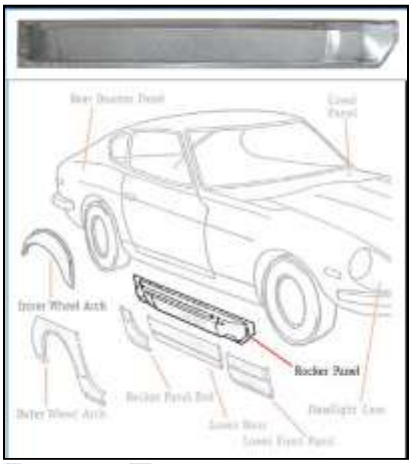
Abstract : Vehicle aspect crash could be a crucial crash event wherever the vehicle is crashed by a movable automobile or vehicle could hit a tree or pole. Minimizing the intrusion into the inhabitant area is vital to guard the inhabitant. In an aspect pole crash, vehicle rocker still plays a crucial role in resisting the load because of the crash. The target is to review the useful performance and potential mass reduction within the vehicle sill/rocker space by use of Glass fiber reinforced polymer (GFRP) . This project investigates the behaviour of GFRP square section rocker panel in a three-point quasi-static bending as compared to traditional rocker panel finite element methodology. Design and analysis of existing Rocker Panel specimens are going to be done by victimization CATIA R5V20 and ANSYS nineteen software. new design & weight optimization of rocker panel specimens are going to be done victimization GFRP . Experimental investigations are going to be done by three-point bending check on UTM.

Keyword : Rocker Panel , Design optimization , 3 Point bending test, UTM .

I. INTRODUCTION

In the 21st century, individuals are additionally headed toward vehicles with higher fuel economy and reduced emission levels. At constant time, because of a rise in awareness on safety and rigorous crash check rules, the automotive makers ar heading towards a smarter a better a wiser design of the inhabitant space by use of high strength materials for better crashworthiness. The term crashworthiness signifies the power of the structure to guard the inhabitant in a crash situation. Crash performance necessities are centered on inhabitant injury parameters and structural deformation measurements like intrusion, acceleration and speed of the deforming structure. Protecting individuals within a crash is difficult as a result of the edges of vehicles having comparatively very little space to soak up energy and defend occupants, in contrast to the front and rear, that have substantial crumple zones.



What is a rocker panel ?
Rocker panels are unit sealed items of robust metal that type a part of the structural body of the automotive. they're associate degree integral half that runs on the facet of your automotive between the front and rear wheel wells. In alternative words, rocker panels keep the rear of your automotive from separating from the front of your automotive.

What is the purpose of providing rocker panels:
The rocker panels facilitate to create a positive the cabin of the automotive does not deform during a manner that might damage the passengers. Basically, in an associate degree accident your car's job is to show into a smushed will protective an indoor capsule. The rocker panel forms the rock bottom fringe of that capsule..

II. LITERATURE REVIEW

Hongshen SSZhang, Gan Huang and Dali Yu. et.al[1], In this examination, the casing construction of a van-type electric truck was taken as an exploration object. Stress, strain, and modular examinations of this edge structure were performed utilizing Abaqus, a limited component programming, to confirm the sanity and wellbeing of the underlying model. The casing structure was streamlined by mathematical examination. The fourth shaft was pushed 524 mm ahead between the establishment points of the force battery pack and the back lifting drag of the front leaf spring. Results showed that the upgraded outline bowing, the full-load slowing down condition, and the full-load torsional working condition stresses diminished by 44.499%, 23.364%, and 31.303%, individually. The twisting solidness of a streamlined edge expanded by 4.026%, while the front and back torsional stiffnesses expanded by 4.442% and 4.092%, individually.

Hartmut Popp, Markus Kollera , Marcus Jahna , Alexander Bergmann. et.al[2], This audit means to introduce the present status of this promising subject for both research facility use and applications on non-ruinous in-situ and in-operando strategies for estimation of mechanical battery boundaries like extension, strain and power, exploratory modular examination, ultrasonic testing and acoustic outflow innovations. The goal of this synopsis is to give bits of knowledge in this arising point by showing benefits, disadvantages, conceivable outcomes and utilizations of every procedure and contrast those with one another, hence giving the perusers a profound understanding into the subject. The examination showed that dilatometric techniques are broadly utilized for examination of LIB cells. One extremely well known methodology is the estimation with 1-D contact sensors. With this, a wide assortment of marvels like Li-arranging of graphite, warm extension and unwinding, full cell development, and Li plating have been explored, and techniques were created for situations like quick accusing of limited damage to the terminals.

Golriz Kermani and Elham Sahraei. et.al[3], In this audit we talked about and examined different methodologies of mechanical testing, material portrayal, limited component demonstrating, and approval strategies utilized in researching the mechanical respectability of Li-particle batteries at the cell level. This paper is a far reaching audit of progressions in exploratory and computational strategies for portrayal of Li-particle batteries under mechanical maltreatment stacking situations. Various ongoing examinations have utilized trial techniques to portray disfigurement and disappointment of batteries and their segments under different ductile and compressive stacking conditions. A few creators have utilized the test information to propose material laws and foster limited component (FE) models. Then, at that point the models have been approved against tests at various levels from examination of shapes to foreseeing disappointment and beginning to short out. In the current audit primary parts of each investigation have been examined and their methodology in mechanical testing, material portrayal, FE displaying, and approval is broke down. The primary focal point of this audit is on mechanical properties at the level of a solitary battery.

Shashank Arora, Ajay Kapoor and Weixiang Shen. et.al[4], This paper presents a deliberate structure that empowers battery pack creators to theoretically break down components of this pool, foster a reasonable comprehension of client needs, and recognize factors that can be ideally changed in accordance with assemble a dependable battery pack that meets different client necessities in whole. A worth based item advancement procedure, ordinarily known as hearty plan strategy (RDM), is applied for assessment of plan perspectives identified with battery cell type and size, bundling engineering, warm administration arrangement and so on of measured EV battery pack. Through the use of RDM a significant mechanical impediment of battery packs' plan is uncovered. It is found that the mechanical plan and the warm plan of battery packs are basically interrelated; implying that disregarding both of the two would think twice about the battery pack. Likewise, mechanical/underlying associations in battery bundling go about as warmth moves ways. Warm ways in a module-level plan should thus be segregated subsequent to thinking about all mechanical hard focuses and associations. All the more significantly, it is discovered that funneling/plumbing alongside the assistants utilized in ordinary fluid cooling or constrained air cooling frameworks limit configurability and adaptability of the battery pack.

Na Yang, Rui Fang, Hongliang Li and Hui Xie. et.al[5], As a significant gadget to secure batteries in electric vehicles, the dynamic and static presentation of the battery box is firmly identified with the wellbeing of the entire vehicle. In this way, study the pressure and uprooting dispersion of the battery box under explicit working conditions to upgrade the plan of the feeble pieces of the battery box's solidness and strength. The outcomes show that the altered model has a decent improvement impact and has fundamentally arrived at the set up plan necessities, which checks the sanity of the primary improvement scheme. Domestic and unfamiliar exploration organizations and auto endeavors have completed a great deal of examination work on the foundational layout and enhancement of battery boxes, dynamic and static qualities investigation, and so on

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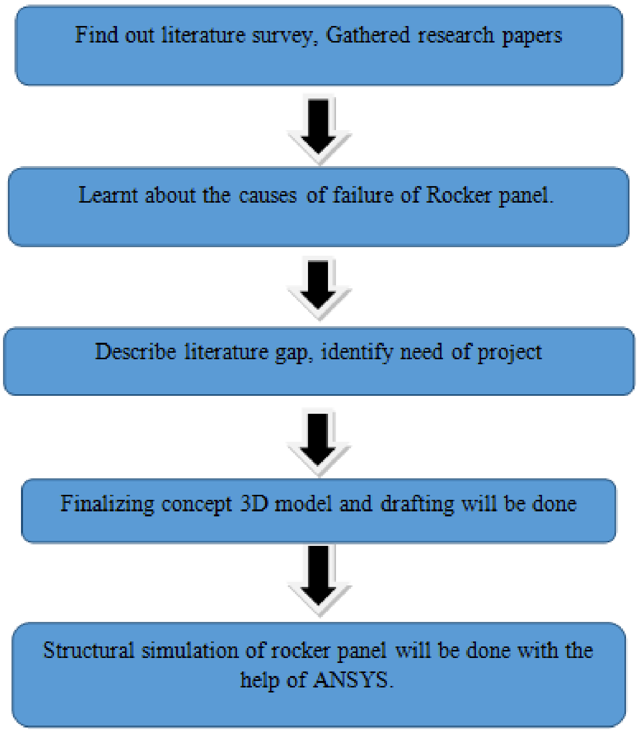
III. PROBLEM STATEMENT

In order to meet the challenges of making a lighter vehicle to achieve fuel economy and good structure in crashworthiness, use of the carbon fiber reinforced polymer(CFRP) materials can be one of the solutions.

IV. OBJECTIVES

- To study and perform static analysis on 4-wheelerrocker panel specimen under loading condition.
- To propose an optimized model this will have better or same performance and reduced weight.
- CAD modelling of 4-wheeler rocker panel specimen in Catia V5R20 software.
- To perform static structural Analysis of optimized4-wheeler rocker panel specimen in ANSYS 19 workbench.
- Experimental investigation of GFRP rocker panel specimen will be done by three-point bending test on UTM.
- Comparative Analysis between Experimental & Analysis results.

V. METHODOLOGY:



DESIGN AND ANALYSIS OF ROCKER PANEL USING REVERSE ENGINEERING METHOD

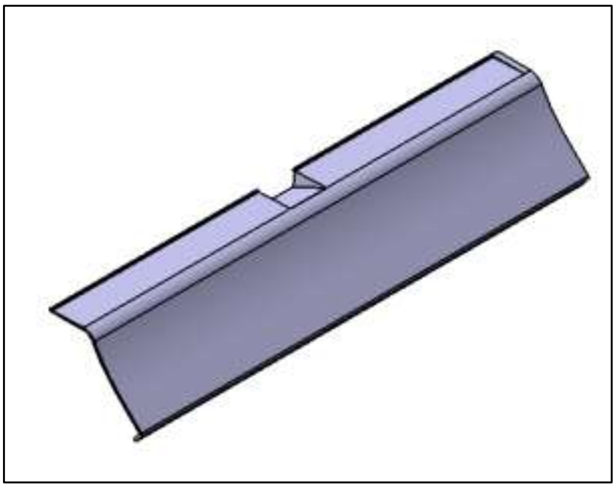
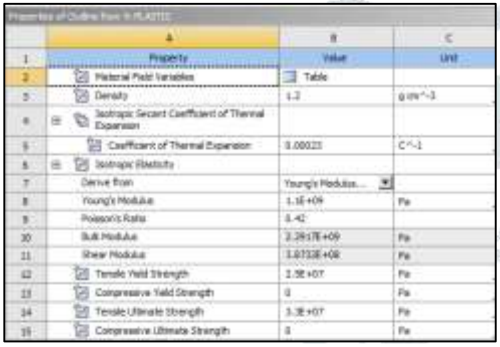


Fig. rocker panel



Properties of Outline Row 4: PLASTIC

	A	B	C
1	Property	Value	Unit
2	Material Field Variables	Table	
3	Density	1.2	g cm^-3
4	Isotropic Secant Coefficient of Thermal Expansion		
5	Coefficient of Thermal Expansion	0.00023	C^-1
6	Isotropic Elasticity		
7	Derive from	Young's Modulus...	
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	2.5E+07	Pa
13	Compressive Yield Strength	0	Pa
14	Tensile Ultimate Strength	3.3E+07	Pa
15	Compressive Ultimate Strength	0	Pa

Fig. rocker arm material properties

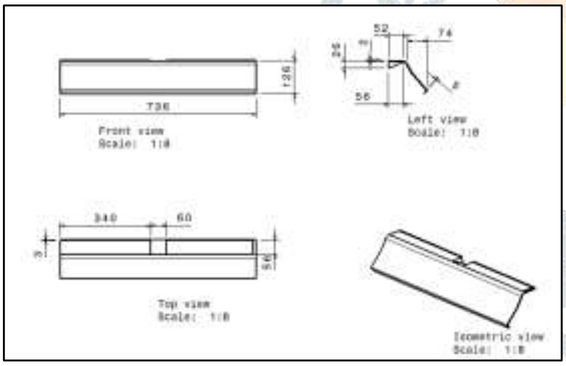


Fig. drafting of rocker panel

ANALYSIS OF EXISTING ROCKER PANEL USING PLASTIC MATERIAL

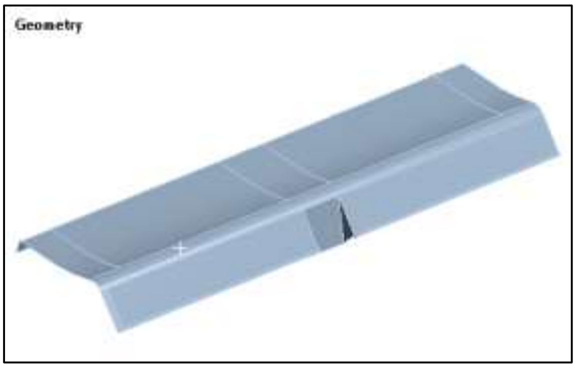


Fig. Geometry of existing rocker panel

Mesh

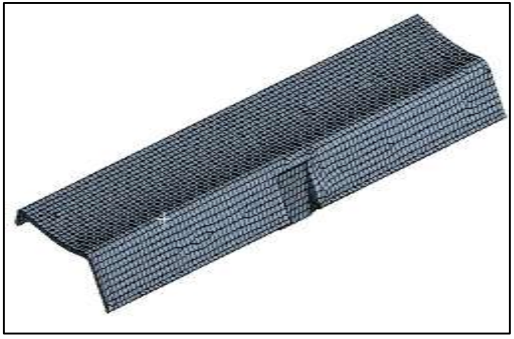
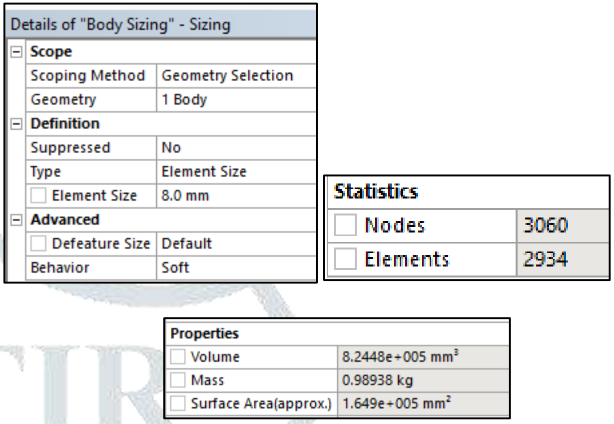


Fig. Meshing of existing rocker panel



Details of "Body Sizing" - Sizing

Scope	
Scoping Method	Geometry Selection
Geometry	1 Body
Definition	
Suppressed	No
Type	Element Size
☐ Element Size	8.0 mm
Advanced	
☐ Defeature Size	Default
Behavior	Soft

Statistics	
☐ Nodes	3060
☐ Elements	2934

Properties	
☐ Volume	8.2448e+005 mm³
☐ Mass	0.98938 kg
☐ Surface Area(approx.)	1.649e+005 mm²

Fig. Meshing details

Boundary condition

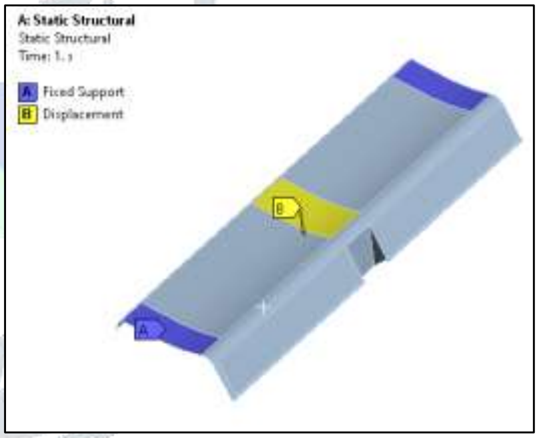


Fig. Boundary condition of existing rocker panel

Total deformation

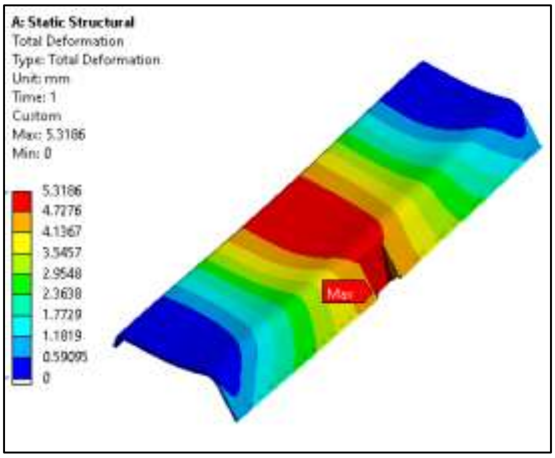


Fig. Total deformation of existing rocker panel

Equivalent stress

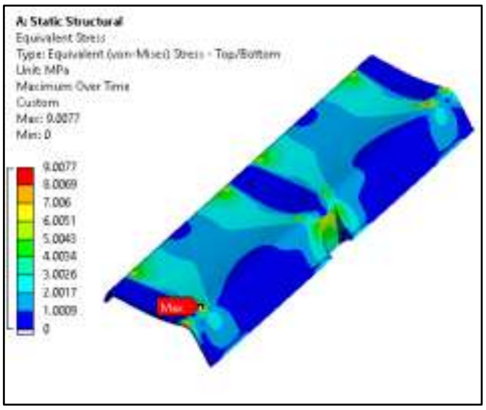


Fig. Equivalent stress of existing rocker panel

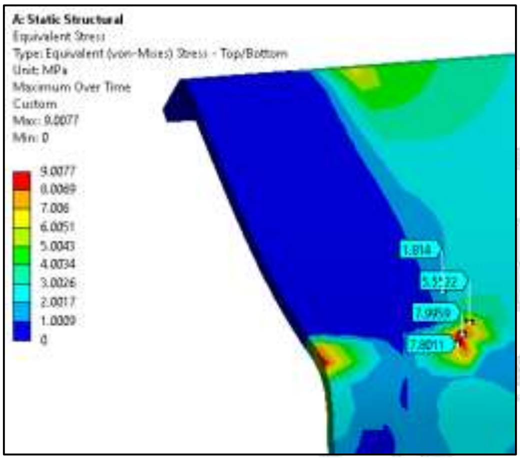
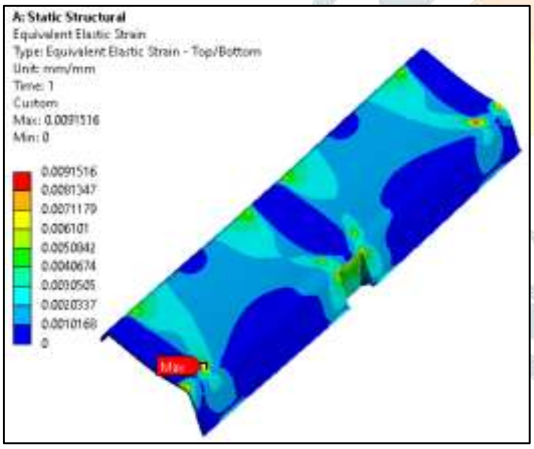
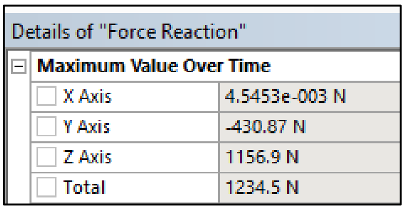


Fig. Equivalent stress of existing rocker panel



Equivalent elastic strain of existing rocker panel



Details of "Force Reaction"

Maximum Value Over Time	
☐ X Axis	4.5453e-003 N
☐ Y Axis	-430.87 N
☐ Z Axis	1156.9 N
☐ Total	1234.5 N

Fig. Force reaction of existing rocker panel

ANALYSIS OF OPTIMIZED ROCKER PANEL USING PLASTIC AND GLASS FIBER COMPOSITE MATERIAL

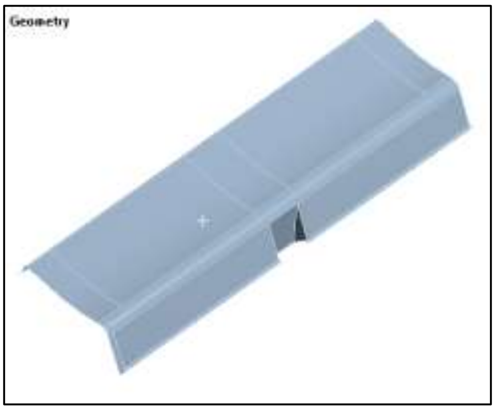
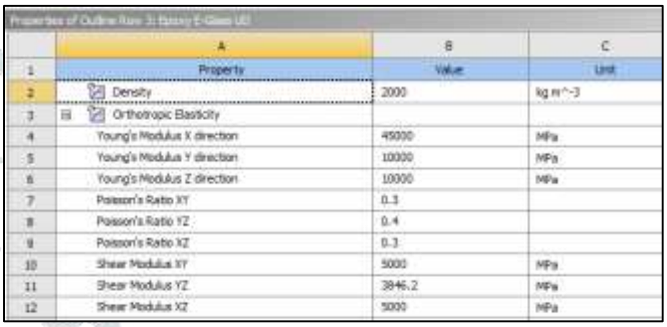
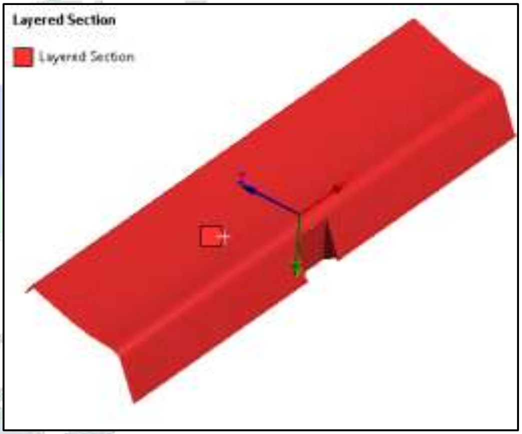


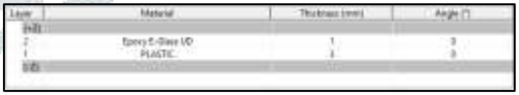
Fig. Geometry of rocker panel with glass fiber



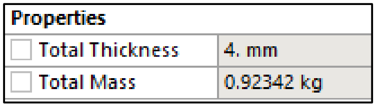
	A	B	C
1	Property	Value	Unit
2	Density	2000	kg m^-3
3	Orthotropic Elasticity		
4	Young's Modulus X direction	45000	MPa
5	Young's Modulus Y direction	10000	MPa
6	Young's Modulus Z direction	10000	MPa
7	Poisson's Ratio XY	0.3	
8	Poisson's Ratio YZ	0.4	
9	Poisson's Ratio XZ	0.3	
10	Shear Modulus XY	5000	MPa
11	Shear Modulus YZ	3846.2	MPa
12	Shear Modulus XZ	5000	MPa

Fig. Material properties of glass fiber





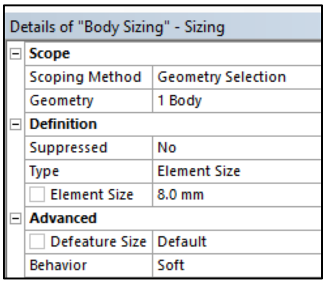
Layer	Material	Thickness (mm)	Angle (°)
(+Z)			
2	Epoxy E-Glass UD	1	0
1	PLASTIC	3	0
(-Z)			



Properties	
☐ Total Thickness	4. mm
☐ Total Mass	0.92342 kg

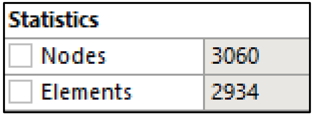
Fig. Layered selection for composite material

Mesh



Details of "Body Sizing" - Sizing

Scope	
Scoping Method	Geometry Selection
Geometry	1 Body
Definition	
Suppressed	No
Type	Element Size
☐ Element Size	8.0 mm
Advanced	
☐ Defeature Size	Default
Behavior	Soft



Statistics	
☐ Nodes	3060
☐ Elements	2934

Fig. Meshing details of rocker panel with glass fiber

boundary condition

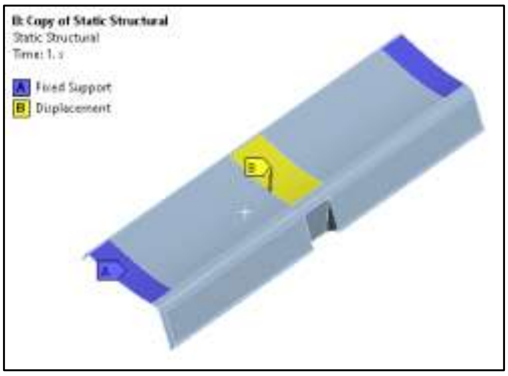


Fig. Rocker panel boundary condition

Total deformation

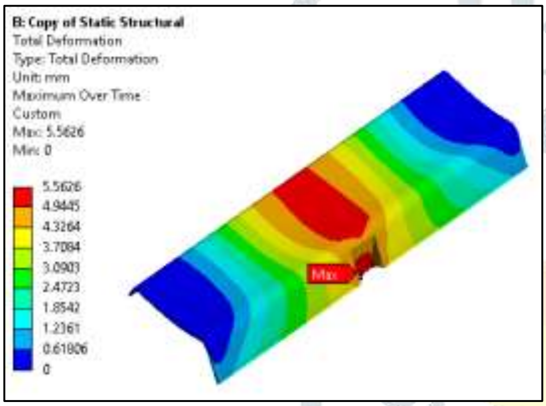
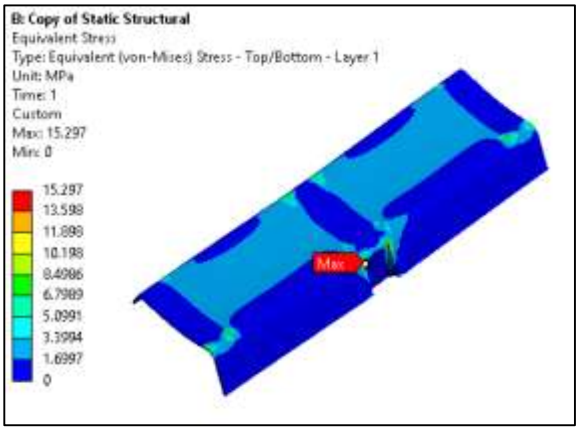


Fig. Total deformation of rocker panel with glass fiber

Equivalent stress



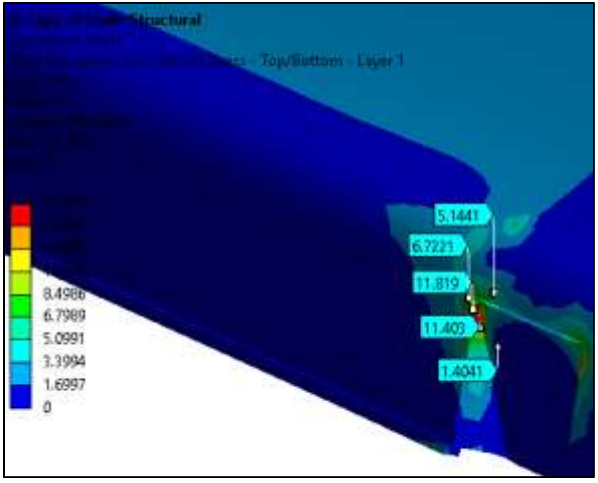


Fig. Equivalent stress of rocker panel with glass fiber

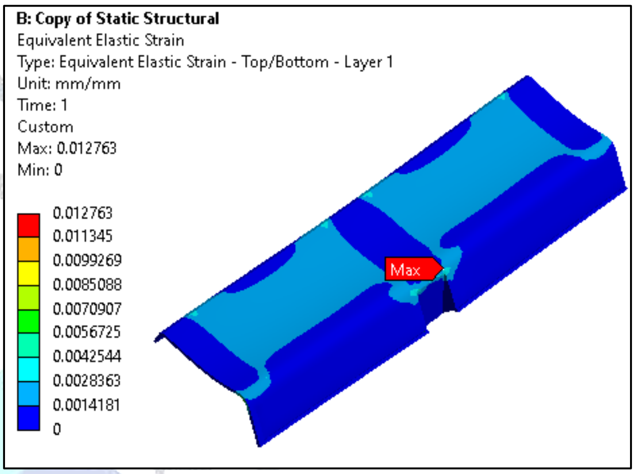
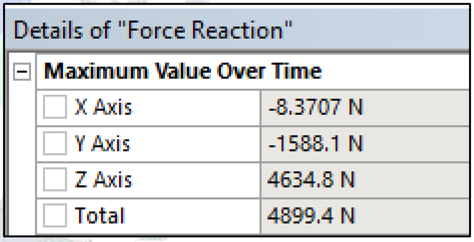


Fig. Equivalent elastic strain



Details of "Force Reaction"

⊟ Maximum Value Over Time	
☐ X Axis	-8.3707 N
☐ Y Axis	-1588.1 N
☐ Z Axis	4634.8 N
☐ Total	4899.4 N

Fig. Force reaction

EXPERIMENTAL VALIDATION:

A Universal Testing Machine (UTM) is used to test both the tensile and compressive strength of materials. Universal Testing Machines are named as such because they can perform many different varieties of tests on an equally diverse range of materials, components, and structures.

Universal Testing Machines can accommodate many kinds of materials, ranging from hard samples, such as metals and concrete, to flexible samples, such as rubber and textiles. This diversity makes the Universal Testing Machine equally applicable to virtually any manufacturing industry.

The UTM is a versatile and valuable piece of testing equipment that can evaluate materials properties such as tensile strength, elasticity, compression, yield strength, elastic and plastic deformation, bend compression, and strain hardening. Different models of Universal Testing Machines have different load capacities, some as low as 5kN and others as high as 2,000kN.

SPECIFICATION OF UTM

1	Max Capacity	400KN
2	Measuring range	0-400KN
3	Least Count	0.04KN
4	Clearance for Tensile Test	50-700 mm
5	Clearance for Compression Test	0- 700 mm
6	Clearance Between column	500 mm
7	Ram stroke	200 mm
8	Power supply	3 Phase , 440Volts , 50 cycle. A.C
9	Overall dimension of machine (L*W*H)	2100*800*2060
10	Weight	2300Kg

Fig. Experimental testing

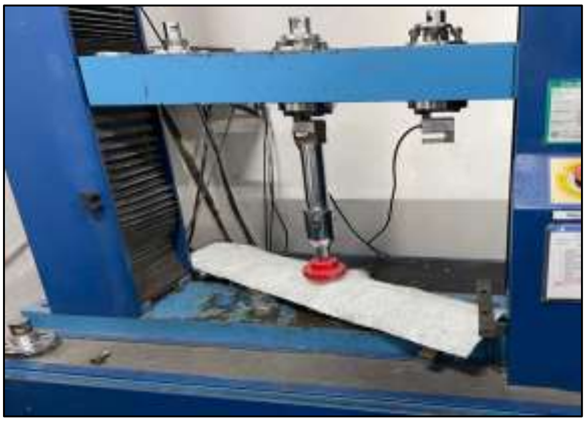


Fig. Rocker panel experimental testing

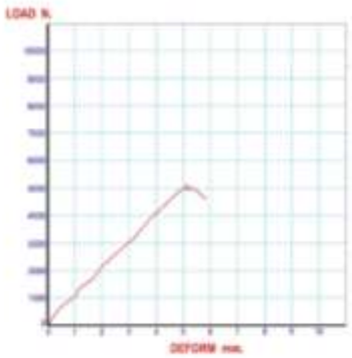


Fig. Rocker panel

As per FEA result the reaction force for optimized rocker panel is 4899 N. And for experimental testing the reaction force for 5 mm displacement is 4950 N.

RESULT AND DISCUSSION

The rocker panel used to protect vehicle from external damage. The material used for rocker panel is plastic. To increase the strength of rocker panel without increasing the glass fiber material is selected.

Applied the glass fiber layer on the rocker panel using hand layup method. As per result the reaction force of rocker panel using composite material is increased.

SR NO	***COMPONENT***	***TOTAL DEFORMATION (mm)***	***EQUIVALENT STRESS (MPa)***	***WEIGHT (kg)***	***REACTION FORCE (N)***
1	EXISTING MODEL	5.3	9	0.989	1234
2	OPTIMIZED MODEL	5.5	15.29	0.92	4899

CONCLUSION

CASE STUDY

In this project we have performed the structural analysis of Rocker panel made of steel and ploted the result of total deflection and Force reaction of Rocker panel.

After the optimization of rocker panel by reducing the thickness of steel plate and layering of carbon fiber the overall weight of the optimized rocker panel is observed.

The optimized rocker panel is also gone through the process of structural analysis and from the plots it is concluded that the optimized rocker panel has best reaction force than the original one. As the reaction force for the original rocker panel is having force reaction of 9754.4 N and the optimized model has the force reaction of 9969.2 N.

ROCKER PANEL

Perform static analysis using ANSYS software and find out optimized model for the rocker panel. The material used for rocker panel for existing material is plastic. The equivalent stress and reaction force generated by the existing rocker panel is 9.00 MPa and 1234 N.

For optimized model layer of glass fiber used for improving strength of model. The equivalent stress and reaction force generated in optimized model is 15.29 MPa and 4899 N. As per analysis result the optimized model perform better in three point bending test.

The weight of existing rocker panel is 0.98 kg and weight of optimized model with glass fiber reinforcement is 0.92 kg. Hence total weight optimized in rocker panel is 6.97%.

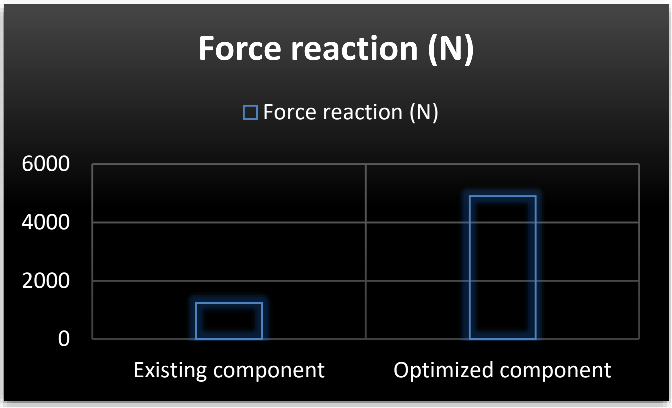


Fig. Force reaction comparison

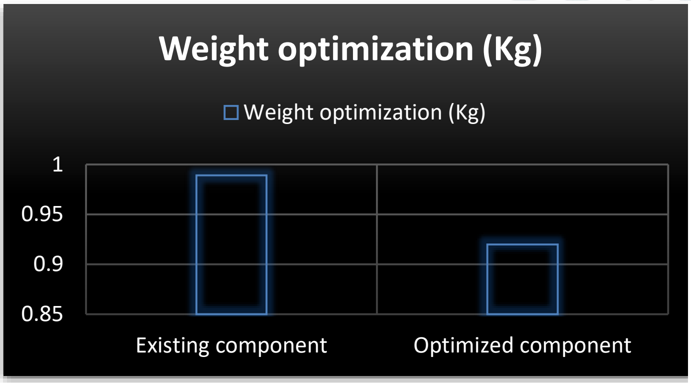


Fig. Weight optimization

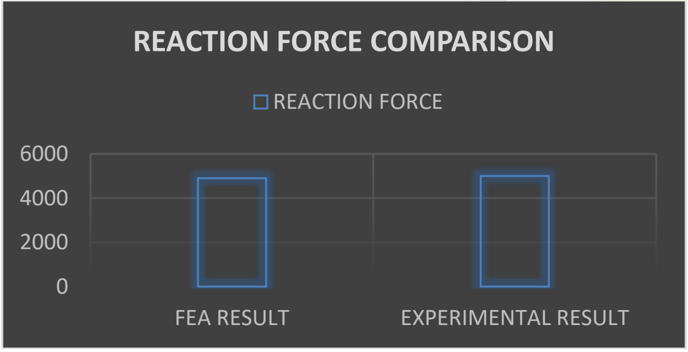


Fig. Comparison between FEA and experimental results

REFERENCES

1. Huili Yu, Hui Zhao and Fangyuan Shi "Bending Performance and Reinforcement of Rocker Panel Components with Unidirectional Carbon Fiber Composite". Materials (Basel) 2019 Sep 27;12(19):3164. doi: 10.3390/ma12193164.
2. Kumar Hemant, Deb Debasis, Chakravarty D."Design of crown pillar thickness using finite element method and multivariate regression analysis". International Journal of Mining Science and Technology Volume 27, Issue 6, November 2017, Pages 955-964
3. Corin Reutera,, Kim-Henning Sauerlandb, Thomas Tröstera "Experimental and numerical crushing analysis of circular CFRP tubes under axial impact loading". Corin Reutera,, Kim-Henning Sauerlandb, Thomas Tröstera "Experimental and numerical crushing analysis of circular CFRP tubes under axial impact loading".
4. Oleg A. Staroverov, Elena M. Strungar, Valery E. Wildemann "Evaluation of the survivability of CFRP honeycomb-cored panels in compression after impact tests". O. A. Staroverov et alii, Frattura ed Integrità Strutturale, 56 (2021) 1-15; DOI: 10.3221/IGF-ESIS.56.01
5. Andrew Miner, Simon Jones "Design, Testing, Analysis, and Material Properties of Carbon Fiber Reinforced Polymers".
6. Aleksandr Cherniaev, Clifford Butcher, John Montesano "Predicting the axial crush response of CFRP tubes using three damage-basedconstitutive models".
7. Kudrin, A.M., Karaeva, O.A., Gabriels, K.S., Solopchenko, A.V. (2018). Determination of the ultimate compressive strength of a polymer composite material after impact in accordance with ASTM D 7137, Bulletin of the Voronezh State Technical University, 14(2), pp. 164-169.
8. Staroverov, O.A., Babushkin, A.V., Gorbunov, S.M. (2019). Evaluation of the damage degree to carbon-fiber composite materials under impact, PNRPU Mechanics Bulletin, 1, pp. 161-172. DOI: 10.15593/perm.mech/2019.1.14,