A Project Stage-I

Report on

Title of Project

DESIGN AND ANALYSIS OF ROCKER PANEL

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CERTIFICATE

This is to certify that Mr. Abhijit Chavan (402D009), Mr. Abhishek Raut (402D045), Mr. Ahamad Shaikh (402D048), Mr. Alishan Shaikh (402D049) have successfully completed the Project Stage-I entitled "**Design and analysis of Rocker Panel/sill**" under my supervision in the partial fulfilment of Degree of Bachelor of Engineering (Mechanical Engineering) of Savitribai Phule Pune University during academic year 2021-22.

Place:

Date :

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ABSTRACT:

Vehicle side crash is a critical crash event where the vehicle is crashed by a movable car or vehicle may hit a tree or pole. Minimizing the intrusion into the occupant space is important to protect the occupant. In side pole crash, vehicle rocker (sill) plays an important role in resisting the load due to the crash. The objective is to study the functional performance and potential mass reduction in the vehicle sill/rocker area by use of composite. It is not easy to acquire the same bending performance as that of a rocker panel by merely replacing it with composite material and increasing the wall thickness. Therefore, reinforcements were employed to improve the bending performance of the rocker panel .This study aimed to redesign one of the most important components of the side structure of a vehicle, the rocker panel, with carbon fiber and E-glass fiber .

In this project investigates the behavior of carbon fiber reinforced rocker panel and E-Glass fiber reinforced rocker panel in a three-point quasi-static bending in comparison to conventional rocker panel structure using finite element method . Design and analysis of existing and new Rocker Panel specimen will be done using CATIA and ANSYS software respectively . Experimental investigation will be done by three-point bending test on UTM

CHAPTER 1

INTRODUCTION

In the twenty-first century, people are more oriented toward vehicles with better fuel economy and reduced emission levels. At the same time, due to an increase in awareness on safety and stringent crash test regulations, the automotive manufacturers are heading towards a smarter design of the occupant space by use of high strength materials for better crashworthiness. The term crashworthiness signifies the ability of the structure to protect the occupant in crash scenario. Crash performance requirements are focused on occupant injury parameters and structural deformation measurements like intrusion, acceleration and velocity of the deforming structure. Protecting people inside crash is challenging because the sides of vehicles have relatively little space to absorb energy and shield occupants, unlike the front and rear, which have substantial crumple zones.

1.1 What is rocker panel ?

Rocker panels are stamped pieces of metal/pastic/rubber that form part of the structural body of the car. They are an integral part that runs along the side of your car between the front and rear wheel wells. In other words, rocker panels keep the back of your car from separating from the front of your car. , rocker panels were needed not so much to connect the front to the rear, but rather to provide a little extra support to keep the middle of a car from sagging. Based on Material Type, the Rocker Panel Market studied across Plastic, Rubber, and Steel.

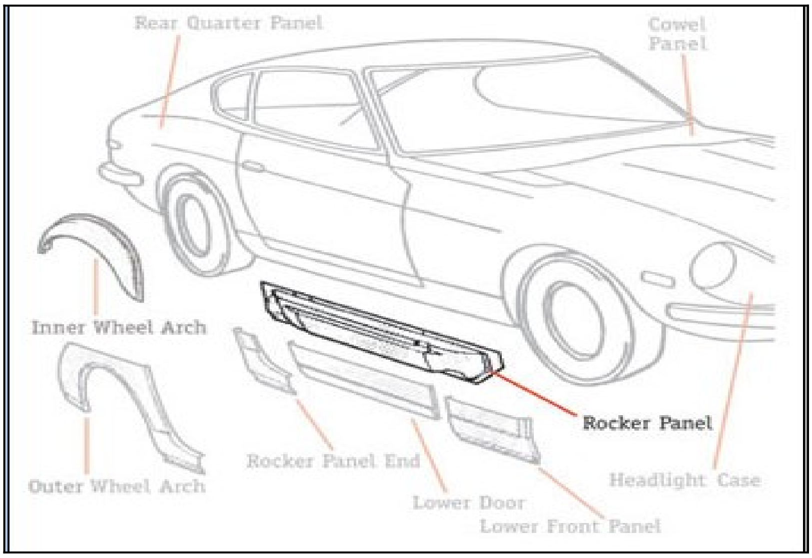

Fig.1.1 Vehicle with Rocker Panel

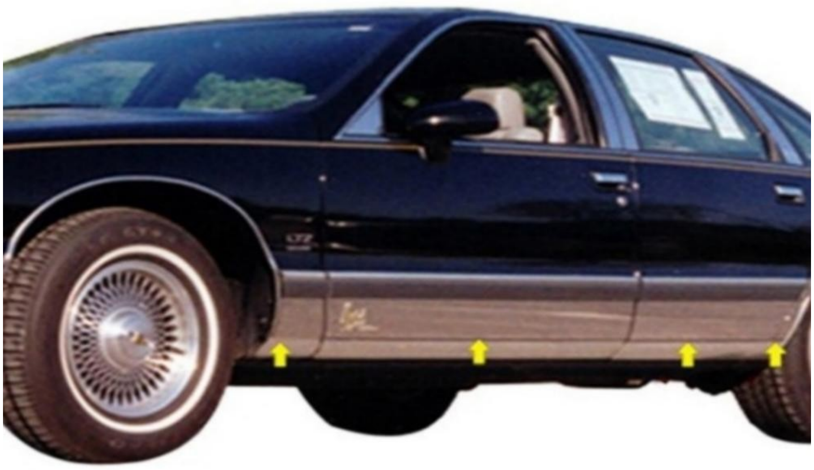

Fig.1.2 Vehicle with Rocker Panel view

1.2 PROBLEM DESCRIPTION:

In order to meet the challenges of making the rocker panel more sustainable by reinforcement of composite material on the rocker panel existing material. The original panel is made of Steel. we need to improve the reaction force of the rocker panel.

1.3 AIM:

Strength Improvement of the rocker panel in the vehicle by reinforcement on plastic rocker panel so as to improve the passenger safety compared to front and rear sides.

1.4 OBJECTIVES:

- To study and perform static analysis on 4-wheeler rocker panel specimen under loading condition.
- To propose an optimized model this will have better performance and reduced weight.
- CAD modelling of 4-wheeler rocker panel specimen in Catia software.
- To perform static structural Analysis of optimized 4-wheeler rocker panel specimen in ANSYS workbench.
- Experimental investigation of carbon fiber rocker panel and E-glass fiber rocker panel specimen will be done by three-point bending test on UTM.

- Comparative Analysis between Experimental & Analysis results.
- Comparative Analysis between rocker panel , carbon fiber reinforced rocker panel and E-glass fiber reinforced rocker panel.

1.5 NEED:

Protecting people inside crash is challenging because the sides of vehicles have relatively little space to absorb energy and shield occupants, unlike the front and rear, which have substantial crumple zones.

The need of this is to redesign one of the most important components of the side structure of a vehicle, the rocker panel, with composite material.

Our results show that it is not easy to acquire the same bending performance as that of a rocker panel by merely replacing it with composite material and increasing the wall thickness. Therefore,reinforcements were employed to improve the bending performance of the rocker panel.

1.6 SCOPE :

Relatively conventional vehicles instead of assembling the thick layers conventional materials

which causes increasing in weight of vehicle and relatively decreasing the engine efficiency of vehicle. So as to overcome these limitations and having passenger safety.

carbon fiber reinforcement and E-GLASS fiber reinforcement will give good results not increasing in weight of vehicle compared to conventional.

CHAPTER-2

LITERATURE REVIEW:

“Bending Performance and Reinforcement of Rocker Panel Components with Unidirectional Carbon Fiber Composite” by Huili Yu, Hui Zhao and Fangyuan Shi .

This study aimed to redesign one of the most important components of the side structure of a vehicle, the rocker panel, with unidirectional carbon fiber composite material. Our results show that it is not easy to acquire the same bending performance as that of a steel rocker panel by merely replacing it with carbon fiber material and increasing the wall thickness. Therefore, reinforcements were employed to improve the bending performance of the carbon fiber rocker panel, and a polypropylene reinforcement method achieved a weight reduction of 40.7% compared with high-strength steel.

“Design of crown pillar thickness using finite element method and multivariate regression analysis” By Kumar Hemant , Deb Debasis, Chakravarty D.

This paper provides a methodology for the evaluation of the required thickness of crown pillars for safe operation at depth ranging from 600 m to 1000 m. Analyses are conducted with the results of 108 non-linear numerical models considering Drucker-Prager material model in plane strain condition. Material properties of ore body rock and thickness of crown pillars are varied and safety Factors of pillars estimated. Then, a generalized statistical relationship between the safety factors of crown pillars with the various input parameters is developed. The developed multivariate regression model is utilized for generating design/stability charts of pillars for different geo-mining conditions. These design charts can be used for the design of crown pillar thickness with the depth of the working, taking into account the changes of the rock mass conditions in underground metal mine.

“Experimental and numerical crushing analysis of circular CFRP tubes under axial impact loading” By Corin Reutera,, Kim-Henning Sauerlandb, Thomas Tröstera

In this paper, a prospective simulation method for composite crushing under axial crash loading is presented. To this end carbon fibre-reinforced plastic (CFRP) circular crash tubes are investigated in drop tower tests. Flat specimen tests are performed to determine calibration parameters and are used for efficient re-parameterization of a transversally isotropic material card used in finite element (FE) simulation. An existing material card for CFRP based on basic tension and compression tests is used as a starting point and only a small set of material parameters is numerically reasonable adjusted to account for crushing. Once calibrated by means of flat specimens the material model is able to cover a variety of different composite layups and specimen geometries, e.g. tube specimens. Therefore, numerical simulation of drop tower testing is carried out and results show good agreement between numerical and experimental results. In addition to these tests, it can be shown that the presented approach is leading to equally good results when the material and geometry of the specimens are changed to a glass fibre-reinforced plastic (GFRP) tube structure.

“Evaluation of the survivability of CFRP honeycomb-cored panels in compression after impact tests” By Oleg A. Staroverov, Elena M. Strungar, Valery E. Wildemann.

This paper is oriented to the experimental research of the mechanics of the CFRP sandwich plates, glass and carbon fiber sample panels with a large-cell honeycomb core. The method for testing polymer composite sample plates in compression after impact (CAI) tests with joint use of a testing machine and a video system for deformation field registration was tested. Analysis of the experimental data obtained highlighted the impactive sensitivity zone for the test specimens. A quantitative assessment of the loadbearing capacity of glass and carbon fiber sample panels in CAI tests with the different levels of the drop weight impact energy was performed. Photos of samples after impact have been provided. Vic-3D non-contact three-dimensional digital optical system was used to register the displacement and deformation fields on the surface of the samples. The video system was used to evaluate various damage mechanisms, including matrix cracking, delaminations, and rupture of the damaged fibers. The paper studied the evolution of non-homogeneous deformation fields on the surface of the composite samples during the post-impact compression tests and analyzed the configuration of non-homogeneous deformation fields.

“Design, Testing, Analysis, and Material Properties of Carbon Fiber ReinforcedJones Polymers” By Andrew Miner, Simon Jones.

This research covers many of the learnings I found in the structures of fiber reinforced polymers, manufacturing processes and controls, testing procedures and standards, important considerations in the design process of CFRPs, and analysis capabilities and methods. This research is organized as a series of short guides to assist students with the individual subject matters at hand. While many of these are bolstered by the knowledge provided in other parts of the document, due to the multifaceted approach to the problem, this is a much easier way to communicate the information to undergraduate science and engineering students trying to work reliably with CFRPs or other composite materials.

"Predicting the axial crush response of CFRP tubes using three damage-based constitutive models" By Aleksandr Cherniaev, Clifford Butcher, John Montesano.

In this study, predictive capabilities of three widely used LS-DYNA composite material models MAT054, MAT058 and MAT262 – were investigated and compared with respect to modeling of axial crushing of CFRP energy absorbers. Results of crush simulations with non-calibrated material models were compared with available experimental data, and then parameter tuning was conducted to improve correlation with experiments. Furthermore, calibrated material models were used to conduct independent crash simulations with distinct composite layups. As a result, advantages and shortcomings of the considered material models, as well as directions for future developments, were identified.

CHAPTER 3

METHODOLOGY

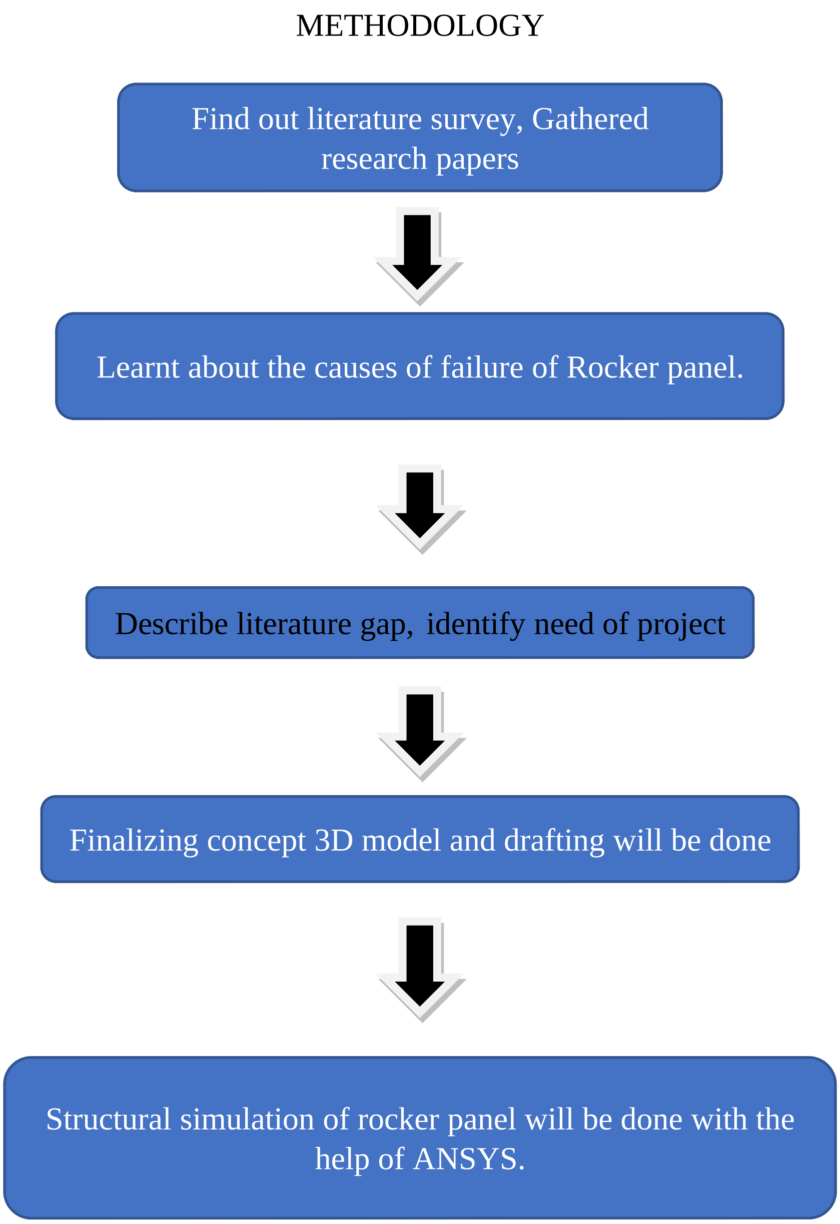

Fig 3.1:Methodology

Firstly the literature survey is done by searching different different research papers regarding rocker panel, E-glass fiber, carbon fiber, etc. Later we decided the model of vehicle of which the rocker panel/sill is to be selected.

Reverse engineering processes are followed so as to convert the physical model into digital model of rocker panel/sill using reverse engineering. Firstly we found the location of shop where we can find the rocker panel/sill. Removed actual rocker panel/sill using gas cutting method. After that we take part i.e. Rocker panel/sill for cleaning process so as to take dimensions accurately. Using hand grinder we give finishing to the part from both side. And give surface finishing at both sides using triangle file so as to remove the excessive burr. After this we went to BADVE ENGINEERING(SUSPENSION UNIT) SAWARDARI, MHALUNGE. To take the dimensions of rocker panel. BADVE ENGINEERING allowed us to use the their inspection laboratory for our measurement process. We measured thickness, radius, height, and length of rocker panel using micrometer, radius gauge, height guage, and measuring tape respectively.

After this the CATIA 2D drafting and 3D model is done.

Analysis of existing rocker panel without reinforcement of E-Glass fiber and with reinforcement of E-Glass fiber is done.

CHAPTER 4

DESIGN AND ANALYSIS

4.1 DESIGN

In today's intensely competitive global market, product enterprises are constantly seeking new ways to shorten lead times for new products developments that meet all customer expectations. In general, product enterprise has invested in CAD CAM, rapid prototyping, and a range of new technologies that provide business benefits. Reverse engineering is now considered one of the technologies that provides business benefits in shortening the product development cycle. Fig below depicts how reverse engineering allows the possibilities of closing the loop between what is as designed and what is actually manufactured.

4.1.1 What is reverse engineering?

Engineering is the process of Designing, Manufacturing, assembling and maintaining products and systems. There are two types of engineering, forward engineering and reverse engineering. Forward engineering is the traditional process of moving from high-level abstractions and logical designs to the physical implementation of the system. In some situations, there may be the physical part / product, without drawings, documentation, or a computer model is known as reverse engineering. Reverse engineering is also defined as the process of obtaining a geometric CAD model from 3-D points acquired by scanning/digitizing existing parts/products.

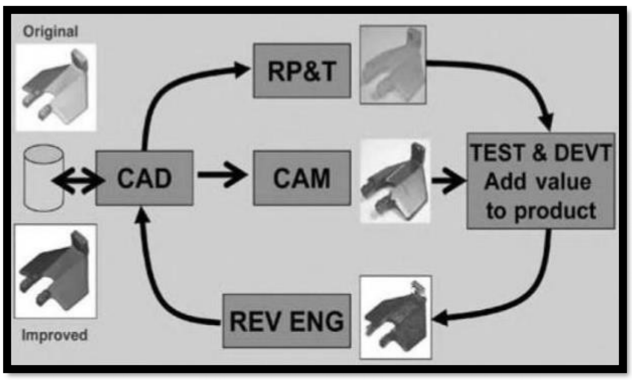

Fig 4.1(a):Product Development cycle

Fig 4.1(b):Physical to Digital process

4.1.2 Why use Reverse Engineering?

Following are some of the reasons for using reverse engineering:

i. The original manufacturer no longer exists, but a customer needs product, e.g. aircraft spares required typically after an aircraft has been in service for several years.

ii. The original manufacturers of a product no longer produces products, e.g. the original product become obsolete.

iii. Some bad features of a product need to be eliminated e.g. excessive wear might indicate where a product should be improved.

iv. Creating 3-D data from an individual, model or sculpture to create, scale, or reproduce artwork.

4.1.3 Design of rocker panel using reverse engineering

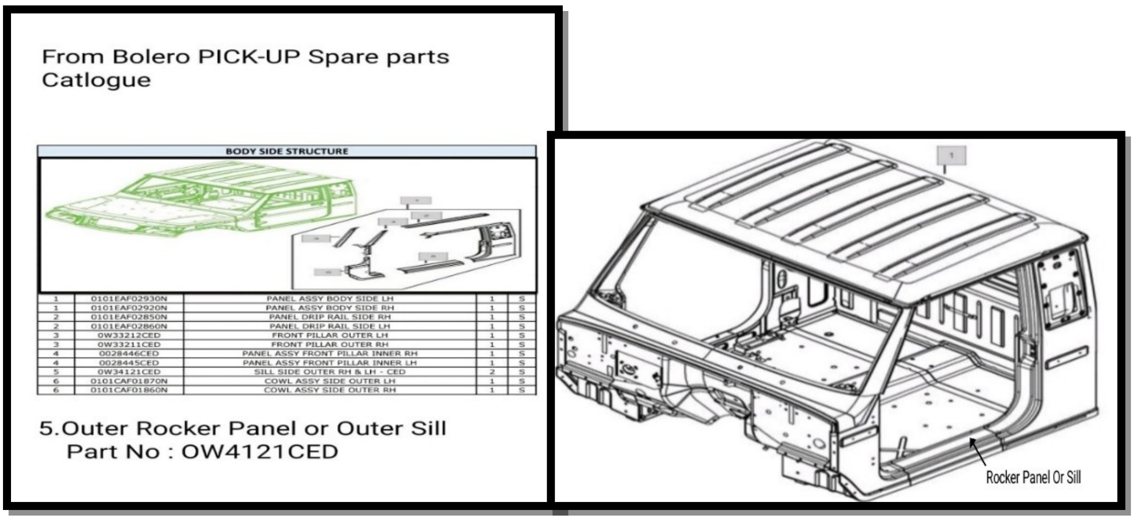

Fig 4.2: location of rocker panel / sill

As shown in the figure, this is the position of an rocker panel of an vehicle. Rocker panels are mounted between the front and rear vehicle, and at lower portion of an vehicle. Above vehicle shown in figure is Mahindra Bolero PICK-UP. In which rocker panel is made up of material STEEL. The actual rocker panel is shown in the figure above. All the dimensions are taken from this physical rocker panel using the Reverse Engineering process to generate the digital model. All dimensions are taken in mm while drafting the CAD model of this rocker panel

Dimension taken by following instrument

A) RADIUS GAUGE:

A radius gauge, also known as a **fillet gauge, is a tool used to measure the radius of an object.**

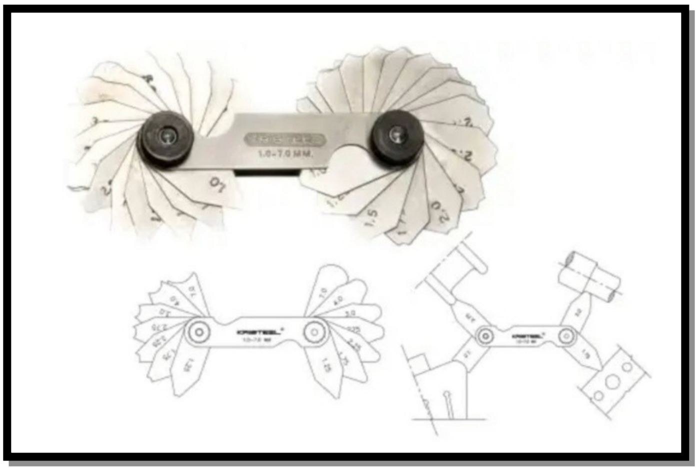

Fig 4.3: Radius Gauge

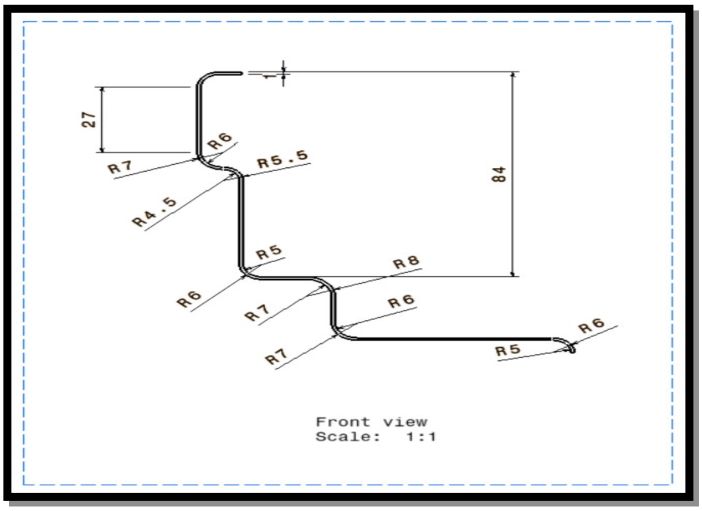

Fig 4.4: Radius measured using radius gauge

B) HEIGHT GAUGE

A height gauge is a **measuring device used for determining the height of objects, and for marking of items to be worked on**.

Fig 4.5: Height guage

C) MICROMETER

It is a measuring device used for determining the THICKNESS of objects, and for marking of items to be worked on. least count of micrometer : 0.01 mm

Fig 4.6:Micrometer

Thickness of rocker panel : 1 mm

Existing rocker panel is as shown in figure. From which we have taken all the dimensions using different types of gauges for generating the CATIA model.

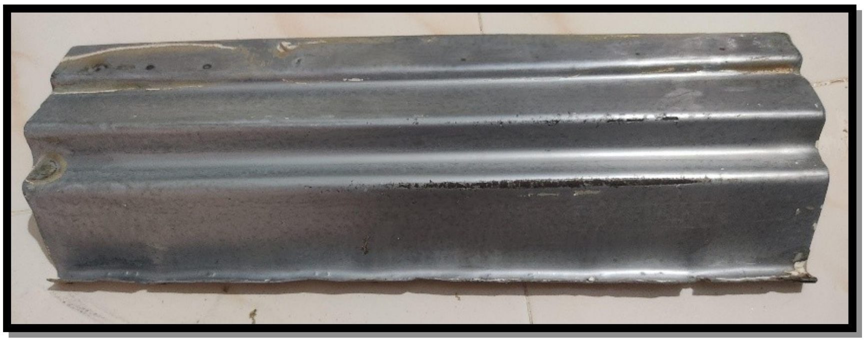

Fig 4.7: Existing rocker panel/sill

Using all the dimensions and data the CATIA model is then generated. The drafting of rocker panel is as follows:

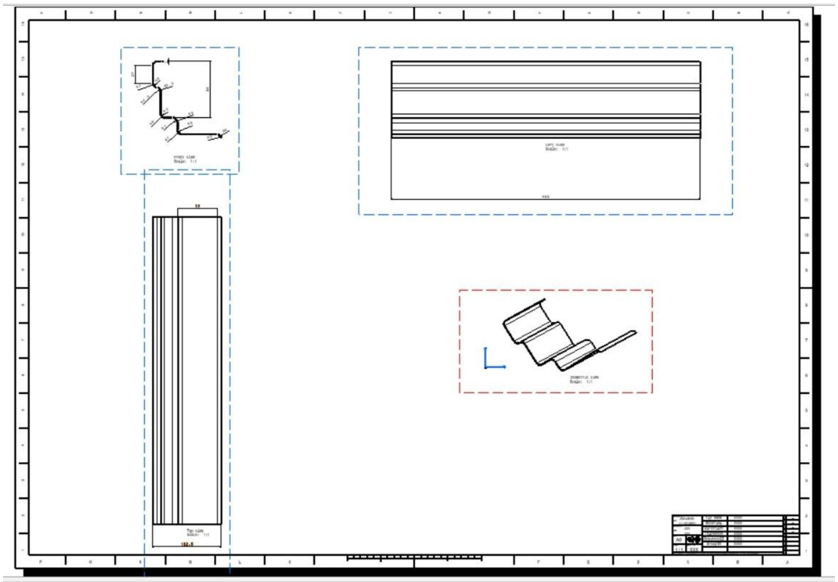

Fig 4.8:2D draft of rocker panel/sill

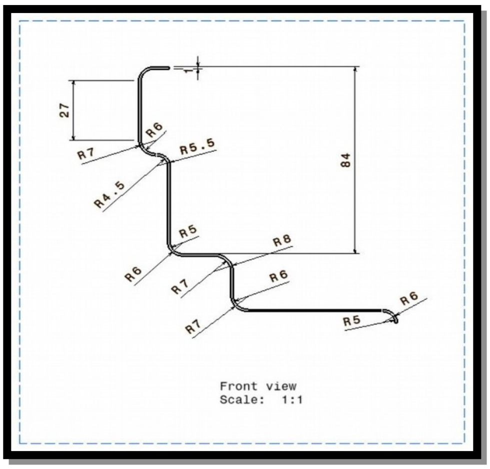

Fig 4.9:front view of rocker panel/sill

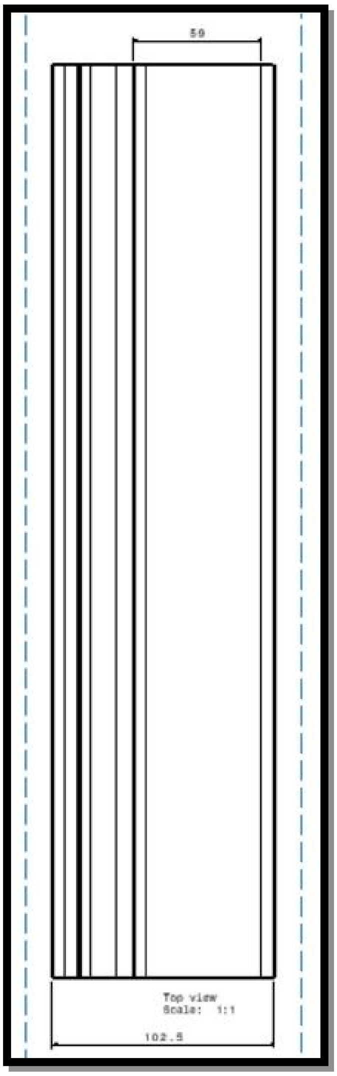

Fig 4.10:Top view of rocker panel/sill

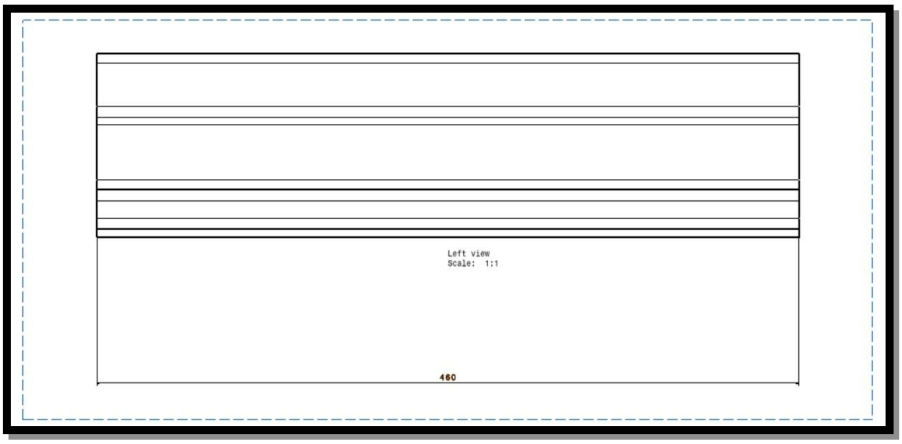

Fig 4.11: Left view of rocker panel/sill

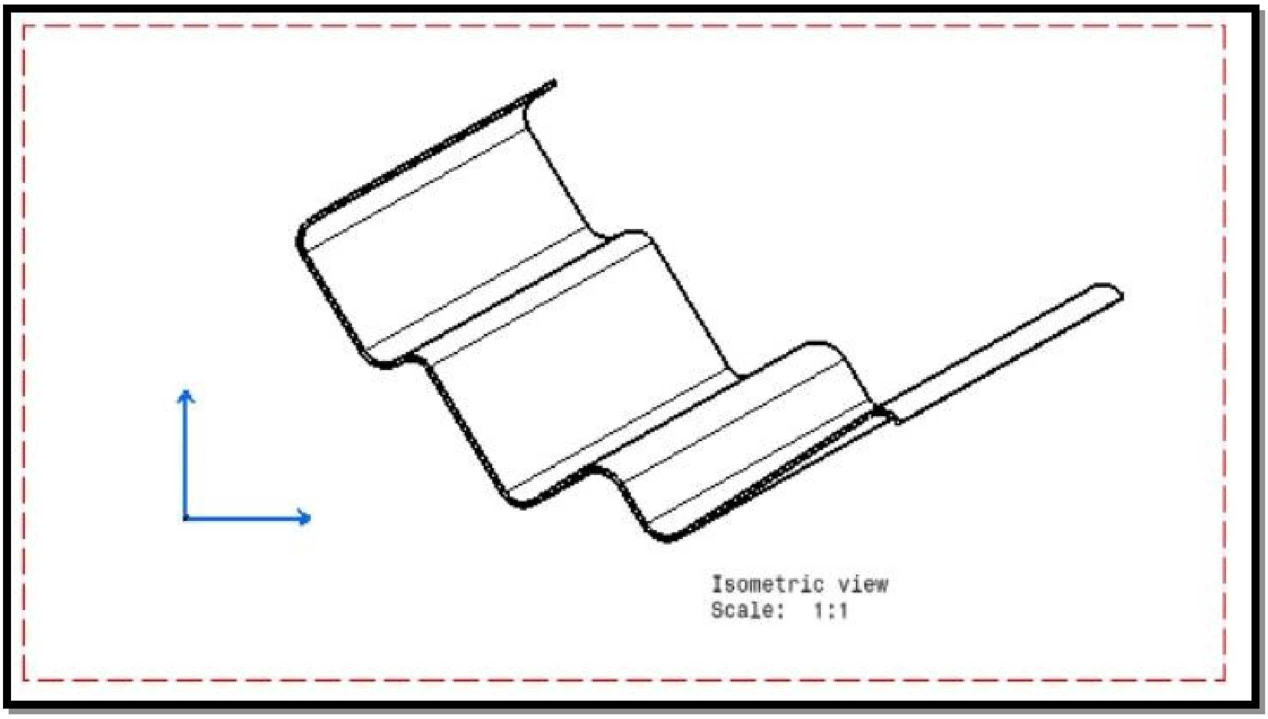

Fig 4.12:Isometric view of rocker panel/sill

3D Model of rocker panel/sill:

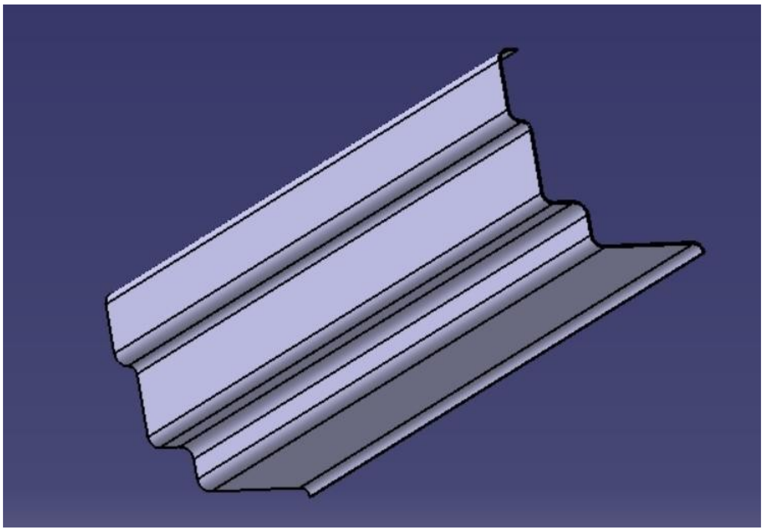

Fig 4.13: 3D model of rocker panel/sill

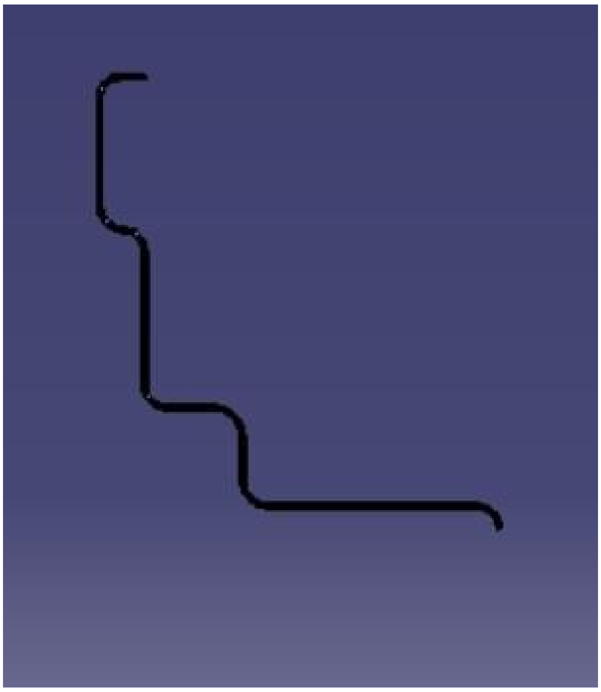

Fig 4.14:front view of rocker panel/sill

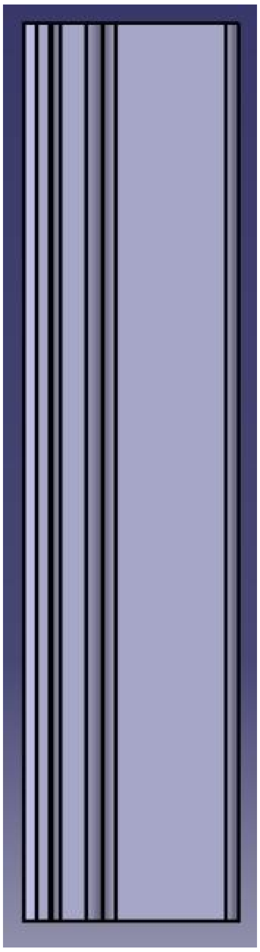

Fig 4.15:Top view of rocker panel/sill

Fig 4.16:Left view of rocker panel/sill

ANALYSIS

4.2) ANALYSIS:

Analysis of existing rocker panel-

The analysis of the rocker panel is done by using the **Finite Element Analysis .**

What is FEA (FINITE ELEMENT ANALYSIS)?

The finite element method (FEM), is a numerical method for solving problems of engineering and mathematical physics. Typical problem areas of interest include structural analysis, heat transfer, fluid flow, mass transport, and electromagnetic potential. The analytical solution of these problems generally require the solution to boundary value problems for partial differential equations. The finite element method formulation of the problem results in a system of algebraic equations. The method yields approximate values of the unknowns at discrete number of points over the domain. To solve the problem, it subdivides a large problem into smaller, simpler parts that are called finite elements.

In the first step, the element equations are simple equations that locally approximate the original complex equations to be studied, where the original equations are often partial differential equations. The process, in mathematical language, is to construct an integral of the inner product of the residual and the weight functions and set the integral to zero. In simple terms, it is a procedure that minimizes the error of approximation by fitting trial functions into the PDE. The residual is the error caused by the trial functions, and the weight functions are polynomial approximation functions that project the residual.

In this, analysis of rocker panel ANSYS (**An**alysis **Sys**tem) software is used. Basically, its present FEM method to solve any problem. Following steps are followed :

i. Geometry
ii. Discretization (Meshing)
iii. Boundary condition
iv. Solve (Solution)
v. Interpretation of results

Workbench contain analysis of different types namely static, modal, harmonic, explicit dynamics, CFD, ACP tool post, CFX, topology optimization etc. as per problem defined.

Step 1: Details of material namely copper, steel, grey cast iron, composite material, fluid domain material is defined in engineering data. i.e. ANSYS default material is structural steel.

Table 4.1:Rocker panel material properties

Properties of Outline Row 3: Structural Steel

	A	B	C	D	E
1	Property	Value	Unit		
2	Material Field Variables	Table			
3	Density	7850	kg m^-3		
4	Isotropic Secant Coefficient of Thermal Expansion				
6	Isotropic Elasticity				
12	Strain-Life Parameters				
20	S-N Curve	Tabular			
24	Tensile Yield Strength	2.5E+08	Pa		
25	Compressive Yield Strength	2.5E+08	Pa		
26	Tensile Ultimate Strength	4.6E+08	Pa		
27	Compressive Ultimate Strength	0	Pa		

Step 2: Import of geometry created in any CAD software namely CATIA, PRO E, SOLIDWORK, INVENTOR etc. in geometry section. If any correction is to be made it can be created in geometry section in Design modeller or space claim.

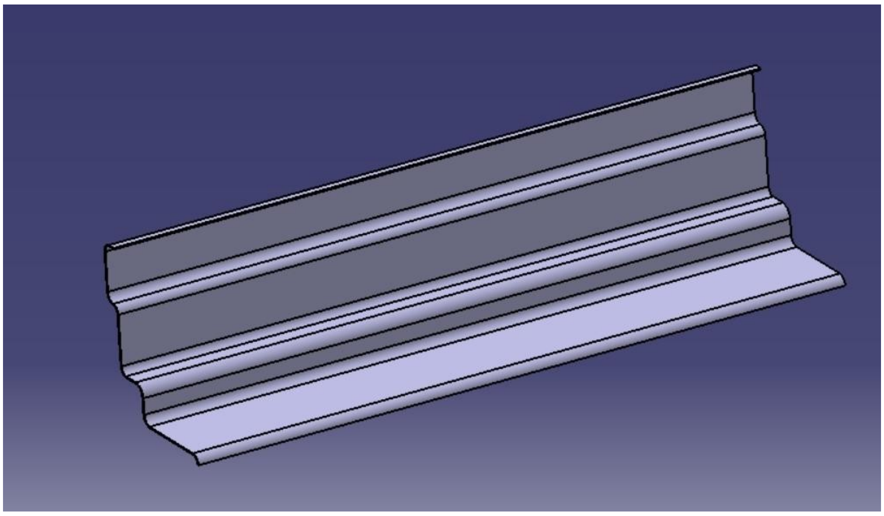

Fig 4.17:Geometry of rocker panel

Step 3: In model section after import of component

- Material is assigned to component as per existing material

- Connection is checked in contact region i.e. bonded, frictionless, frictional, no separation etc. for multi body components.
- Meshing or discretization is performed i.e. to break components in small pieces (elements) as per size i.e. preferably tetra mesh and hexahedral mesh for 3D geometry and for 2 D quad or tria are generally preferred.

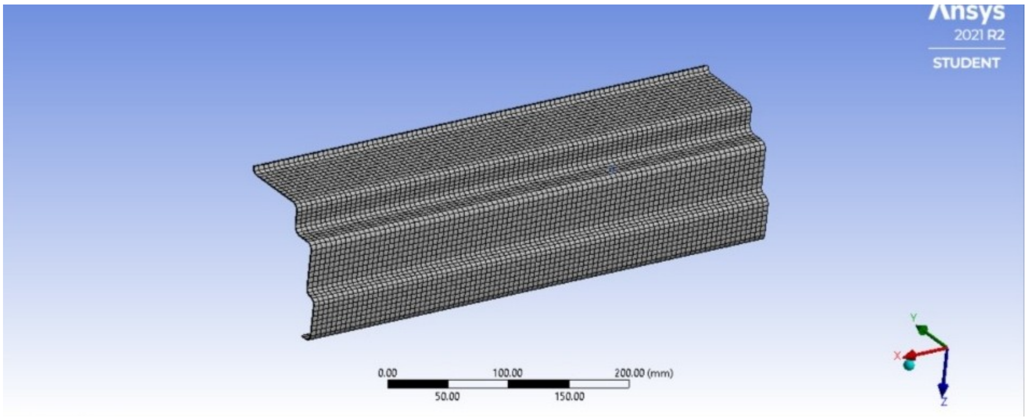

Fig 4.18:meshing of rocker panel

Table 4.2:meshing details of rocker panel

Details of "Body Sizing" - Sizing	
Scope	
Scoping Method	Geometry Selection
Geometry	1 Body
Definition	
Suppressed	No
Type	Element Size
Element Size	5.0 mm
Advanced	
Defeature Size	Default
Behavior	Soft

Properties	
Volume	96530 mm³
Mass	0.75776 kg
Scale Factor Va...	1.
Statistics	
Bodies	1
Active Bodies	1
Nodes	32264
Elements	4508
Mesh Metric	None

Step 4: Boundary condition are applied as per analysis namely in fixed support, pressure, force, displacement, velocity as per condition.

Boundary Condition:

We have taken both the ends as fixed support and middle portion is subjected to displcement of 20mm and we are going to determie the force reaction of rocker panel.

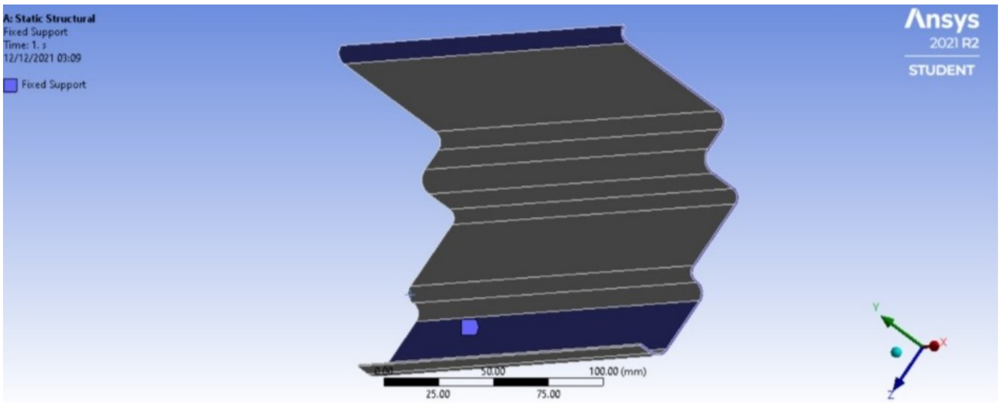

Fig 4.19 :Boundary conditions for rocker panel

Step 5: Now problem is well defined and solve option is selected to obtain the solution in the form of equivalent stress, strain, energy, reaction force etcetc.

Total deformation-

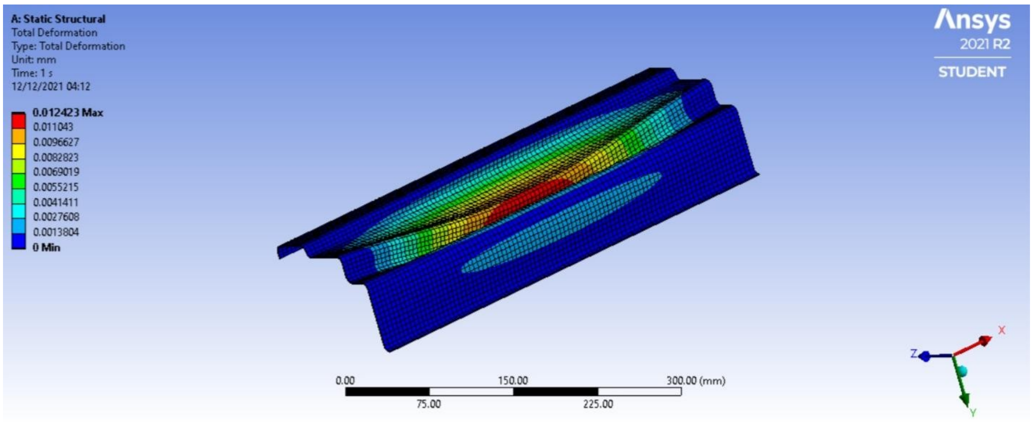

Fig 4.20:Total deformation

Table 4.3:Total deformation

Results	
Minimum	0. mm
Maximum	1.2423e-002 mm

Equivalent stress-

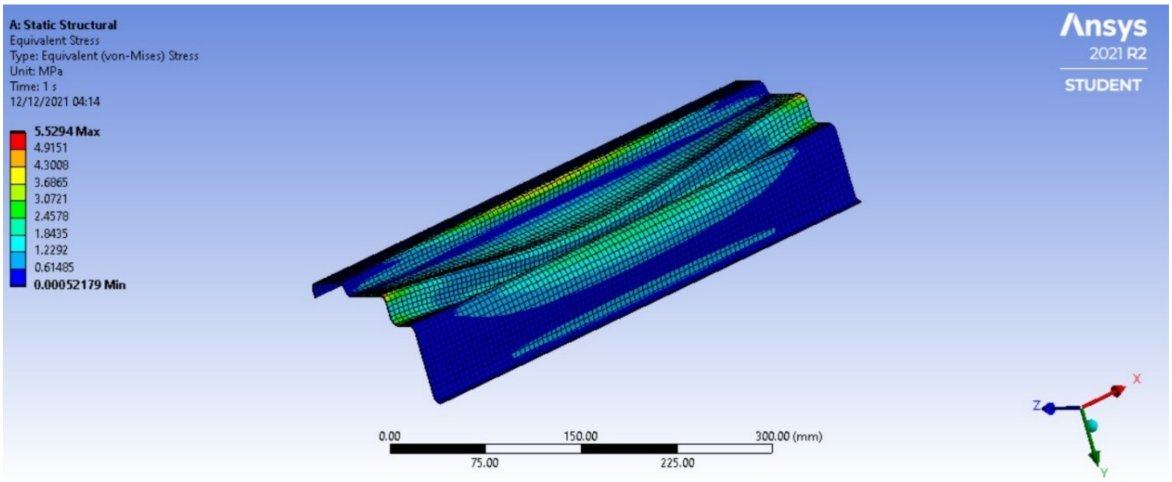

Fig 4.21 :Equivalent stress

Table 4.4:Equivalent stress

Results	
Minimum	5.2179e-004 MPa
Maximum	5.5294 MPa
Average	0.87168 MPa

Equivalent elastic strain-

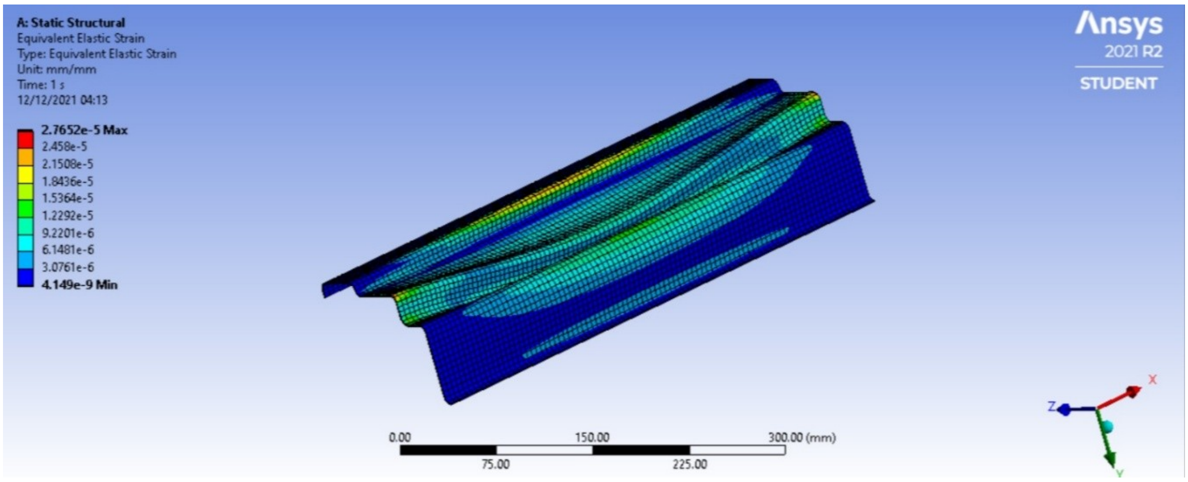

Fig 4.22:Equivalent elastic strain

Table 4.5:Equivalent elastic strain

Results	
Minimum	4.149e-009 mm/mm
Maximum	2.7652e-005 mm/mm
Average	4.9457e-006 mm/mm

Force reaction-

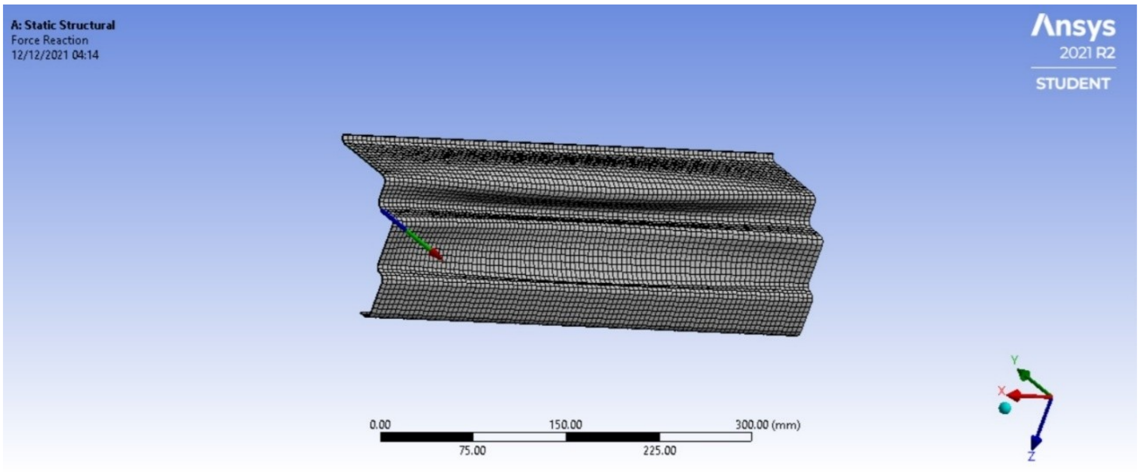

Fig 4.23:force reaction

Table 4.6:force reaction

Results	
Maximum Value Over Time	
X Axis	9.3302e-009 N
Y Axis	-200. N
Z Axis	8.7039e-008 N
Total	200. N
Minimum Value Over Time	
X Axis	9.3302e-009 N
Y Axis	-200. N
Z Axis	8.7039e-008 N
Total	200. N

CHAPTER 5

SUMMARY

Rocker panel is generally made up of plastic or metal that is placed on the sides of a passenger . It is fixed below the door opening and between the front and the rear wheels to provide structural support to the car . It is not easy to acquire the same bending performance as that of a rocker panel by merely replacing it with composite material and increasing the wall thickness. Therefore, reinforcements were employed to improve the bending performance of the rocker panel .This study aimed to redesign one of the most important components of the side structure of a vehicle, the rocker panel, with carbon fiber and E-glass fiber .

In this project analysis of rocker panel of bolero pick-up made up of steel is done in ANSYS SOFTWARE . In this analysis results are total maximum deformation is 0.012423 , maximum equivalent stress is 5.5294 mpa and maximum elastic strain is 2.652 . Then we will conduct the anlysis of rocker panel reinforced with e-glass fiber and carbon fiber respectively in ansys .

CHAPTER 6

REFERENCES

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