FEA ANALYSIS & OPTIMIZATION OF BRAKE PEDAL

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Abstract: *In Automobile Industry brake pedals are widely used, which acts as a linkage between occupant and brake mechanism. Regular existing brake pedal is seems to be overdesigned as per requirement of FEA. Existing brake pedal model is generated by using CATIA V5. Brake Model is again designed using CATIA and analyzed in ANSYS and comparison between stress and deformation is carried out with new design. Based on the techniques of basic designing the model is modified to be hollow from inside which results in material and related cost saving of the model. The foresaid outcomes are observed for a variety of loads under defined boundary conditions providing realistic environment.*

Keywords: Brake Pedal, CAE, Finite Element, Optimization etc.

1. INTRODUCTION

In recent year, the material competes with each other for existing and new market. Brake pedals used by driver of a vehicle to operate the brakes. The brake system in car is a sealed hydraulic system and relies on close tolerances between the brake shoes and drums or brake pads and rotors. It is one of the most significant systems of a vehicle. It has some basic roles, it should slow a moving vehicle, it needs to hold a vehicle stationary when stopped, It should bring a vehicle to a stop. Brake pedal is used as component for study. CAD Model of brake pedal is developed in 3D modeling software CATIA V5. In optimization design of brake pedal, a weight should be minimized. In automobile industry, mass of weight reduction is becoming important issue. Automotive industry is growing exponentially towards light weight vehicle, cost effective vehicle components and environmentally friendly. Vehicle weight reduction is one of the promising strategies to improve fuel consumption. By reducing vehicle mass, the inertial forces that the engine has to overcome when accelerating is less, and the work or energy required to move the vehicle is decreased. A new brake pedal design will be proposed without any new material substitution by using topology optimization. Based on analysis results, new design of brake pedal will be proposed to replace the existing brake pedal with significant weight reduction

Figure 1.1 Brake Pedal

Yadav et al (2016) studies the importance of lightweight in vehicle. Weight reduction is well known strategy for improving fuel consumption in vehicle and present and important opportunity to reduce fuel use in transportation sector. The reduced weight of vehicle reduces the emission and fuel consumption. Less weight means les material which ultimately reduces the material use which improves cost of company.

Dhande & Jamdar (2014) studies the replacing the clutch and accelerator pedal by composite material. The purpose is to reduction in the weight. The Design of various sections are created on

Catia V5 and FEA analysis of these section is done. Von-mices stresses in the sections at various node points are calculated. Various results are taken on deflection, weight and stress.
Imran & Aquib (2018) study the important components of vehicle. Brake pedal is important component of automotive vehicle which decelerates and stop the vehicle. The importance of changing design in high speed vehicle. The design and optimization of component is done to increase strength, make it comfortable and in economic. Topology optimized and static stress analysis has been carried out to get better performance of the car. They did the analysis o two different materials, such as ductile cast iron 350/140 and aluminum A 359-T0. Aluminum A359-T0 shows higher strength, light weight, good corrosion resistance and show two times higher factor of safety than the ductile cast iron.
Kondhalkar & Pawar (2017) studied the solid modeling brake mechanism. Existing design seems to be overdesign as per requirement. They perform the topology optimization of brake pedal. The cad modeling is done on Catia V5. They conclude that the weight of the new optimized pedal is less than existing one.

Problem Statement

Problem has been formulated with the help of findings (outcomes) in critical literature survey and effort to fill the gap between the research works in literature. The aims and scope of the research work is to reduce the weight of an existing brake pedal design of an automotive with the application of theoretical, numerical and optimization techniques without the substitution of material.

Objectives

1. To prepare CAD design of brake pedal using CATIA V5.
2. FEA Analysis of existing brake pedal.
3. To prepare CAD design of Optimized brake pedal on CATIA V5.
4. To perform analysis of optimized brake pedal by using FEA.

2. MODELLING & ANALYSIS OF EXISTING BRAKE PADDLE

Weight Calculation

According to BMI weight of average of person is 60 Kg and 20 kg addition weight ,
FOS= 1.3 , Gravity =9.81m/s^2
Reduction to body weight 40% ,
Therefore [(60 + 20) *1.3* 9.81*0.4]/2
Load =200 N.

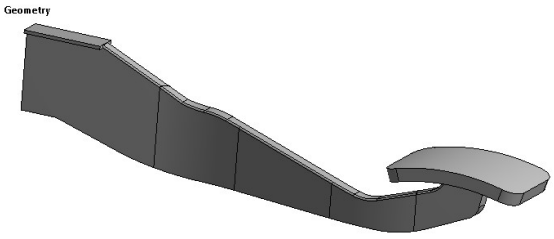

Fig 2.1 3D Model of existing brake paddle

The next step in ANSYS workbench is to generate a meshing, after applying some material properties & creating geometry.

Element Type: Second order Hexahedron

• Elements count: 20743

• Nodes count:34046

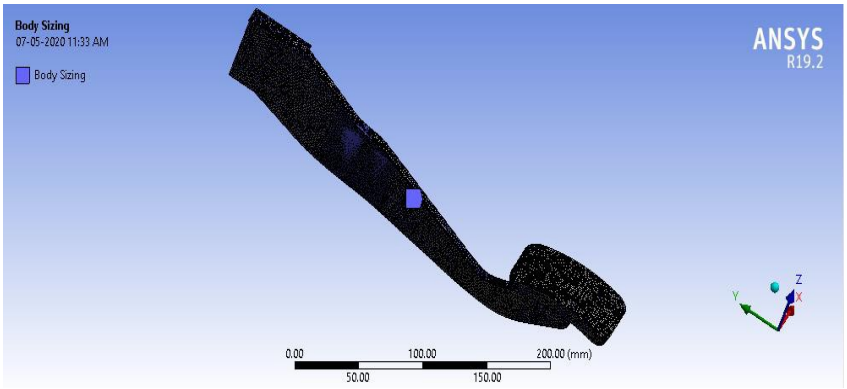

Fig 2.2 Meshing of existing Brake pedal

The boundary conditions such as loads & constraints are imposed, after meshing the model, It is important to apply correct loads & boundary conditions, To get accurate results.
Existing model of Brake Pedal is fixed at one end at point A.
The Force of 200 N is applied on the other end B.

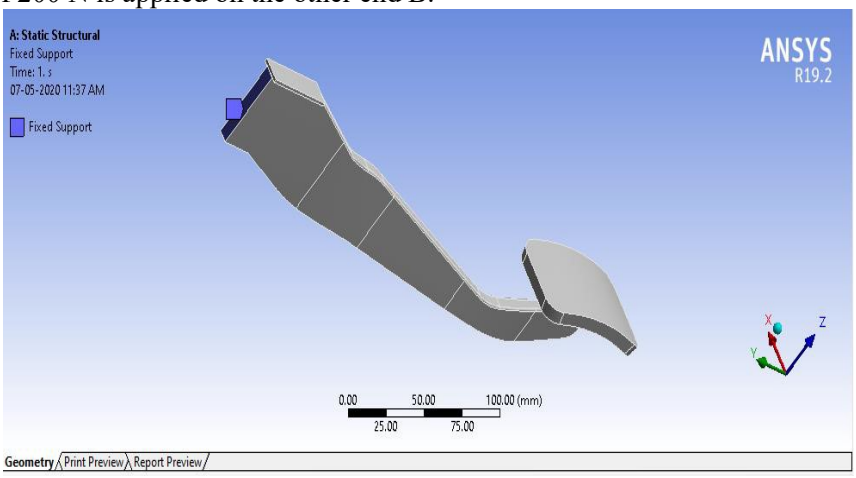

Fig 2.3 Fixed Support

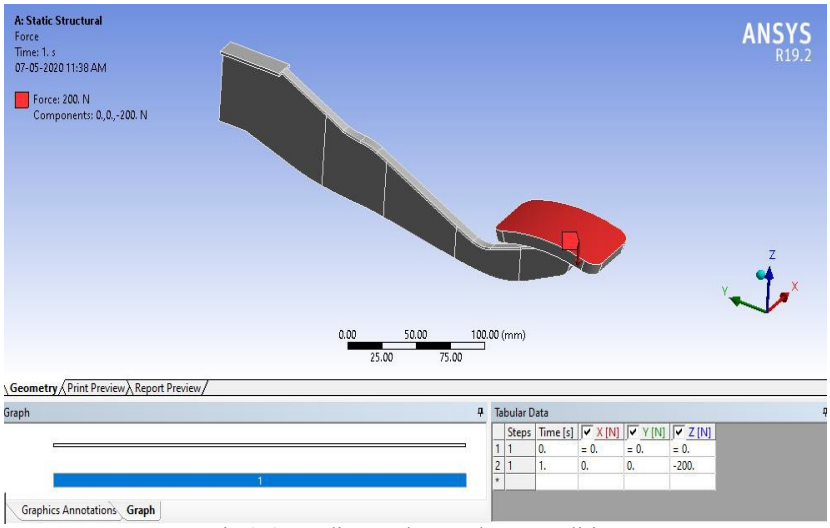

Fig 2.4 Loading and Boundary Condition

Results of Existing Brake Pedal

1)Total Deformation

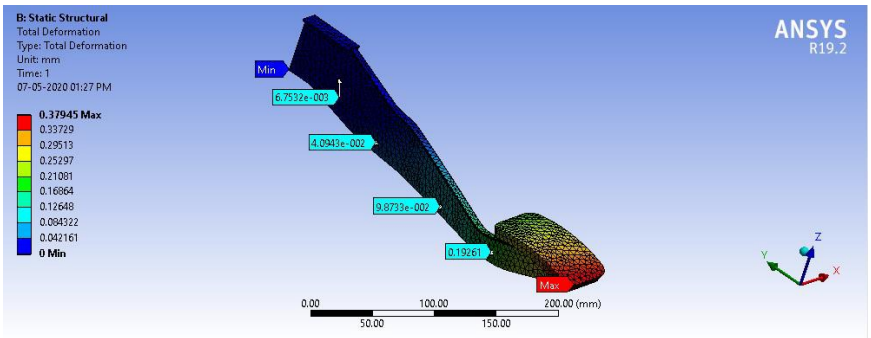

Fig 2.5 Total Deformation of Existing pedal

Maximum deformation found in the given model is 0.37945 mm and that of the minimum is 0 mm.

2) Equivalent (Von-Mices) Stress

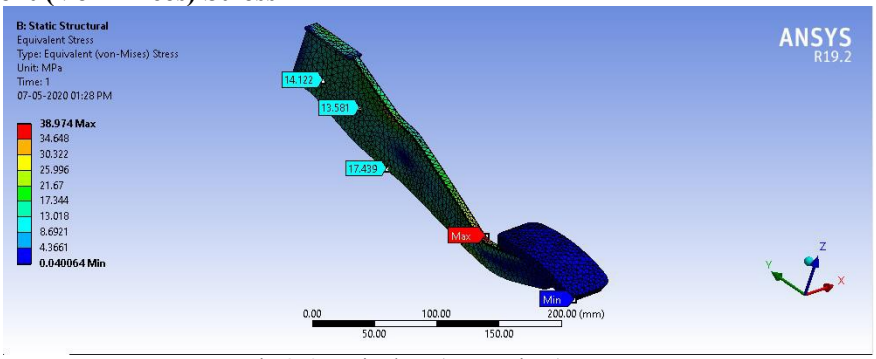

Fig 2.6 Equivalent (Von-Mices) Stress

The maximum stress is developed at the end which is 38.974 MPa. Which is less than 140MPa (Allowable stress).

3) Equi- Elastic Strain

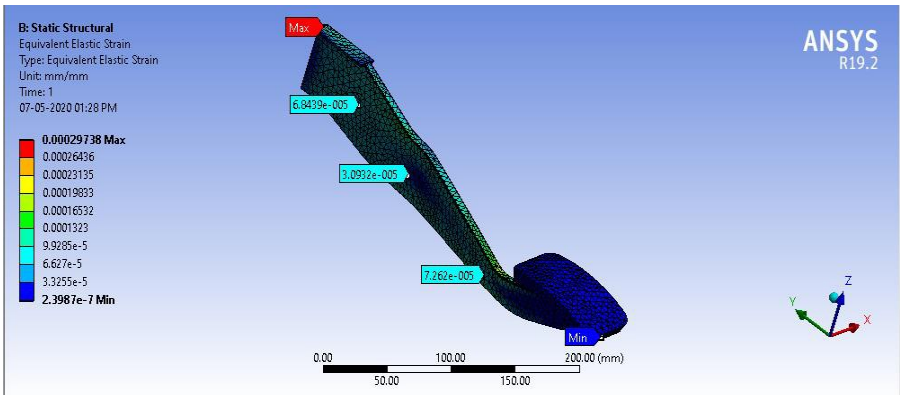

Fig 2.7 Equi- Elastic Strain

Value of strain developed is 29738 micro strain.

3. MODELLING AND ANALYSIS OF OPTIMIZED BRAKE PEDAL

3D model of Optimized Brake pedal

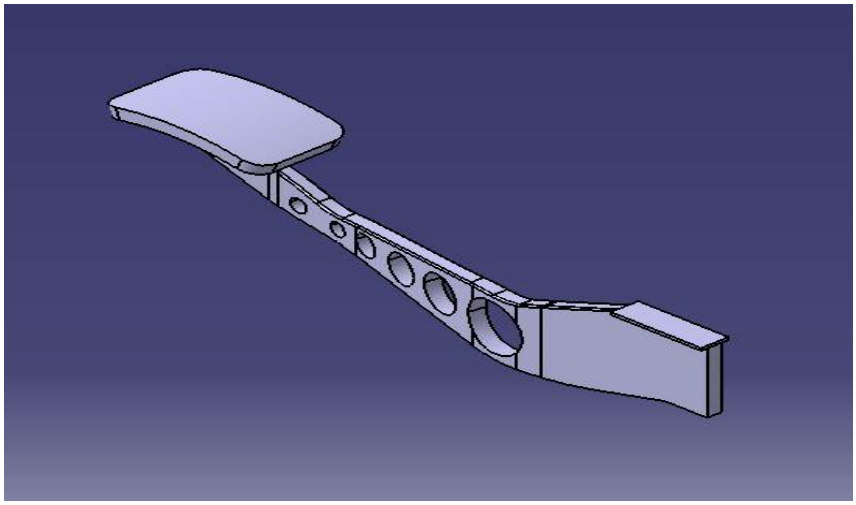

Fig 3.1 3D model of Optimized Brake pedal.

Meshing

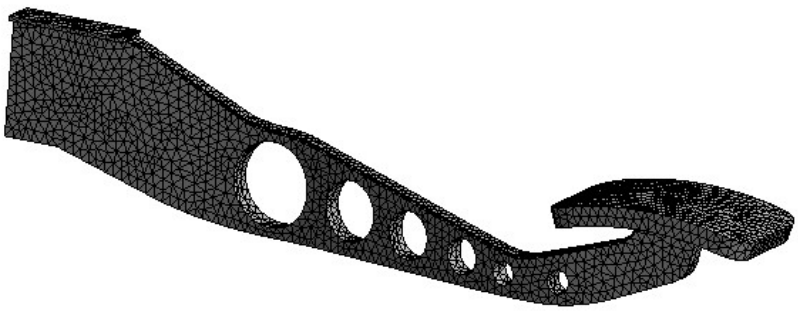

Fig 3.2 Meshing of Optimized Brake pedal

To establish the geometry model by CATIA, then input the geometry to the ANSYS to carry out pre-treatment operations like geometry cleanup, meshing, loads, constraints, etc. Initially we need to collect the information regarding different loads acting on the bracket and the packaging data for fixing design space. The base bracket results from testing and finite element analysis (FEA) point of view for evaluating final optimized design.

Boundary Conditions

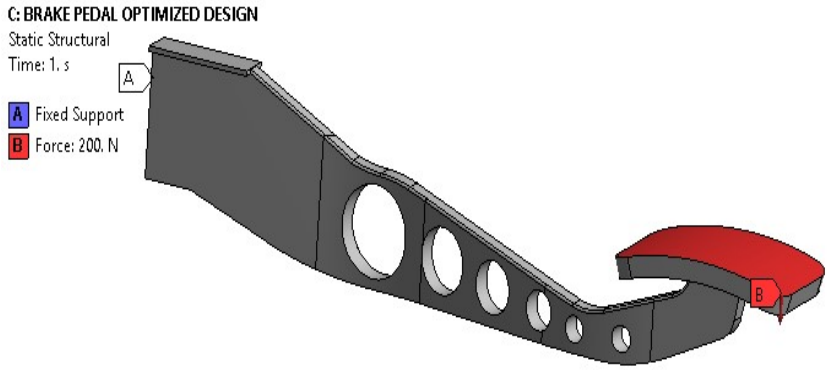

Fig 3.3 Boundary Conditions of Optimized Model.

Optimized model of Brake Pedal is fixed at one end at point A. The Force of 200 N is applied on the other end B.

Results of Optimized Brake Pedal

1)Total Deformation

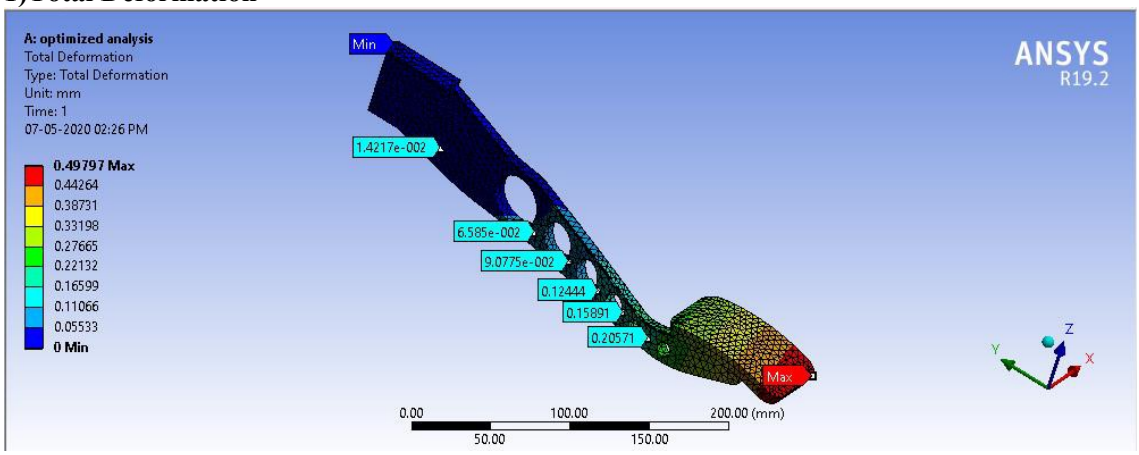

Fig 3.4 Deformation of Optimized Model.

Maximum deformation found in the given model is.0.497997 mm and that of the minimum is 0 mm.

2) Equivalent (Von-Mices) Stress

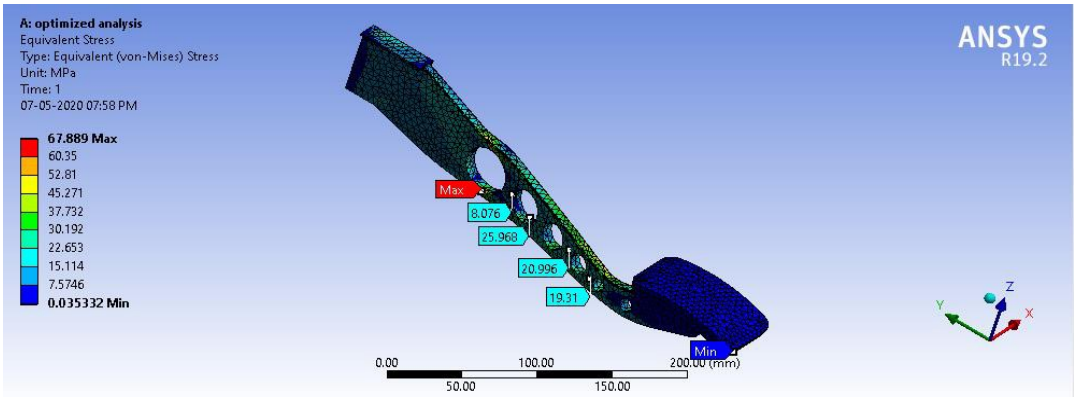

Fig 3.5 Equivalent (Von-Mices) Stress

The maximum stress is developed at the end which is 67.889 MPa. Which is less than 140 MPa (Allowable stress).

3) Equi- Elastic Strain

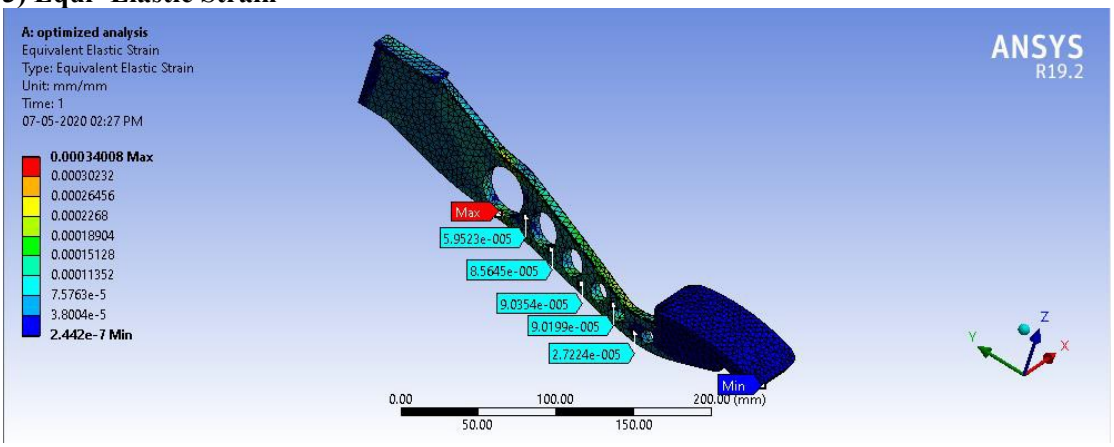

Fig 3.6 Equi- Elastic Strain

Value of strain developed is 34008 micro strain.

COMPARISON OF ORIGINAL MODEL AND OPTIMIZED MODEL

Parameters	Regular Model	Optimized Model
Total Deformation	0.37945mm	0.497997 mm
Equivalent (Von-Mices) Stress	38.974 MPa	67.889 MPa
Equi- Elastic Strain	0.00029738 mm	0.00034008 mm

Original model (1049.5g) was reduced to Optimized Model (904 g) i.e. around 13.86 % reductions is achieved through optimization.

4. CONCLUSION

Brake pedal is one of the important component of automotive vehicle, which decelerate and stop the vehicle.The modeling of existing brake pedal is carried out and analyzed. Further the model was optimized. It was found that the existing brake pedal was 1049.5 grams and after optimization it was

904 grams. So there was around 13.86% reduction in weight through optimization and also cost of manufacturing of is reduced.

5. REFERENCES

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