International Research Journal of Engineering and Technology (IRJET) e-ISSN: 2395 -0056
Volume: 04 Issue: 05 | May -2017 www.irjet.net p-ISSN: 2395-0072

STATIC STRUCTURAL ANALYSIS AND OPTIMIZATION OF BRAKE PEDAL

Miss. ASHWINI N.GAWANDE[1], Prof.G.E.KONDHALKAR[2], Prof. ASHISH R.PAWAR[3]

[1]*PG Student, Design Engineering, APCOE & R, Parvati, Pune*
[2]*HOD, Mechanical Engg.Department, APCOE & R, Parvati, Pune*
[3]*Asst.Professor, Mechanical Engg.Department, APCOE & R, Parvati, Pune*

---***---

Abstract - *Brake pedals are widely used in all automotives, which acts as a linkage between occupant and brake mechanism. Existing design seems to be overdesigned as per requirement finite element analysis will be used to apply cantilever load optistruct solver will be used to perform topology optimization. The model of an existing brake pedal was generated using CATIA V5 solid modelling software. Finally, a new light weight design brake pedal is proposed. The result of the study shows that the weight of a new designed brake pedal was less as compared to an existing brake pedal without sacrificing its performance requirement.*

***Key Words*: BRAKE PEDAL, FEA, OPTIMIZATION**

1. INTRODUCTION

1.1 Background

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.

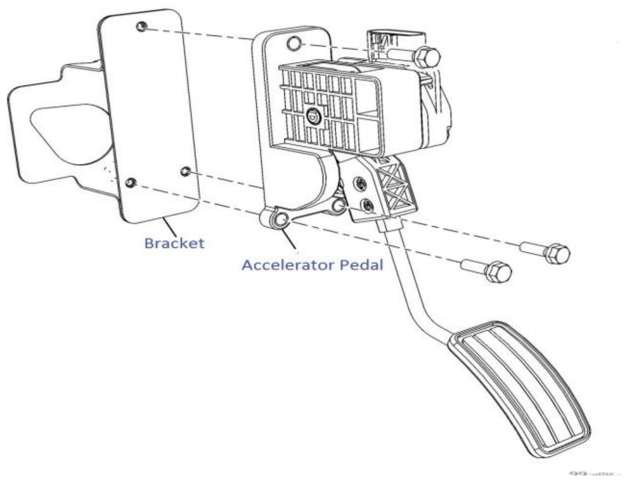

Fig-1.Brake Pedal

Brake pedal of TATA STORME 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. To reduce the material, Topology optimization is used. Optimization is reducing the weight and cost of product. In automobile industry, it is obligatory to look for cheap & lightweight materials and which should be easily accessible. At present, brake pedals are made from metal but accelerator pedals and composite clutches are successfully utilized in automotive vehicles. This study is concentrated on variable-material for the conceptual design brake pedal profile.

1.2. LITERATURE REVIEW

Mohd Sapuan Salit [1] in automotive industries, Metalic accelerators and clutch pedal are replacing with polymeric-based composite pedals and The aim of replacement is weight reduction, cost saving of pedals using composites. In this research work, brake pedals have been investigated analytically and computationally from the properties of available and suitable polymeric-based composite, a final design of a composite brake pedal has been made.

Sandeep Ghatge [2] the automotive industries accelerator and clutch pedal are replacing by light weight materials such as plastic, polymer composites, aluminium and its alloys, etc. The purpose of replacement is improvement in corrosion resistance and reduction weight, cost. In design aspect; the steel material is replaced by light materials. In this study different lightweight materials of brake pedal are compared with conventional steel. For different sections for different loading and boundary conditions, these materials are analyzed. The purpose of this study is to design and analyze the brake pedal using CATIA and ANSYS software.

K K Dhande [3] in automotive vehicles, the conventional brake, accelerator and clutch pedals are replaced by polymeric-based composite pedals. The purpose of replacement from metallic pedal to polymeric-based composite material is to improve material degradation by corrosion and reduce the weight, cost. In this research work, as per the design parameters, the four different sections of polymeric based brake pedals are analyzed .The sections are analyzed and arrived at a winning concept based on stiffness comparison. From the winning concept, a full scale model is developed while developing full scale model an ergonomic study has been made on few hatch back and SUVs car's to improve the driver's comfort and due to breaking operation, the fatigue is reduce. The pedal is modeled and analysis using CATIA software & ANSYS software. The results have shown polymeric-based composite material replaced with present metallic pedal. By using composite material, the weight reduction of 66.7% is achieved.

Mohd Nizam Sudin [4] the modern automotive industry is continuing to strive for light weight vehicle in improving fuel efficiency and emissions reduction. To produce a good performance car to design vehicles with optimum weight is important. In order to reduce the weight of vehicle without sacrificing its integrity, this purpose of these project is to employ topology optimization technique to propose an optimal design of component in early phase of product development. The model of an existing brake pedal was generated using CATIA V5 software and Topology optimization by using Altair Optistruct software. Finally, a new light weight design of brake pedal is proposed. The result shows that the weight of a new designed brake pedal was 22% less as compared to an existing brake pedal without sacrificing its performance requirement.

Bhagyashri Kurkure [5] Now a days industries are replacing accelerator and clutch pedal by lightweight materials such as polymer plastic, composites, aluminium and its alloys, etc. The purpose is to reduce weight, cost, and improvement in corrosion resistance without change in material reduction. a commercial vehicle casted brake pedal lever. The FEM and analysis of a brake pedal lever has been carried out. The FE model was generated in CATIA or Pro-E and imported in ANSYS for stress analysis and then optimizing it with the help of Optistruct software. A comparison of baseline and optimized model FEA results have been done to conclude.

Dr Hossein Saidpour [6] the vehicle component of materials is dependent on a supply and demand process, subject to requirements. Metals i.e steel, aluminium and magnesium are used for elements of the body structure and panels and Plastics are used for exterior attachments to the body. Cars consist of steel and iron but due to the impending use of multi material constructions, it is expected that the amount of steel and iron used is reduced. the steel unibodies are multi material unibodies and aluminium space frames. Magnesium and steel space frame concepts for volume applications are still under development. The materials are replaced by durability and specific strength/ stiffness of high performance carbon fiber composites

Pankaj Chhabra [7] To determine design concept,Concurrent Engineering (CE) approach is used and material of the composite accelerator pedal at conceptual design stage. using the Morphological approach, the Various design concepts are generated. at design stage, CATIA is used and ANSYS is used for analysis. on the basis of past research & specifications, material selection is done .the pedal arm profile on the basis of stress, mass & volume, and deformation results achieved on ANSYS. Analyzed and optimized the accelerator pedal for safety parameters and finally prototyped using Selective Laser Sintering. the feasibility of composite accelerator pedal with glass filled polyamide providing saving better properties and substantial weight than existing metallic pedal.

1.3 Methodology

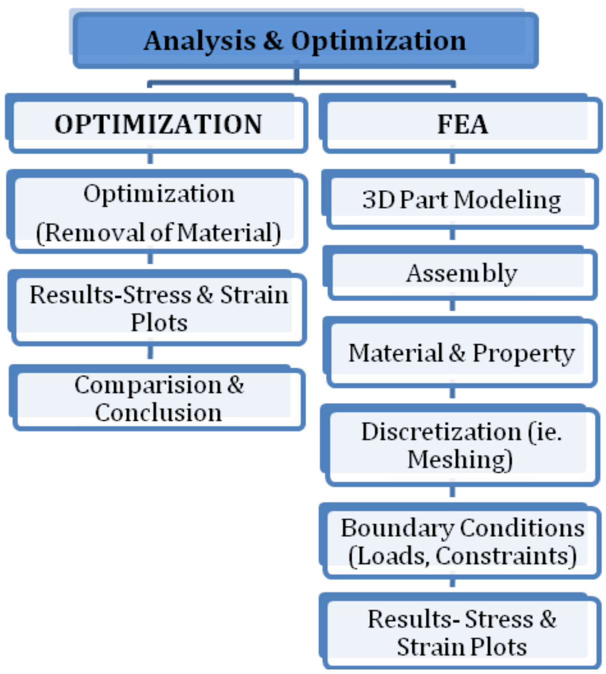

Fig-2. Methodology

2. FE ANALYSIS OF BRAKE PEDAL

2.1 Modeling of Brake Pedal

The first step to start the analysis with the ANSYS programs. For carrying out detail analysis of brake pedal, the static Structural analysis was selected. The geometry of brake pedal was created in ANSYS by taking all the parameters of brake pedal. After creating geometry, material properties were applied to brake pedal.

Material properties:

The values of young's modulus, poisons ratio, density, and yield strength for brake pedal are taken from material library of the FEA PACKAGE.

Material- Steel

Young's Modulus- 200 GPa

Poisons Ratio- 0.3

Density- 7850 kg/m^3

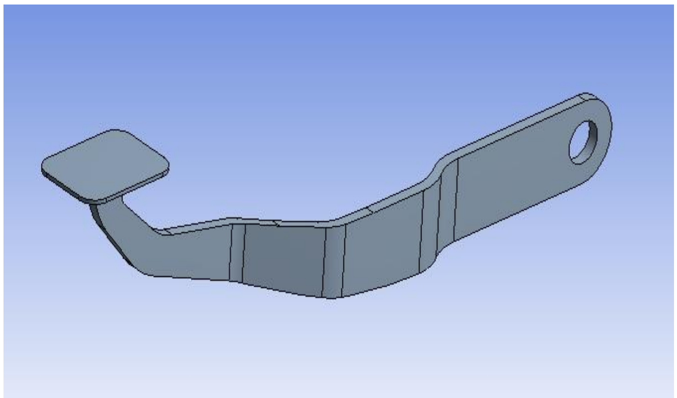

Fig. -3. CAD Model of Brake Pedal.

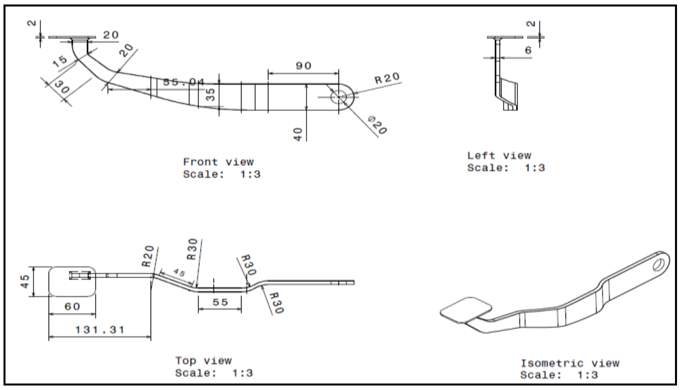

Fig. -4. Drafting of Existing Brake Pedal.

Mesh Generation

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

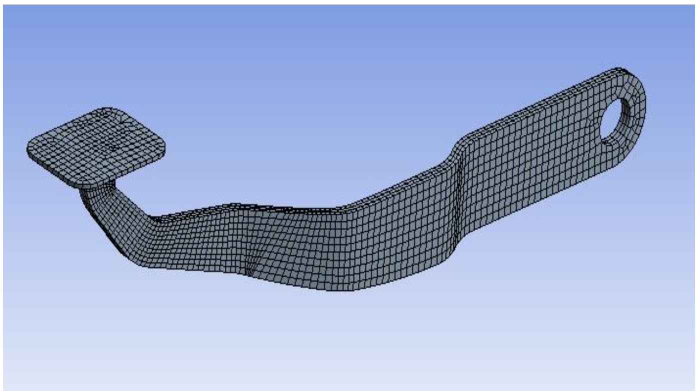

Fig. -5. Discretized Model

- Element Type: Second order Hexahedron
- Elements count: 3042
- Nodes count:20671

Loading and Boundary Condition

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.

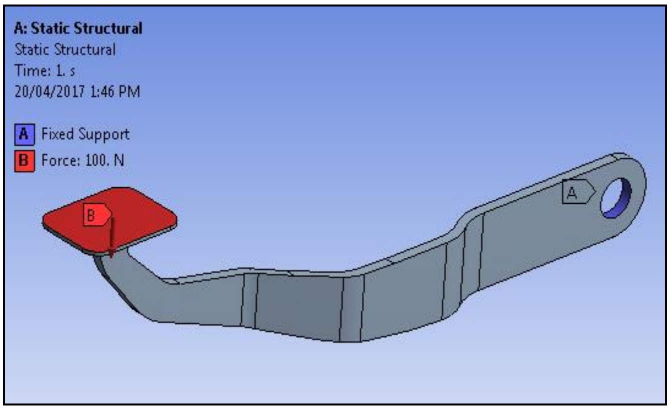

Fig. -6. Existing model of Brake Pedal is fixed at one end at point A.

The Force of 100 N is applied on the other end B Boundary Condition.

Deformation

Maximum deformation found in the given model is 0.73983 mm and that of the minimum is 0.082204 mm.

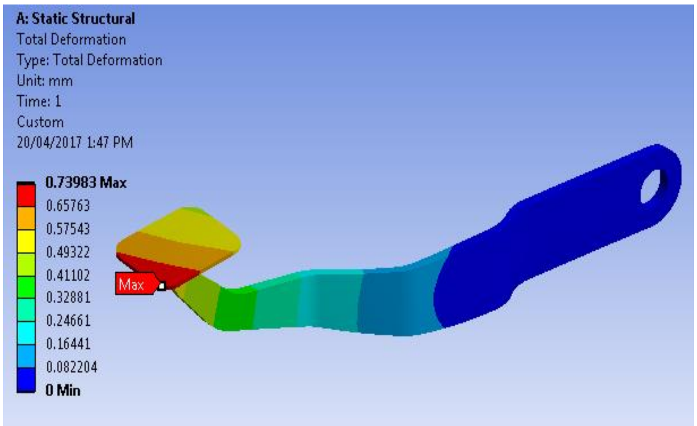

Fig. -7. Deformation of existing model

Von- Mises

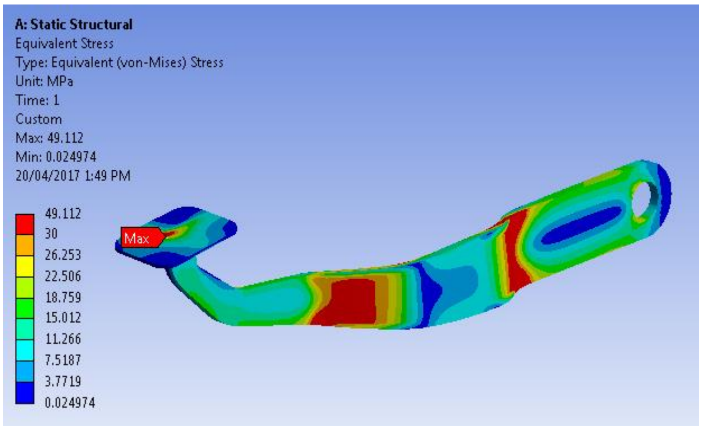

Fig. -8. Von- Mises stress of existing model

the maximum stress is developed at the end which is 49.112MPa.

Equi-Elastic Strain.

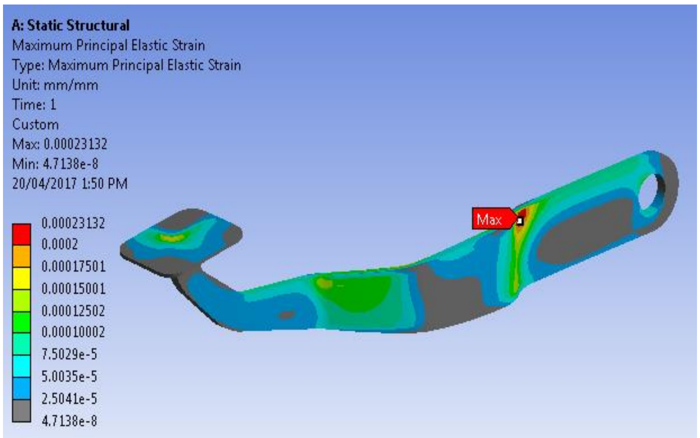

Fig. -9. Equi-Elastic Strain of Brake Padel.

Value of strain developed is 231 microstrain

3. OPTIMIZATION

3.1Topology Optimization

Topology optimization deals with mathematical method that optimizes material layout for a given set of loads and boundary conditions within a given design space.

There are three types of structure:

- Size
- Shape
- Topology

Optimized Model

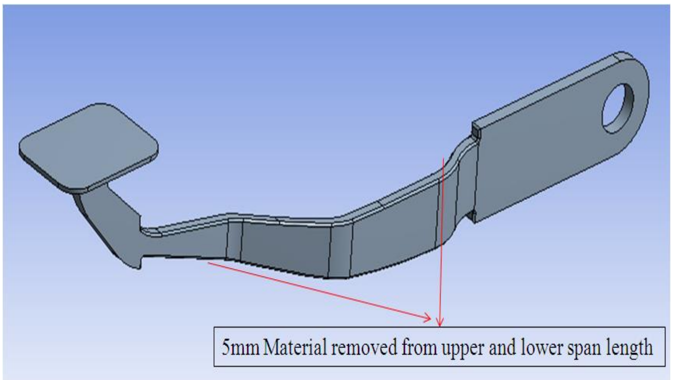

Fig. -10. CAD Geometry of Optimized Model.

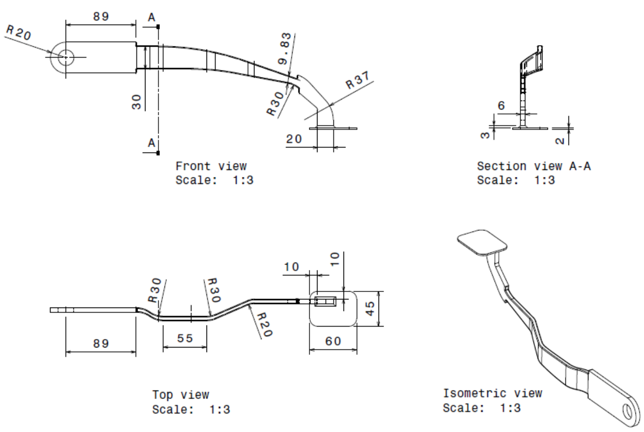

Fig. -11. Drafting of Optimized Brake Pedal.

Boundary Conditions

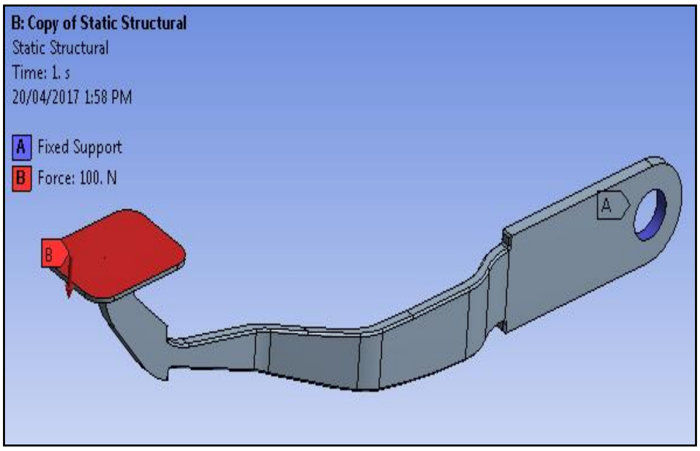

Fig. -12. Boundary Conditions of Optimized Model.

Optimized model of Brake Pedal is fixed at one end at point A. The Force of 100 N is applied on the other end B.

Deformation

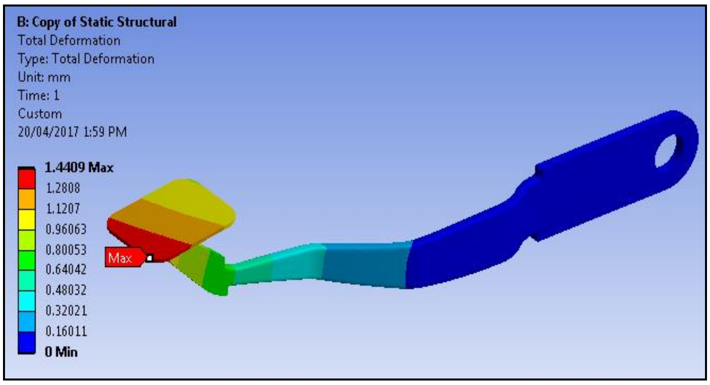

Fig. -13. Deformation of Optimized Model.

Von- Mises

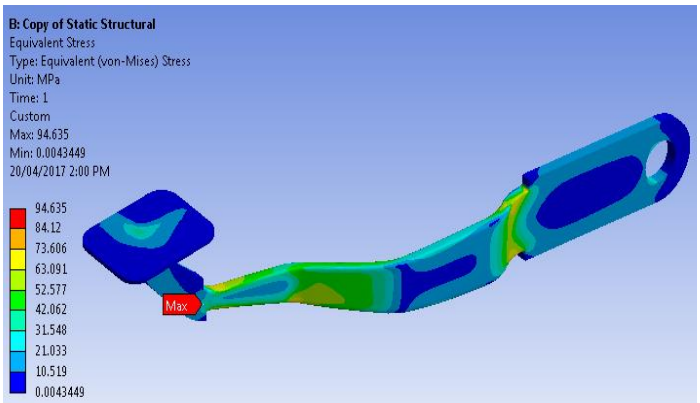

Fig. -14. Von-Mises of Optimized Model.

Maximum deformation found in the given model is 94.635 mm and that of the minimum is 0.00434 mm.

4. CONCLUSIONS

From results of finite element analysis it is observed that the maximum stress value is within the safety limit. There is a great potential to optimize, this safety limit which can be done by removing material from low stressed region thus optimizing its weight without affecting its structural behavior. The maximum displacement value is also very less. So, the material from low stressed region is can be removed without affecting its strength and is within the yield strength.

- Both design produces stress within yield limit of material i.e 200 MPa

- Total mass reduction of 16.45 % has been achieved due to optimization of part.

REFERENCES

[1] Dr.K.K.Dhande, Prof .N.I.Jamadar, Sandeep Ghatge, *"Conceptual Design and Analysis of Brake Pedal Profile"*, International Journal of Innovative Research in Science, Engineering and Technology, Volume 3, Issue 11, November 2014.

[2] Dr Hossein Saidpour, *"Lightweight High Performance Materials for Car Body Structures"*, NTI Technology Conference, CEME, Ford Motor Company, 16 June 2004.

[3] Bhagyashri Kurkure1, Mr. D. B. Sadaphale, *"Optimization of Brake Pedal"*, International Journal of Mechanical and Industrial Technology ISSN 2348-7593 (Online), Vol. 3, Issue 1, Month: April 2015 - September 2015.

[4] Pankaj Chhabra, *"Concurrent Design and Prototyping of Composite Accelerator Pedal"*, International Journal of Advancements in Technology, ISSN 0976-4860, Vol. 2 No. 4 October 2011.

[5] Mohd Nizam Sudin, Musthafah Mohd Tahir, Faiz Redza Ramli, Shamsul Anuar Shamsuddin, *"Topology Optimization in Automotive Brake Pedal Redesign"*, International Journal of Engineering and Technology (IJET), ISSN : 0975-4024, Volume 6, No 1 Feb-Mar 2014.

[6] Mohd Sapuan Salit, Mohd Syed Ali Molla and Md Liakot Ali, *"CONCEPTUAL DESIGN OF AN AUTOMOTIVE COMPOSITE BRAKE PEDAL"*, Suranaree J. Sci. Technol. 12(3):173-177, Mar 28, 2004; Revised: Aug 1, 2005; Accepted: Aug 3, 2005.

[7] K K Dhande, N I Jamadar and Sandeep Ghatge, *"DESIGN AND ANALYSIS OF COMPOSITE BRAKE PEDAL: AN ERGONOMIC APPROACH"*, International Journal of Mechanical Engineering and Robotic Research, Volume 3, No. 3, July 2014, ISSN 2278 – 0149.