Design & Analysis of Accelerator Pedal for Four Wheeler Commercial Vehicle

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Abstract— In this Project we are going to study the current design & position of Accelerated pedal in one of the four wheeler commercial vehicle as per material, design, & ergonomics consideration. Here we will optimize the material & Design of the APM. In this Project we study the current design of the accelerating pedal according to material, design & ergonomic consideration and then propose the new composite design of the accelerated model. The motive of this project becomes to bring the overall Safety & comfort of the driver by making suitable design modification in the design of pedal. After successfully design the Accelerated Pedal, we will validate it on the vehicle itself. For this Piaggio Vehicles Outdoor Testing Department will help us in evaluating the performance of our design by subjective as well as objective testing.

Key words: Accelerator Pedal, Four Wheeler Vehicle

I. INTRODUCTION

Four whalers commercial vehicle or small commercial vehicle are normally used for transporting of materials short intra city deliveries, working on narrow village roads, long highway hauls carrying small bulky loads or even heavy cargo. This category can be characterized as less than 1000cc engine and 3.5 tons of weight. Design engineers have great challenge to provide better design which can work for small commercial vehicle as there is less space available for design and also the requirement of the components as per big commercial vehicles. Thus, it is very much necessary for the designers to provide not only a better design of parts having less space but also of minimum weight and cost, keeping design safe under all loading conditions.

A. *Foot controls*

Foot controls is the general term given to the 3 most important controls of the vehicle which are operated by the driver's foot. These are Accelerator control pedal, Brake control pedal and clutch control pedal.

Fig. 1.1: Foot control of a vehicle

The function of accelerator pedal is to open the throttle the fuel injection pump as per the drivers input through the pedal travel.

Clutch and brake pedal both works on the same principle of Pascal law and principle of leverage. When the pedal is pressed the piston of the master cylinder moves and pressurized the fluid as per Pascal's law. This pressurized fluid then goes into the slave cylinder (in case of clutch control) or wheel cylinder (in case of brake cylinder) and actuate the push rod or brake caliper.

B. *Accelerated Pedal System*

Accelerated-pedal System registers the drive's wishes after a change in engine torque and sends a corresponding signal to the engine control unit for further processing.

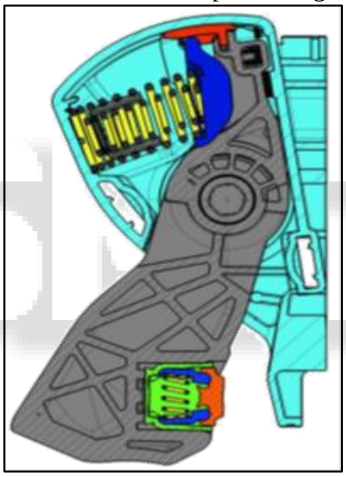

Fig. 1.2: Cross-section of accelerated pedal System

C. *Components of Accelerated Pedal System*

– Below are the components of the accelerated pedal system.

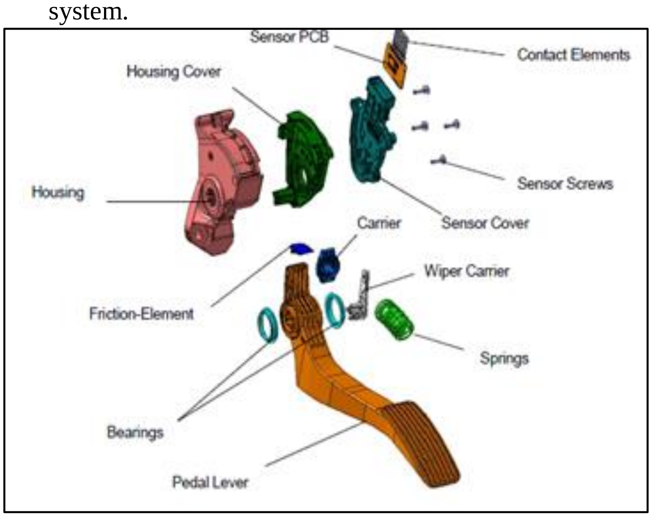

Fig. 1.3: Components of APS

D. Problem Statement

In present Accelerated pedal, we are using metal pedal lever which is taking more weight, area & force applied on it which leads to failure and also it breaks during the application in less time. Here we are going to change it by Plastic pedal lever which will optimize the current design & also improve safety & operating comfort of the drive.

E. Objectives

The main objectives of the proposed research work are as follows:

- Study the existing Pedal lever of the accelerated system
- Design & analysis of the pedal lever for Accelerated system

II. LITERATURE REVIEW

This paper investigates the interaction between human sensory and motor properties at the foot during the operation of an automobile pedal, as an example of human-machine systems, and demonstrates the close relationship between the perceptual properties of force resistance at the foot and the loads for foot joints much depending on the pedal layout. Finally, based on biomechanical and perceptual analyses, a human-inspired design method of pedal dynamic properties is discussed. [1]

Concurrent Engineering (CE) approach has been used to determine the most optimum decision on design concept and material of the composite accelerator pedal at conceptual design stage. Comprehensive studies are carried out to prepare the design specifications of composite accelerator pedal. Various design concepts are generated using the Morphological approach. In particular at design stage, CATIA is used to generate various design concepts followed by analysis on ANSYS. Simultaneously, material selection is done on the basis of past research & specifications. Rating/weighting matrix evaluation method is used to select the best concept for the profile of pedal arm on the basis of mass, volume, stress and deformation results achieved on ANSYS. The composite accelerator pedal is optimized and analyzed for safety parameters and finally prototyped using Selective Laser Sintering.[2]

The design and development of an ergonomic data measurement system for driver–pedals interaction. The work focuses in particular on the actuation of the acceleration and brake pedals, and aims to support the development of a deeper understanding of the factors influencing the driving comfort associated with the right leg. The ergonomic data measurement system integrates five subsystems: an electro goniometry system and a pressure-pads system to monitor driver's positioning and movements, an electromyography system to observe the muscular activity of the lower leg, the vehicle on-board diagnostic system, a GPS system and an audio-visual system for providing environment and driving situation information. A validation exercise involving a series of test drive events confirmed the system capability to record meaningful objective comfort data which can differentiate between driving postures and styles. [3]

The integration of human impedance properties into a human-machine system composed of the variable impedance-controlled robot. Focusing a human-machine interface system manipulated by the lower extremities, human leg impedance properties during maintained leg posture were investigated according to the leg posture and foot force. Next a set of basic tests was carried out to evaluate the designed control structure with the database of the measured human impedance by using the developed experimental device. [4]

Managing product development cycle time has been one of the critical competencies needed for meeting the competition. Using a series of approaches the product development process has been made concurrent. Overlapping phases of development involves intense interactions among team members, cross-functional teaming, use of information technology enablers and frequent reviews among team members, customers and suppliers. Taking up product development along with manufacturing process specifications improves manufacturability as well as assimilability. Many firms, including automobile firms and aerospace manufacturers have been able to reduce the product development cycle time along with the reduction in failure rates and rework. Enhancing horizontal interactions and early specification of deliverables facilitates coordination, paving the way for reducing time to market and product costs.[5]

III. METHODOLOGY ADOPTED

As per objective is to design the new pedal made of composite material, hence we have first studied the present design and then the necessary modification proposed. Thus methodology adopted in this study can be divided into two phases.

1) Material Selection
2) Design Analysis

A. Material selection

In Phase one, for material selection, we study the present design of foot pedal of accelerated model. In present Design, There is foot pedal is in Sheet metal. The components of present Foot pedal is as below

1) CEW/CDW (Cold Drawn) Tube
2) CR Sheet
3) Rubber

In proposed Design, the foot pedal is to be made by Glass filled Polyamide by Injection molding machine.

Percentage of Glass Filling	25 % by volume
Tensile Modulus	5800 Mpa
Tensile strength	37.5 MPa
Possion's ratio	0.31
Density	840 kg/m3
Moisture Absorption	0.35%
Creep resistance	Suitable
Corrosion resistance	Suitable
Chemical Resistance	Alkalis, Hydrocarbons , Fuels and Solvents

Table 1: Material Properties of Glass Filled Polyamide

B. Design Analysis

In phase two, Design Analysis We studied the present design of foot pedal of accelerated model & proposed a new design and compares the Stress & displacement level with the help of Ansys software for the same.

We did the CAE analysis for the existing & proposed Accelerator pedal by the using ANSYS software in which we done the Stress analysis & Dispalcement analysis.

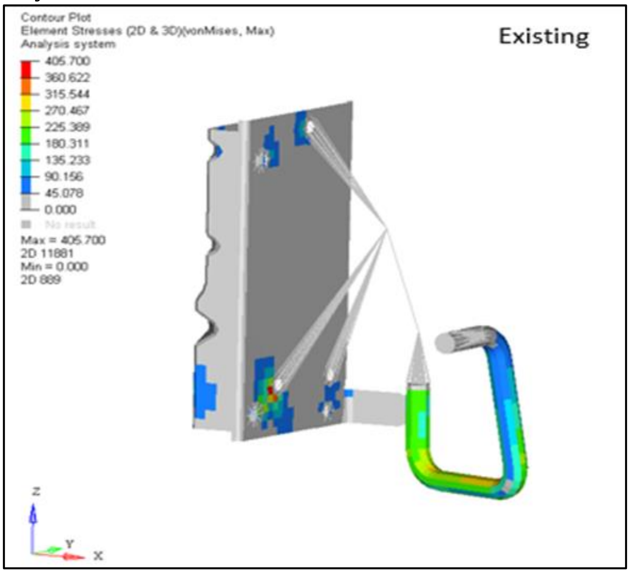

Fig. 1.4: Stress analysis of existing Accelerated pedal

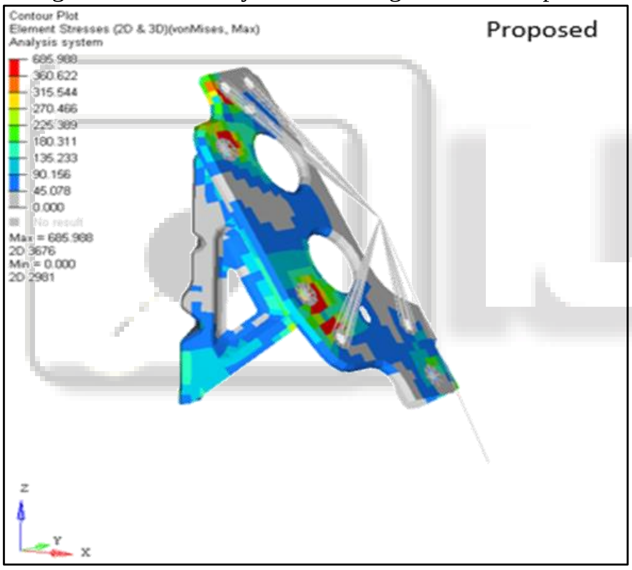

Fig. 1.5: Stress analysis of existing proposed pedal

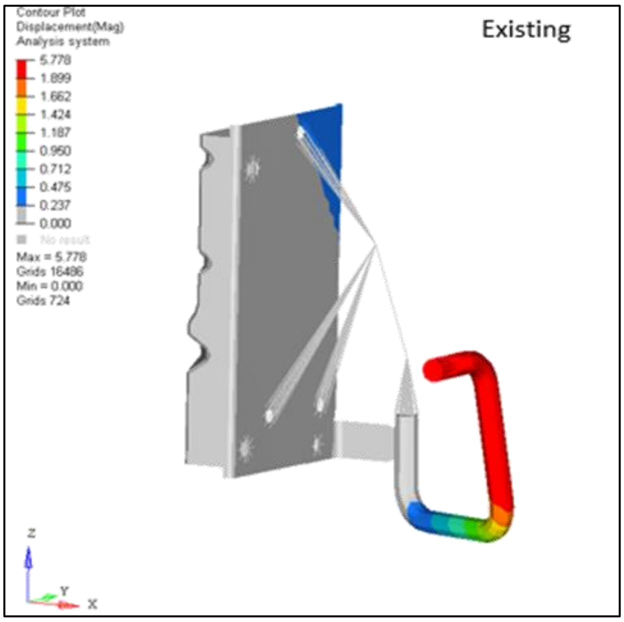

Fig. 1.6: Displacement analysis of existing Accelerated pedal

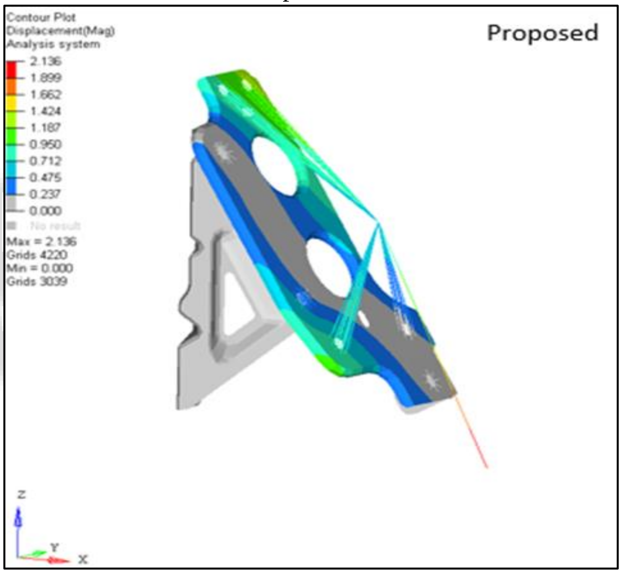

Fig. 1.7: Displacement analysis of existing Accelerated pedal

The output what we had received as per stress & displcament analysis is as below.

In Exisiting pedal, Maximum stress is 405 Mpa & for proposed the Maximum stress is 685 Mpa. So there is 41% decrease in Stress as compared with existing pedal, proposed arrangement shows decrease in stress values. In this analysis the stress contour is plotted with the threshold value of minimum stress component.

For displcment analysis the maximum dispalcment on Exiting pedal is 5.8 & on propsed pedal is 2.2 mm.

Below are the calculated FEA Result & Analytical result for Exiting & proposed Accelearated pedal.

For calculation of Stress & Maximum deflection on the model we have used the basic formules of Stress & strain which is in very detail so i am putting the gernal formules of Stress, Shear Stress & Strain.

Normal stress,

$\sigma = F_n/A$

Where σ = normal stress ((Pa), N/m^2)
Fn = normal component force (N)
A = area (m2)
Shear (Deformation),
∈=dl/l_0
= σ/E
dl = change of length (m)
l0 = intial length
ϵ = strain – unitless
E= Young's modulus

On the basis of these basic formulas we have done the analytical analysis.

Therefore considering Existing pedal as a benchmark, proposed pedal is suitable to replace the same.

IV. Conclusion

We study the Existing metallic accelerator pedal on the parameter of material section, Design analysis & Ergonomics consideration and finds that the Existing Metallic Pedal is suitable to replace with Proposed Pedal which is to be manufactured by composite material. At last as per the Subjective analysis of the pedal the Validation is going on & we are hopeful that it will be succeed.

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