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WEIGHT OPTIMIZATION OF BRAKE DRUM IN SMALL COMMERCIAL VEHICLE BY USING FEA

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ABSTRACT

This paper describes method for brake drum weight optimization in small commercial vehicle The braking system is one of the key parts of automobile chassis system, and its performance directly affects the safety of vehicle. The important component of the braking system is the brake drum. With the high speed and heavy load of the automobile, higher requirements are put forward for the performance.

Brake drum weight optimization by FEA includes, Stress and natural frequency of brake drums CAD model has being evaluated by ANSYS software. Number iteration has conducted to find optimal brake drum design. Brake drum deflection (displacement) and durability life has compared with benchmark vehicle. Visual validation of brake drum weight optimization has save a lot and give guideline for brake drum weight reduction in other variants

Keywords: Analysis, Brake drum, FEA, Weight, Optimization.

1. INTRODUCTION

Planned to reduce the small commercial vehicle brake drum weight without comparing deflection (Displacement) by finding optimum wall thickness and base flange thickness. Brake drum Nature frequency also being evaluation to prediction durability life with and without weight reduction.

Creo parametric software is being used for modelling and ANSYS software has be used for visual validation. Visual validation will include Drum deflection (Displacement) and Durability life evaluation of the brake drum. Different sets of brake drum CAD model has being prepared with different flange and wall thickness for visual validation.

Braking torque and forces acting brake drum during braking application as per calculated based on vehicle load as per market condition and Benchmark vehicle data.

Physical validation has planned on Brake Dyno meter and vehicle as well. Where, we will try to establish correlation between Drum brakes visual and physical validation. Established correlation will be used as guideline for brake drum weight reduction in Heavy vehicles and Cars.

Brake drum physical validation will cost around 30 Lakhs per vehicle and it will further increases with number of iterations. Cost of physical validation will be eliminated OR reduced with help of Established correlation in this project.

We have proposed to reduce the brake drum weight by one kilogram per drum and two kilogram per vehicle. Proposed Brake drum weight reduction will save cost of Rs 300 per vehicle and annual cost saving to the organisation of one Crore.

2. METHODOLOGY

Below is the methodology by which we are performing dissertation work in order to optimize small commercial vehicle brake drum. Methodology used in the analysis and design of the brake drum.

Research Paper and study of past work done.

For This Project We were focusing on finding research papers for prediction of research gap and the idea to find new concept with mind-set of project development regarding design and manufacturing. The research papers were gave us the domains and works which were already completed and provided lots of information regarding design and analysis of brake drum for weight optimization by using various material.

Collection of Data to design brake drum.

From research papers and resources we were collect the data for actual design to overcome the bugs and challenges. And we were come to know about various section used for brake drum. The all collected data was used for getting proper path for development.

Benchmark and production brake drum dimensional and metallurgical details will be collected by Reverse engineering for brake drum purchased from market.

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Creo design for model building

For our project the next step to design of brake drum with approximate calculations of different forces acting on brake drum. For Creo modeling, we have taken the help of some of the research papers and Reverse engineering data .We have developed the 3D model of our project that is brake drum design in Creo 7 software.

3D CAD model will be replica of actual brake drums. Profile and weight will be meet 90% to actual brake drum

Preparation of test set up for testing

In this step we will do the testing of brake drum with different level of torque acting on it, this will give us data regarding different parameter which help us to improve the design of brake drum and for selection of design.

Physical testing of brake drum has conducted on brake dyno meter. Brake dyno meter is instruct use to measure force generated by brake assembly and test brake complement like brake assemblies and brake drum strength.

Flowchart of Methodology

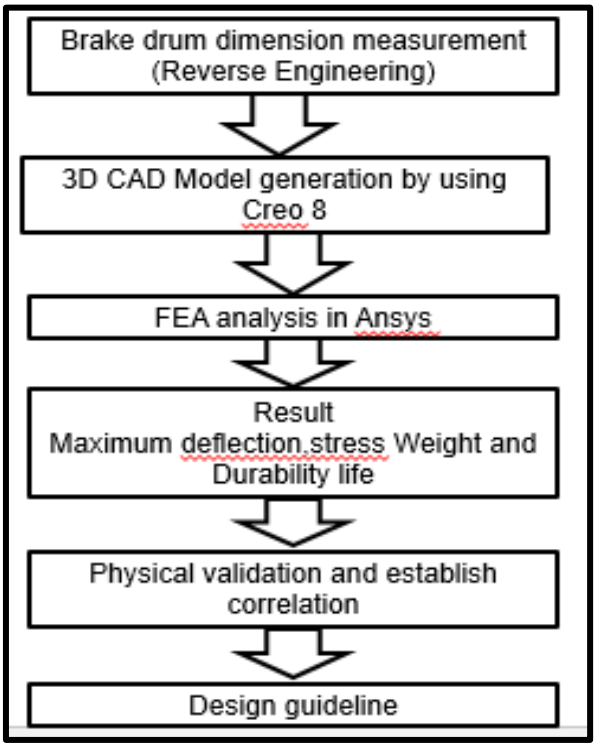

Figure 1: Flowchart of Methodology

3. RESULTS AND DISCUSSION

FEA results for production vehicle brake drum and Proposals for load case are compiled below

Table-1: Result comparison

Parameters	Production vehicle	Proposal 1	Proposal 2
Weight (Kg)	8.4	7.4	7.6
Brake size	Ø254	Ø254	Ø254
Torque (Kgm)	104	104	104
Material	FG 260	FG 260	FG 260
Yield strength (Mpa)	169	169	169
Ultimate strength (Mpa)	260	260	260
Max displacement (mm)	0.19	0.29	0.23
Max stress (Mpa)	30	38(55)	55
1 st node Natural frequency (Hz)	366	348	336

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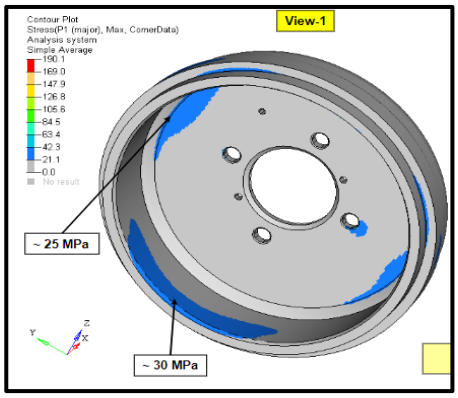
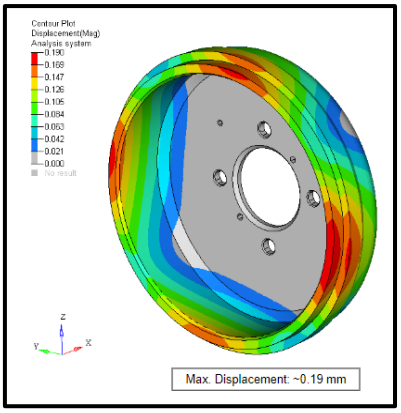
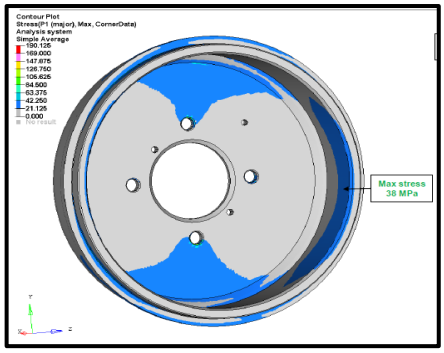
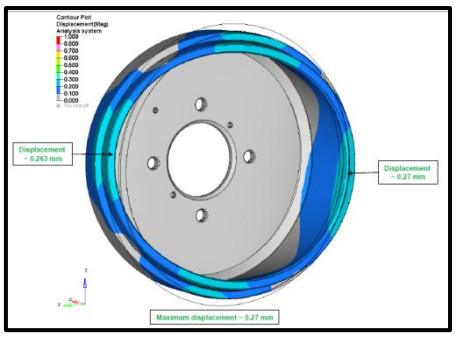
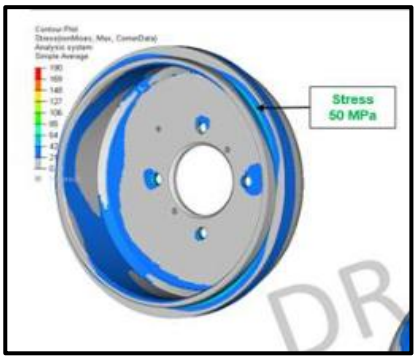
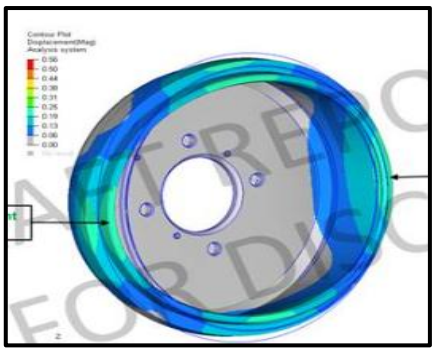
Table 3: Stress Plot for Production brake drum

Sr. No.	Parameter		Stress	Deflection
1	Production brake drum	Snap		
		Values	30 Mpa	0.19 mm
2	Proposal 1	Snap		
		Values	38(55) Mpa	0.29mm
2	Proposal 2	Snap		
		Values	55 Mpa	0.23mm

As per above result, Brake drum deflection in production brake drum is 0.19 mm and stress values is around 30 Mpa against Material FG 260 yield strength i.e. 169 Mpa.

So, Good margin is available for design optimization in terms of stress but Proposal 1 is having 50 % higher deflection which may leads to lower brake efficiency and further design iteration has required.

In proposal 2, we have increased brake drum collar width for reduction deflection and it is verified in FEA. Brake drum deflection were reduce from 0.29 mm to 0.23 mm which is 20 % more than base design and Good to go for physical validation.

While doing brake drum weight optimization, Vehicle safety and brake performance should be remaining in line with production vehicle otherwise proposals are not practical acceptable as it compromise customer safety.

4. CONCLUSION

It is observed from the result, maximum deflection are developed in the various type proposals due to combination of brake pressure and torque is having good correlation between FEA and physical testing.

A comparison of maximum deflection values and stress is done for all proposals. By comparing Ansys result and physical testing results and weight to strength ratio, Proposal 2 is better than that of Proposal 1.

On the basis of modal analysis and the design of experimental, the main design parameters of brake drum are optimized.

Thus, the following conclusions can be obtained.

Based on the three-dimensional solid model created by Creo parameterics and imported into ANSYS software, the finite element model is obtained, which has high modelling efficiency and saves a lot of modelling time.

On the basis of modal analysis, three important dimensions of brake drum are defined as input parameters, and the weight, the first, second and third natural frequencies are defined as the output parameters.

The response surface model between the input and output parameters is established according to the design of experiment. The input parameters are optimized by design model with different cross section.

The solution is chosen as the optimal solution based on the production technique. The weight of brake drum optimization without changing displacement and natural frequency.

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