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Study & Analysis of the Dynamic behaviour for Supercharger by using Finite element Method

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ABSTRACT: Supercharger is a device that increases the pressure or density of air a supplied to an internal combustion chamber of an engine. The intake cycle level of oxygen to the engine is more to burn more fuel resulting to perform more work i.e power output increases. Supercharger is one of the large volume production components with a complex geometry in the Internal Combustion (I.C) Engine. It has to perform tremendous amount of work in order to give better work output. In this study case we have performed the Modal and harmonic Analysis on a super charger to identify the critical mode shapes and the critical stress locations. In this study the modelling of supercharger is carried out in CATIA V5r21 Cad software and Finite element Analysis on supercharger Using Ansys. Meshing was done in Hypermesh to get the fine mesh. In this study Strength of material, vonmises stresses, and various engineering processes are the main consideration.

KEYWORDS: Supercharger, FEA analysis, CATIA, ANSYS, HYPERMESH.

I. INTRODUCTION

The power that transmitted to the supercharger by means of gear, shaft, belt which is connected to the engine crankshaft. When the turbine produces the power by exhaust gas is called as Turbo Super charger. most of the cases the Dynamic compressors which has heavy loading properties rely on accelerating air at high speed intake which result in exchanging the that the velocity for pressure by diffusing or reducing it down. Supercharger is component that can artificially increase the density of air by compressing.

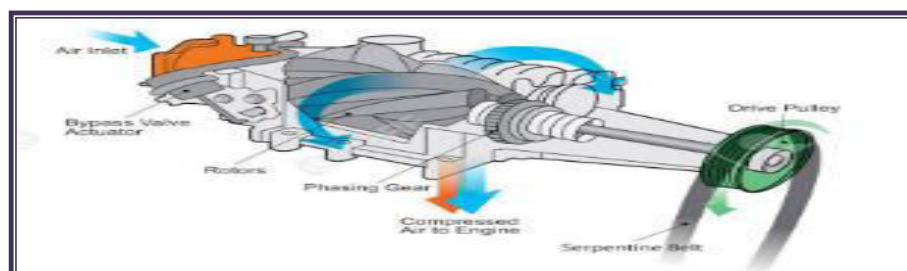


Fig 1 shows the working procedure and terminology

The above figure shows the working procedure inside the supercharger it has been clearly shown that air inlet to the supercharger chamber which is regulated by the Bypass valve actuator and falls on the rotors. The phasing gears are in contact with rotor. The phasing gear attached to the shaft and the power output is driven by the drive pulley.

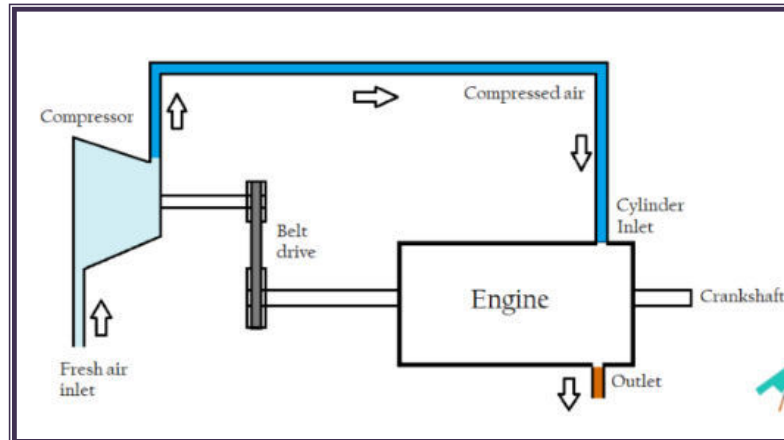


Fig 2.Schematic diagram of Air flow inside the engine

From the above schematic diagram It has been clearly shown that the fresh air is initially compressed to increase the pressure level and then it goes to the engine cylinder component which is carburettor here the air and fuel mixed and to the combustion chamber. The supercharger which receives the pressurised air from the compressor chamber. The main work of super charger is to push harder the pressurised air to produce the height net work done.

Paper is organized as follows. Section II describes related info about Supercharger, section III lists out various materials and manufacturing processes for Supercharger whereas section IV presents the Modeling and Analysis and section V presents Loading of Boundary Conditions , Section VI Presents the Experimental results and VII Presents the conclusion.

II. RELATED INFORMATION

The main advantage of supercharger is to increase the net work done reflects in transmission of high power output with respect to fuel consumption accordingly. Depending upon the working principles and method of air, gas transfer the Supercharger are broadly classified mainly into two types

- 1). Positive displacement pumps
- 2) Dynamic compressors

Positive displacement pumps:

Positive displacement pumps mostly deliver fixed volume of air per revolution at all speeds. This is almost constant at all the driven speeds for a given pressure with a low leakage capacity.

The major types of Positive displacement pumps are as follows

Roots, Sliding vane, Lysholm twin-screw and Scroll type super charger which is also called as G-lader

Dynamic compressors :

These compressors accelerate air at higher speeds intent exchanges the high velocity to the pressure.

The major types of Dynamic compressors are as follows

Centrifugal and multi-stage axial flow

And further the superchargers are classified according to the type of drives as follows

- Gear drive
- Belt (v-Belt, Flat belt ,Synchronous belt)
- Direct drive

Chain Drive etc

III. MATERIALS AND MANUFACTURING PROCESSES

The material selection must tend to necessary properties for the imposed implication. Few Requirements that need to be satisfied are weight ,rigid, Ability to withstand from various environmental attacks, Service life and reliability. The material should withstand various mechanical properties like Bending, Torsional and buckling loads, Compressive shear, Elastic limit, fatigue and stress conditions. Secondly the material should very cost effective and easily available. For this study we have considered Aluminium metal which is comparatively light weight and which is good



conductivity of heat and long life with good fatigue life, the model analysis is carried on model with aluminium. Physical properties of the Aluminium are stated as follows

Material type	Poissons Ratio	Youngs Modulud	Density	Bulk Modulus	Shear modulus
Aluminium	0.33	7.1E+10 pa	2770 kg ⁻³	6.9608E+10 pa	2.669E+10 pa

Table1.Shows the Physical properties of aluminium

IV. MODELING AND ANALYSIS

This study is to identify the best design based on modal and harmonica analysis stress and life factor of three models which are designed in cad software are used. The Early computer aided drawing system uses geometry construction and editing techniques to create on the base model. This create the models of wire frame and surfaces that could be edited by a geometric editing, Later on periodic experiments parametric modeling systems were introduced, which will used to build relationships between geometric entities. These techniques based on constraints and parametric expressions defined by the user used to build the base models, but sometimes user face an error from carrying out a modification due to constraints Parametric systems also relied heavily on bodies created from swept sketches, loft bodies generated in surface modeling and did not have a wide variety of construction and editing techniques.

Modeling of Design@ 1, Design@2 and Design@3 Supercharger is done using CATIA. CATIA is one of the powerful modeling software package which the most effective parametric modeling and surface feature based modeling software. Solid modeling is done in CATIA which has a rich set of features to create and modify the designs. And CATIA constitute a user friendly environment. In this paper 3-D solid Supercharger is considered for the analysis.

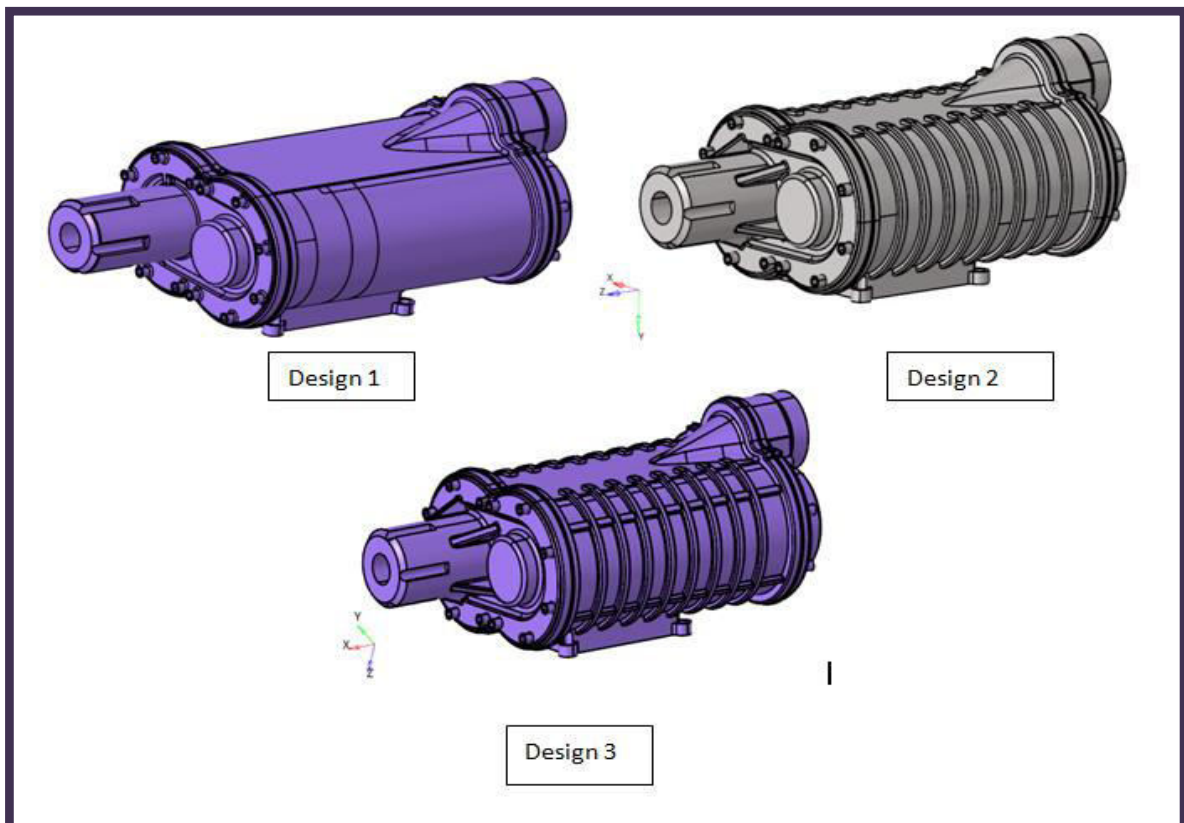


Fig 3. Projects Design@1, Design@2 and Design@3

The procedure in CATIA in modeling the solid bar as follows; In order to generate the 2D Sketch which is the profile of the web; profile is projected using “project 3D element” option and need to convert the projected 3d element to the construction element and then tr “rotate” option is used to rotate the projected profile from the centre of axis and fillet according to the finish in Catia Software and convert this cat part to IGES(Initial Graphic Exchange Specification) format which need to upload in Hypermesh which can be easily uploaded in Hypermesh software without any internal errors. The CATIA part file can also be saved as STEP file.

The method of FEA depends on decomposition or diving the component into a finite number of sub-domains (elements) for which the systematic approximate solution is constructed by applying the variational or weighted residual methods. This is one of the general method carried out in each part on simulation bases.

In terms reduces the problem to that of a finite number of unknowns by dividing the domain into elements and by expressing the unknown field variable in terms of the assumed approximating functions within each element. These functions are defined in terms of the values of the field variables at specific points, referred to as nodes. The finite element method is a kind of a numerical procedure that can be used to obtain solutions to a large class of engineering problems involving stress analysis, electro-magnetism, heat transfer, and fluid flow.



Fig 4.shows the mesh presentation

Meshing has been carried out with hyper mesh tool with second order tetra element. Minimum element Size 1mm used to capture the fillets in the model. And maximum element size Up to 5mm .

Analysis systems which commonly called “ANSYS” it is a finite element analysis software package it is a numerical method of deconstructing a complex system into very small pieces (of user Defined design size) called elements. The software internally creates the equation according to the behaviour of the elements after deconstruction. Workbench environment in ANSYS is an intuitive up-front finite element analysis tool that is used in conjunction with CAD systems and/or Design Model. it was mainly chosen software to solve the complex problems in structural, thermal, and electromagnetic analyses. The ANSYS and the workbench mainly focuses on the existing geometry, element disintegrating, with the applied loads as per the requirement solving the problems and finally viewing the results.

V. LOADING AND BOUNDARY CONDITION

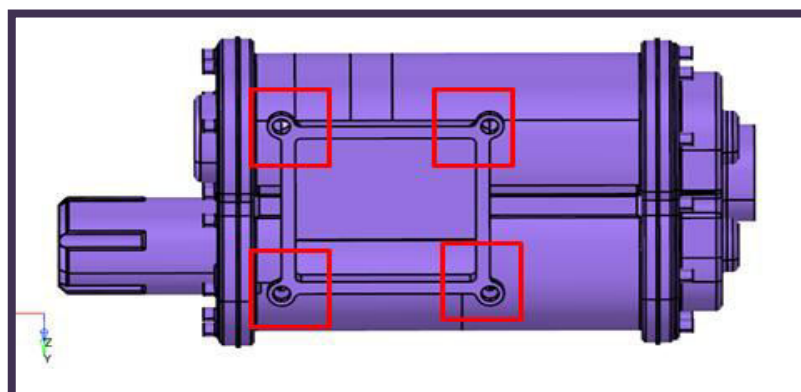


Fig 5.Show the Applied boundary conditions



In engine the supercharger experiences lot of stress and variable pressure conditions of the air. From the above figure 3 it has been clearly stated that the highlighted Part has been constrained to apply the boundary conditions. The boundary conditions are given with respect to the newly created polar co-ordinate system. These Boundary Condition option which constrains all degrees of freedom except in radial direction (theta constraint) Using ANSYS. The degree of freedom is arrested Since the rotational motion of tea solid model is constrained.

this study, Analysis to observe the dynamic response of the supercharger in first step we performed the modal analysis up to first 10 natural frequencies followed by the frequency response analysis this is because the supercharger experiences the cyclic loads

Loading Procedure

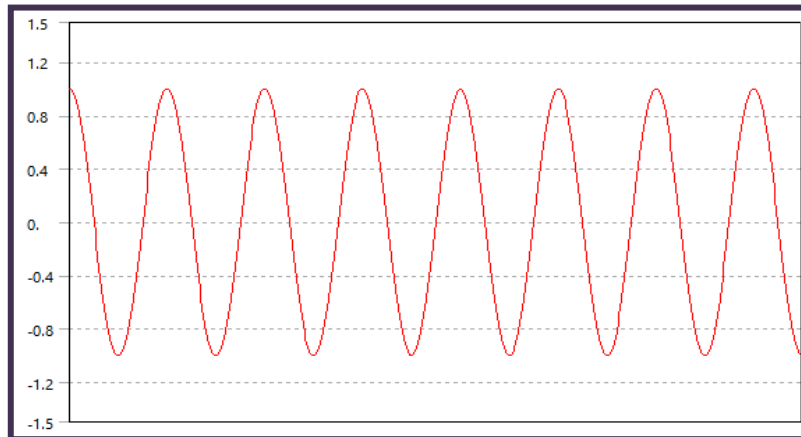


Fig 6.Constant amplitude of fully reversed loading given to the Super charger.

VI. RESULTS AND DISCUSSION

By comparing the natural frequencies of first mode shape of three designs it was found that the Frequency ranges at different mode on Design@1, Design@2 and Design@3 is shown

For Design@1

Mode	Frequency [Hz]
1.	111.4
2.	126.97
3.	231.63
4.	266.52
5.	369.47
6.	410.53
7.	494.09
8.	527.85
9.	599.54
10.	689.18

Mode	Frequency [Hz]	Mode	Frequency [Hz]
1.	915.13	1.	921.26
2.	1024.6	2.	1027.6
3.	1963.6	3.	1971.1
4.	2202.3	4.	2209.6
5.	3278.8	5.	3299.2
6.	3573.	6.	3607.1
7.	3829.6	7.	3860.7
8.	4249.7	8.	4284.4
9.	5001.5	9.	5041.4
10.	5381.4	10.	5500.5

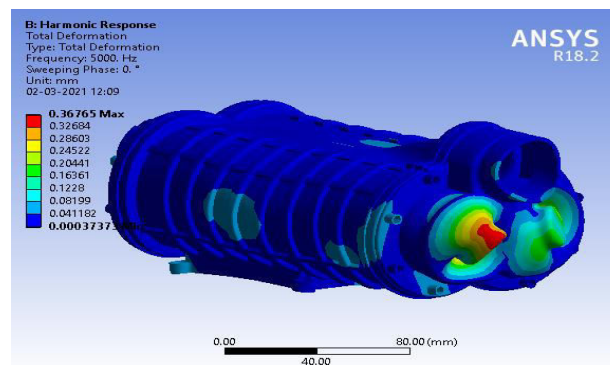
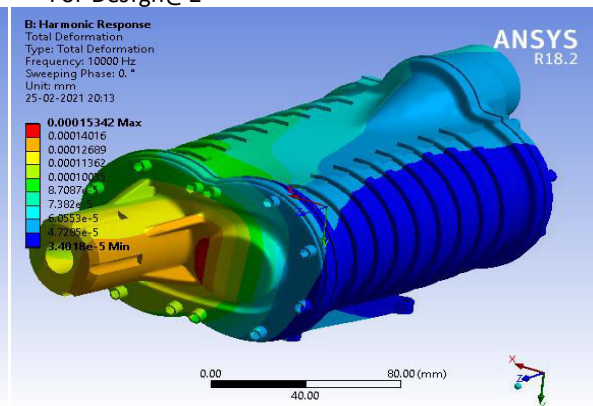
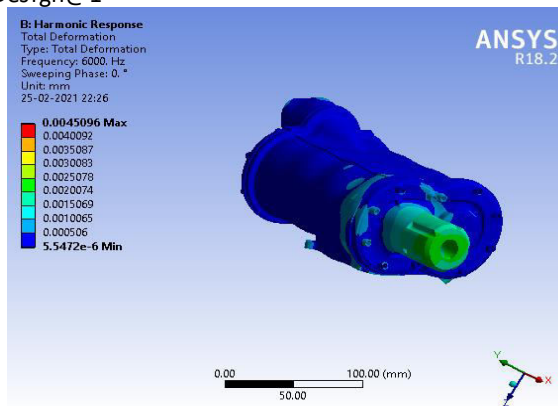
For Design@2

Total Deformation Due to cyclic loads

For Design@1

For Design@3

For Design@2



For Design@3

VII. CONCLUSION

From the above obtained experimental results The maximum deformation appears at the back side of the supercharger surface for design@3. The maximum stress appears at the at the back side of the supercharger surface for design@3. The value of von-misses stresses that comes out from the analysis is far less than material yield stress so our all three design is safe. While comparing the all three designs, design 2 is more feasible design why because design 2



and design 3 got the first natural frequencies nearby range. When comparing with weights design@2 has best weight to strength ratio.

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