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Design Optimization of High Pressure Fuel Pump by Study State Dynamic Analysis by Using Finite Element Method

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ABSTRACT: A fuel pump is a major component in motor vehicles which transfers liquid from the fuel tank to the carburetor of the internal combustion engine. Whereas carburetor is a device that mixes air and fuel in air-fuel mixing ratio for the combustion chamber. Modal analysis is one of the important powerful tool to spot the dynamic characteristics of structures which produces heavy vibrations and resonating frequencies with high amplitude. The factors that influences modal parameters are-resonant frequency, mode shape and damping characteristics that experiences on the structures at various operating conditions for the improvement of strength, reliability at the planning state. During this work Design Optimization of High Pressure Fuel Pump by study state dynamic analysis by using Finite element method simulate the obtained results with the help of shape optimization improves the dynamic characteristics of the pump or an structure During this study, analysis for pre-processing Hypermesh is employed together with Abaqus solver and Hyper view software is used for post processing techniques.

KEY WORDS: FEA, Fuel injection internal gear pump, Hypermesh, Modal analysis

I. INTRODUCTION

Fuel injection Internal Gear Pump is one of its kind high precision and fuel pressuring type positive displacement internal gear pump which prepared by high graded material of cast-iron. The closed tolerances were carried out by nitrated gear shafted rotor which gives better performance to relinquish long life. Fuel injection gear pump is a flange mounted which produces a maximum amount of vacuum determined by the cavity between the gear teeth. within the pressure range limits and capacities these pumps modified profile teeth cutting to produce accurate capacity. These fuel pumps are capable to run liquid up to 500 CST viscosity and up to a temperature of 200°C. Pumps has a mechanical sealing finish in order to prevent from leakage. The suction and delivery connections which are available in 3/8", 1/2", 3/4" and 1" size. And with a capacity Range of 60 LPH to 6000 LPH with operating pressure up to 35 kg/cm², the duty maximum recommended pressure for a continuous duty pumps may vary upto 30 kg/cm², can be used at a speed of 2800 Rpm. These pumps can run anti clock and clock vice according to the requirement which show the double performance levels compared to the normal.

II. MODELING AND ANALYSIS

Basically CAD Systems are used in order to construct the geometry and editing purposes for the creation of new model. The geometry like wireframe and surface can be easily modified and do editing with these techniques. These systems don't have capability to understand the relationship between the geometry. For this parametric modelling techniques were introduced later, which build or create relationship between geometric entities these systems mostly depend on bodies created from swept sketches. Modeling of Pressure Fuel Pump is carried out in CATIA V5R21

CATIA is a software package which is very efficient and user friendly that uses for solid modeling, which has the rich set of features to create or to design the model. In this report 3-D solid Fuel pump is considered for the analysis. Procedure of preparing solid model of fuel pump in CATIA is as follows-Initially the 2D sketch which is the profile of the web is creating by the "project 3D elements" and turn this projected sketch into a geometrical element, and use rotate option to the sketch to create the solid. After the creation of solid body in CATIA, convert the file into IGES file

format for meshing purpose. IGES means Initial Graphic Exchange Specification; this IGES file can be easily imported to any software without obstacles. And CAT part Can also be saved as a step format.

In this study report, After creation of solid body we have ran the finite element analysis on the design. Based on the results that obtained the changes are made on the model accordingly

Two Design Model have been created to identify the best possible design in terms of Dynamic Characteristics.

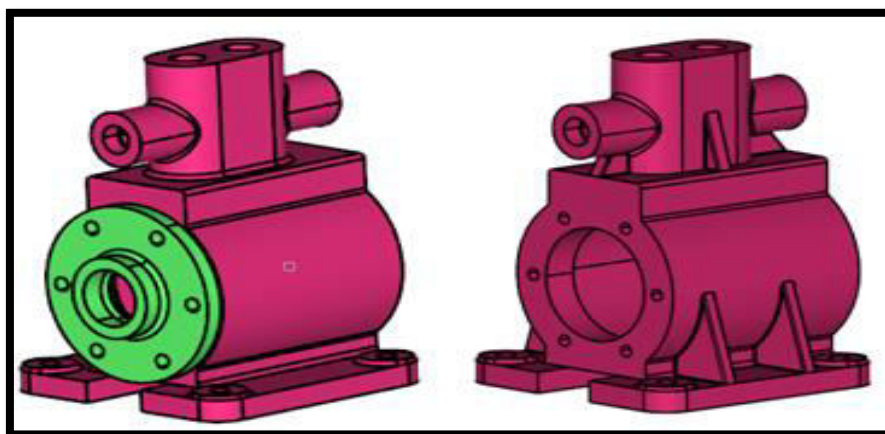


Figure 1: CAD models of FIG pumps

i. MESHING

The process of converting infinite number of degrees of freedom into finite number of degrees of freedom for analysis is called as MESHING. Meshing of the model is carried out by the available software i.e. Hypermesh. It is a tool which constitute the well effectiveness in meshing which deals with both solid and shell model

Hypermesh as a variable option that can mesh across the multiple surface boundaries. Model editing features include combining, detaching, and translating of elements. Hypermesh can check meshes for duplicate elements, facet warpage, aspect ratio, skewness, and that can be display and modify element normal's.

In the present study case tetra mesh is carried out on the model. Initially, a collector is created named as "shell" and the surfaces of the component are meshed using triangular elements. Then, another collector is created and the "Tetramesh" option in which meshing is carried out on the entire body. The element used in this work is the first order tetrahedral element. HYPERMESH is a very effective package to maintain various mesh qualities like warpage angle, jacobian, minimum and maximum angle, minimum and maximum length.

Materials used for the analysis are listed below table:

Components	Material	Young's Modulus (MPa)	Poisson's Ratio	Density (tonnes/mm ³)
Housing	Steel BSK46	2.1E5 MPa	0.3	7.8E-9
Gear	ANESIS15	2.1E5 MPa	0.3	7.8E-9
Cam shaft	A3003-O	7.2E4 MPa	0.28	2.8E-9
Bearings	Stainless Steel 440C	200E3 MPa	0.3	7.8E-9

Table 1: Material properties

ii. BOUNDARY AND LOADING CONDITIONS

Generally Fuel pumps are fixed to engines with tight bolted connections. Instead of modeling the bolts we are used the Coup kin elements. Coup kin elements are used in bolt locations and fixed in all degrees of freedom.

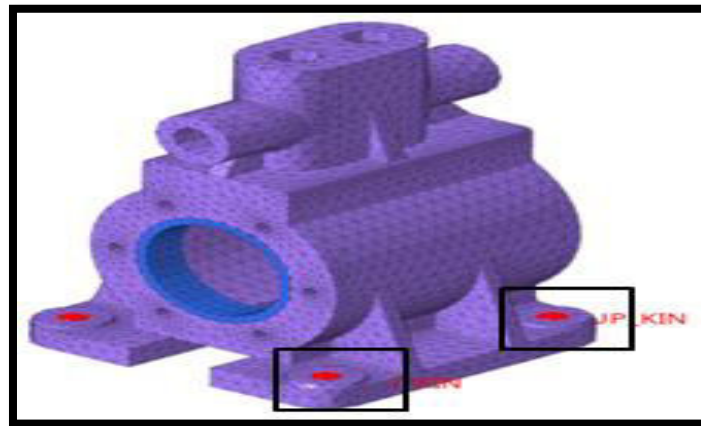


Figure 2: Mesh model and BC condition.

For loading conditions in Abaqus solver we are used the lanczo eigensolver. for lanczo solve we need to provide the maximum frequency of interest or may be the the number of eigenvalues required; Abaqus/Standard will determine a suitable block size. If we specify both the number of eigenvalues and frequency of interest, the actual number of eigenvalues Abaqus/Standard will issue a corresponding warning frequency extraction.

The minimum frequencies of interest can also be specified. Abaqus/Standard will pull out eigen values until both the requested number of eigenvalues has been extracted within the given range or all the frequencies

III. RESULTS

First 10 natural frequencies of two designs are listed below:

Mode no	Frequency(Hz) Design@ 1	Frequency(Hz) Design@ 2
1	134.66	148.1
2	136.64	168.96
3	289.09	316.3
4	317.66	327.5
5	435.05	443.29
6	495.63	501.94
7	579.24	594.22
8	592.92	606.56
9	616.57	668.54
10	842.13	897.89

Table 2: Natural frequencies of Design 1,2

Mass participation factor of Design1 listed in below table:

Mode no	Frequency (Hz)	X-Direction	Y-Direction	Z-direction
1	134.66	0.01	0.01	56.84
2	136.64	49.34	5.30	0.01
3	289.09	6.91	84.70	0.01
4	317.66	0.01	0.01	3.91
5	435.05	7.51	5.14	0.01
6	495.63	0.01	0.01	1.46
7	579.24	0.01	0.01	12.61
8	592.92	0.03	0.01	1.94
9	616.57	21.52	0.06	0.01
10	842.13	0.01	0.01	2.37

Table 3: Mass participation factor table of Design@1

From the above mentioned table, 50% of mass is acting in X- direction @ 136 Hz . 84% of mass is acting in Y- direction @ 289 Hz From the above table, 56% of mass is acting in Z- direction @ 134 Hz, Mode 1, 2 and 3 are critical modes.

Mass participation factor of Design@2 listed in below table:

Modeno	Frequency (Hz)	X-Direction	Y-Direction	Z-direction
1	148.1	50.13	3.76	0.01
2	168.96	0.01	0.01	58.15
3	316.3	6.84	82.37	0.01
4	327.5	0.00	0.02	2.82
5	443.29	6.76	10.32	0.01
6	501.94	0.01	0.01	1.43
7	594.22	0.01	0.01	14.59
8	606.56	0.02	0.01	0.59
9	668.54	24.95	0.08	0.01
10	897.89	0.01	0.01	9.84

Table 4: Mass participation factor table of Design 2

From the above mentioned table, 50% of mass is acting in X- direction @ 148 Hz ,82% of mass is acting in Y- direction @ 316 Hz From the above table, 58% of mass is acting in Z- direction @ 168 Hz .From the above table, Mode 1,2 and 3 are critical modes.

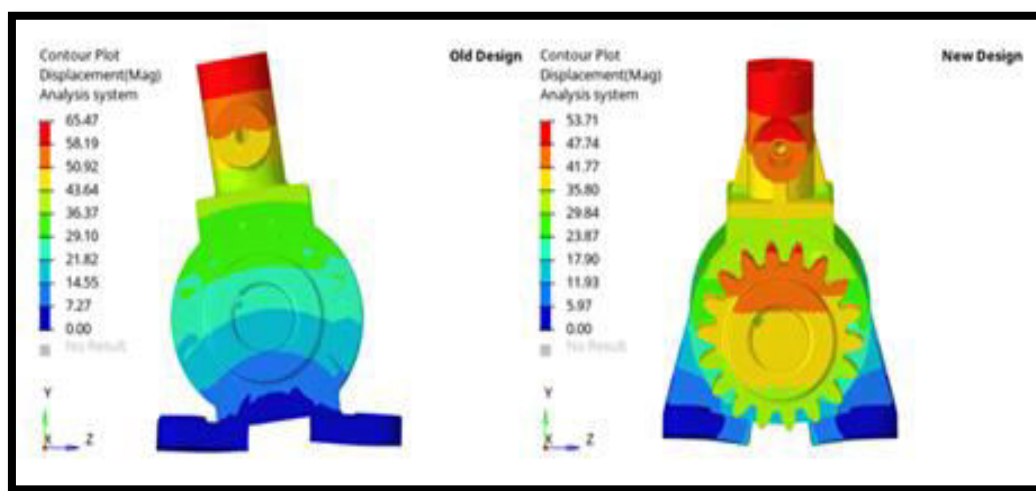


Figure 3: 1st Mode shapes of Old and new design

IV. CONCLUSION

In this work we performed Design Optimization of High Pressure Fuel Pump by study state dynamic analysis by using Finite element method. Based on the obtained results with help of shape optimization improve the dynamic characteristic of base design. With addition of ribs to the body we had increased the first natural frequency from 134Hz to 148Hz with minimal weight increment. With adding ribs, the structure got enough strength through the rib to change the mode behavior that we can clearly observe from slide no 41 to 43. And we also plot the mass participation factors to know which co ordinate directions our structure will displace more. There is a more chance of improve the structure with topography that is optimization of thickness.

REFERENCES

- [1] Kenneth A. R., (1983), "Experimental Modal Analysis, Structural Modification and FEM Analysis on Desktop Computer", Journal of Sound and Vibration.
- [2] Mark H. R., (1997), "Is It a Mode Shape, or an Operating Deflection Shape?", Sound and Vibration Magazine 30th Anniversary Issue.
- [3] Andrew S. E. and Mark H. R., (1998), "Virtual Experimental Modal Analysis", *proceedings, IMAC XVI, Mechanical Dynamics, inc. Mesa, Arizona, Vibrant Technology, Inc., Jamestown, California.*
- [4] Brian J. S. and Mark. H. R., (1999), "Experimental Modal Analysis", CSI Reliability Week, Orlando, FL, Vibrant Technology, Inc. Jamestown, California.
- [5] Hermen V.A., (2001), "Structural Dynamics Modeling using Modal Analysis Applications, Trends and Challenges", *Proceedings, IEEE Instrumentation and Measurement Technology Conference;*
- [6] Rafal P. and Artur K., (2011), "Modal Analysis of Multi-Degree of Freedom Systems with Repeated Frequencies", *Journal of Theoretical and Applied Mechanics Vol. 49, pp.343-354.*
- [7] Haifeng Lv. And Junfan, (2011), "The Experimental Modal Analysis of Motorcycle Structure", *proceedings, International Conference on Electronics andptoelectronics.*
- [8] Junfeng H, Dachang Z. Qiang C. and Qihua, (2011), "Active Vibration Control of a Flexible Beam on Experimental Modal Analysis", *Proceeding, International Conference on Advanced Computer Control, IEEE, 978-1-4244-8810-0/11.*
- [9] Ravi P. and Seshu D. R., (2008), "A Study on Dynamic Characteristics of Structural Materials Using Modal Analysis", *Asian Journal of Civil Engineering; Vol.9 No.2, pp.141-152.*



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