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NATURAL FREQUENCY EXPLORATIONOF CONNECTING ROD BY FEA MODAL ANALYSIS AND EXPERIMENTALMODAL ANALYSIS

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ABSTRACT:

The connecting rod is an intermediate element between the piston and the crankshaft. Its main function is to transmit thrust and ejection from the piston pin onto the crank pin, so as to convert the reciprocating motion of the piston into the crank rotating motion. This study includes FEA analysis and experimental modal analysis of a cane. A parametric model of the connecting rod is modelled using the CATIA V5 R19 software, and the finite element analysis is performed using the ANSYS software. The finite element method is used to determine the natural frequency of a cane and comparing the results with the FFT analyser. FFT analysis is performed by hanging the connecting rod at the toeing foot, and the experimental results are compared with FEM.

KEYWORDS: Connecting rod, FEA, FFT Analysis.

I. INTRODUCTION:

The connecting rod is the connection between the piston and the shaft with the rotating crankshaft. The small end of the connecting rod is connected to the piston by means of a fork. The large connecting end of the rod is connected to the crankshaft. The function of the connecting rod is the conversion of the reciprocating motion of the piston into the rotational motion of the crankshaft.

The combination of axial stresses and torsion acting on the rod in function. Axial stresses are produced due to the inertia of pressure in the cylinder and force due to alternative motions. While the bending stresses are caused by the centrifugal effect. To achieve maximum rigidity with minimum weight, the cross-section of the connecting rod is designed as a section I. The small end of the rod is a solid substance of the eye or a separate eye; this is the end of the piston pin. The big end rests on the crankpin and is always divided by heavy-duty motors. In some connecting rods, it drilled a hole between the two ends for lubricating oil transporting from the big end to the end of a small for lubricating the piston and the piston pin.

Pravardhan S Chenoy and Ali Fatemi [1] studied "Optimizing the connection panel to reduce weight and cost." The authors carried out optimization to reduce the weight and cost of fabricating the forged connecting rod in forged steel. The main purpose of this study was to explore the possibilities for reducing the costs and costs of forging forged steel forging. The forged steel fork is subjected to cyclic loading, including the maximum load of the gas compression load and dynamic grip at 5700 rpm, which corresponds to a 360 ° rotation angle. Structural factors considered for weight loss during the optimization process included fatigue strength, static resistance, buckling resistance, bending stiffness and axial rigidity. Additional constraints imposed during the optimization process included maintaining the hardness and the optimized rod interchangeability with the existing one. The cost was reduced by changing the existing material of the forged steel forged steel rod (C-70). Separation of the process of destruction eliminates the need to separately mold the cap and the stem connecting the body or the need to go to the saw or to process the connecting rod of the forging into two. In addition, they eliminated the heat treatment, the processing of the end surfaces of the crank and the drilling of the bushing.

South Australia Sajjadi, H.R.Esatpour, M TorabiParisi [2] studied "Comparison of microstructures and mechanical properties of aluminum alloys A356 / Al2O3 by mixing composite processes and Compo casting." Metal matrix composites (MMCs) are the most promising for obtaining improved mechanical properties such as hardness, Young's modulus, the resistance of 0.2% and tensile strength due to the presence of nano-reinforcing particles and micro-dimensions in the array. As a rule, with respect to mechanical properties, reinforcements cause more resistance and hardness, often due to some plasticity. Aluminum Matrices Composites (AMC), reinforced particles and whiskers are widely used for high-performance applications such as automotive, military, aerospace and electrical because of their physical and mechanical properties have improved.

Salah Eldin Mohammed MasriBaharom, Abdul Rashid Abdul Aziz [3] studied "Comparative analysis of the two proposed models of connecting rods to the crankshaft of engines with the finite method." Two coils of the author's model have been simulated for the pedal motor in CATIA V5 and the finite element analysis of the two models using the FEA tool (ANSYS Workbench). The two connecting rods were modeled to have the same volume for apple-to-apple comparison. The first model was created for the traditional connecting rod and the second model in the form of a rod Y. In the case of I (compressive load) - the load was applied to the small end of the connecting rods as a compression load and the large end side was correct. In case II (tensile load) - the load was applied to the small end of the connecting rods as a compressive load and the side of the large end was corrected. The stress results highlighted the results were obtained from ANSYS workbench.

B. Anusha, C.VijayaBaskar Reddy [4] studied "Comparison of materials for a double rod with ANSYS." The size of the selected connecting rod can be found using a caliper and a manometer, shown in the table, and are listed in the table. Depending on the size, the connecting rod model is generated using PRO / E (Creo-parametric). In this analysis, we use two cast iron and stainless steel materials.

Ramanprith Singh [5] studied "in the orthotropic and isotropic stresses of analysis of the finite element method." It was carried out for the conventional analysis of steel, and the other was performed on an E-glass / epoxy connecting rod, while retaining all the same parameters for analysis.

II. METHOD:

The 3D model of the connecting rod was developed in software CAD. The connecting rod was considered while free boundary conditions since it allow the component to freely vibrate without interference from other parts. This speeds up even the best visualization of forms associated with the natural frequency mode. To test the FE model, you must recognize the dynamic properties, such as the modulus of elasticity, the density and the Poisson's ratio of the component. Only linear behaviour is displayed in the modal analysis, while nonlinear properties are ignored.

III. FEA MODAL ANALYSIS:

Modal analysis FEA stem connection is performed for two different materials. The first modal analysis is performed using a 16MnCr5 stainless steel material, and then an alternative material in LM9 aluminium. The solid model created in CATIA V5R19 is imported into ANSYS 14. After import, the connection must be done in the ANSYS of the SOLID45 element selection. Then apply the constraint and execute the analysis model for carbon steel 16MnCr5 material.

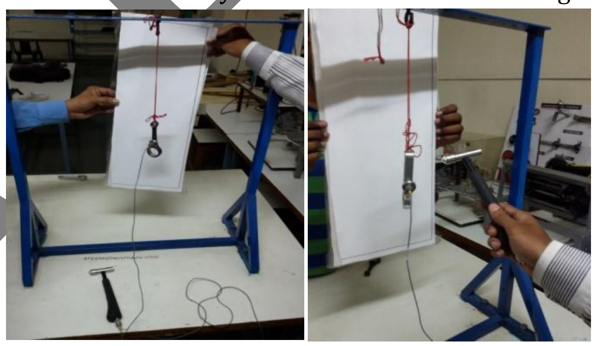
The solid model created in CATIA V5R19 is imported into ANSYS 14. After import, the connection must be done in the ANSYS of the SOLID45 element selection. Then apply the constraint and execute the analysis model for the aluminium material LM9.

IV. EXPERIMENTAL MODAL ANALYSIS:

The connecting rod was tested through EMA with free boundary conditions. An observational approach is to explore what shape shapes and natural frequencies of structures through the impact hammer test are formed by successive steps.

1. Generation of model.
2. Model test setting
3. Divide the structure deficient number of points with the appropriate special distribution.
4. Wobble up the structure with impact hammer.
5. Taking the measurements
6. Analysis of measured output data.
7. Establishment with the FEM data.

The test equipment used for the experiment is a fast Fourier transform (FFT) with sixteen channels, together with a data acquisition system made from the front of the SCADA. The structure was excited with a shock hammer (Dytran Make 5800B3) in all predefined locations, as shown in Fig. 1, and the response was collected using a three-axis accelerometer (PCB T356A02 and 356B21) at a given transmission point of the transmission point (DPTF). The type of EMA is known as the Frequency Response Function (FRF) method, which simultaneously evaluates the input excitation and output response. The essence of all the frequency response functions (FRF) was solved to extract the natural frequencies and modes. Figure 1 shows the experimental modal analysis created for the connecting rod.



(a) (b)

Fig. 1.Set up of Experimental Modal Analysis of connecting rod(a) Carbon steel 16MnCr5(b) Aluminium LM9

Figure 1 shows the installation of an experimental modal analysis of an aluminium rod connecting the LM9 carbon steel. For this reason, the sphere connections are interrupted at the end in the vertical perspective. The accelerometer is connected to the connector for measuring the frequency response when the excitation is given by a shock hammer.

An experimental analysis of the model, also known as modal analysis or model testing is related to the determination of natural frequencies, attenuation coefficients, and forms through the test mode of vibration. Two main ideas are involved:

• When the structure, car or any system is energized, its reaction has a sharp peak at resonance, when the forcing frequency is equal to the natural frequency, when the damping is not large.

• At 180 °, the characteristic of the phase changes when the frequency is forced through the natural frequency of the structure or machine and the stage will be at an angle of 90 ° to resonance.

The experimental modal analysis is carried out by suspending the connecting rod at the small end and the experimental results in comparison with stainless steel and aluminium LM9. Experimental analysis of the modal frequencies was determined.

V. RESULTS AND DISCUSSION:

Natural frequencies obtained for connecting rod of carbon steel and aluminium LM9 material by FEA & EMA are given in table 1.

Table. 1.Natural frequencies for Connecting rod of Carbon steel 16MnCr5 & Aluminium LM9 material by FEA & EMA

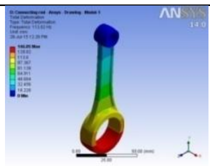
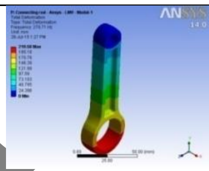
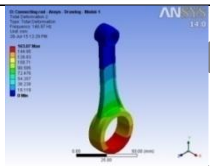
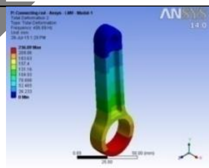
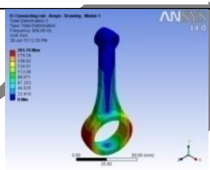
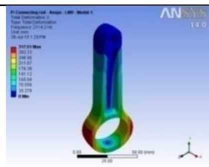
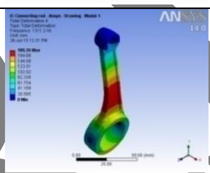
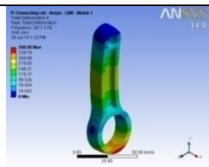
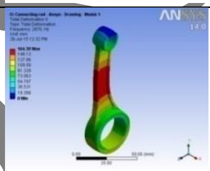
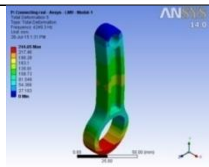
Mode No.	Carbon steel (16MnCr5)			Aluminium LM9		
	EMA	FEA		EMA	FEA	
	Natural frequency (Hz)	Natural frequency (Hz)	Mode shapes	Natural frequency (Hz)	Natural frequency (Hz)	Mode shapes
1	127	113		256	279	
2	163	147		441	487	
3	629	607		2045	2114	
4	1363	1311		3384	3411	
5	2816	2876		4207	4249	

Table 1 show the natural frequencies found from experimental modal analysis and finite element analysis of Carbon steel &Aluminium LM9 connecting rod. Natural frequencies for first five modes are noted by both the methods.

The graph of comparison of natural frequencies for different materials is shown in Fig. 2&3.

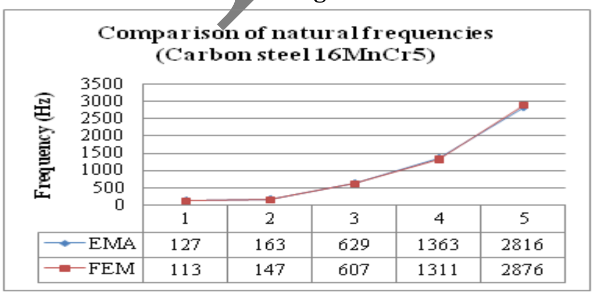


Fig. 2.Comparison of natural frequencies (Carbon steel 16MnCr5)

Figure 2 show the graph of comparison of natural frequencies found from experimental modal analysis and finite element analysis of Carbon steel connecting rod. Natural frequencies for first five modes are compared by both the methods and the variation found is within the limit.

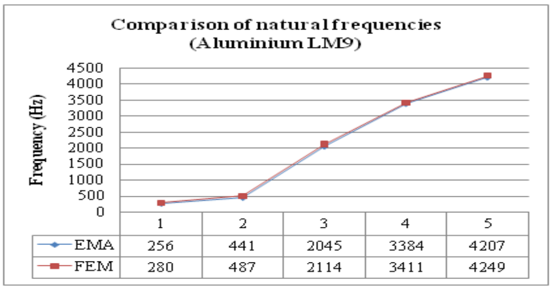


Fig. 3.Comparison of natural frequencies (Aluminium LM9)

Figure 3 show the graph of comparison of natural frequencies found from experimental modal analysis and finite element analysis of Aluminium LM9 connecting rod.

Natural frequencies for first five modes are compared by both the methods and the variation found is within the limit.

VI. CONCLUSION:

This work investigated the most suitable material for the connecting rod. The modal analysis was performed on the connecting rod with the FEM simulation tools based on the computer. The EMA was then conducted using an FFT analyser to find the natural frequencies of the connecting rod. The following conclusions can be drawn from this study.

Some natural frequencies using the FEA method are practically analogous to certain Eigen frequencies using the EMA method for the soul of an existing compound in carbon steel (16MnCr5).

The natural frequencies determined using the FEA method are almost identical to the natural frequencies determined using the EMA method for the connecting rod in LM9 aluminium.

It should be noted that the natural frequency of the LM9 aluminium rod is higher than the existing carbon steel reference plate (16MnCr5).

It should also be noted that the connecting rod LM9 aluminium is light weight relative to the rod of the existing stainless steel (16MnCr5).

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