

# PROJECT AND EXAMINATION OF LINKING ROD

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## ABSTRACT:

The simulation results are validated with the theoretical results.

From the analysis compared to the conventional material, Inconel-718 has less thermal expansion for gudgeon pin.

**Keywords:** Gudgeon pin, dynamic analysis, MMC connecting Rod and Aluminium alloys.

**INTRODUCTION** In an internal combustion engine, the expansion of the high-temperature and high-pressure gases which are produced by combustion, apply direct force to components of the engine, Such as turbine blades, pistons, rotor or a nozzle. Due to This force the component moves a distance, transforming chemical energy into useful mechanical energy.

## LITERATURE REVIEW

Puneet et al. [1] studied properties of different materials used for the production of connecting rod such as cast steel, forged steel, aluminium-360, AlFASiC (Aluminium based composite material reinforced with silicon carbide).

Sayeed et al. The connecting rod is designed in Pro/Engineer and forces are calculated. Analysis is done on the connecting rod using materials aluminium 6061, aluminium 7075, aluminium 2014 and carbon fibre 280. One is the aluminium connecting rod using machining process and the other is Carbon fibre connecting rod using hand layup method. The rods were tested in ideal condition and the rod undergo loads at different loads. The composite material like carbon fibre has good strength and can be used for connecting rod but with a better epoxy which can withstand the heat inside the chamber. The crank shaft if replaced with aluminium will give good results and induce much less pressure on the aluminium connecting rod and help increase its life.

Govind et al. [3] concluded that Al-5083 alloy micro silicon carbide composite has good properties. Composite's tensile strength, modulus of elasticity, Hardness, compressive strength and density increased by increasing the weight % of SiC in composites. They are conducted in ultrasonic Stir casting processing the mechanical properties increased by increasing wt. % of SiC. And also from the static analysis, the stress induced by using Hyper works is less than the material allowable limit of stress. The model presented here is safe design under given loading conditions. The results revealed that with the increasing wt. The weight of composite connecting rod is almost 1/3rd of the existing alloy steel connecting rod.

Pro-e solid modelling software is used to generate the 3-D solid model and analysed the connecting rod. The stress, strain, deformation of connecting rod by varying material with same geometry. The material used for connecting rod Al6061 is high Deformation, low Vonmises stress and low Vonmises strain when compared to Al6061+B4C.

Dharun et al. [5] modelled and analysed standard steel and composite connecting rods by using Pro-E Wildfire 4.0 and ANSYS WORKBENCH 11.0 software respectively. A comparative study was undertaken

between these materials and conclude that the stress and fatigue analysis of the composite connecting rods is found to be better than that of the standard connecting rod. Here the material replaced forged carbon steel into metal matrix composite (MMC) of connecting rod.

## EXPERIMENTAL ANALYSIS OF THE CONNECCTING ROD

### Experimental Analysis Using FFT Analyser

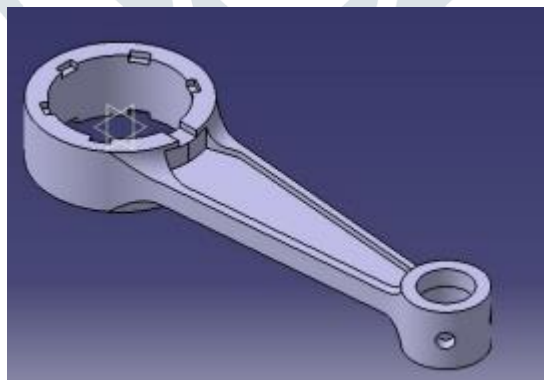
FFT analyser convert signals from time or space domain function to frequency domain function.

Coco is a plat form that can run in either Dynamic Signal Analyzer or Vibration Data Collector mode. This is widely used in industries to measure the vibrations and check the balancing, looseness and misalignment problems.



Design model of connecting Rod

The finite element model of the connecting rod is designed by using CATIA V5 R20 as per the specifications. The finite element model of the Connecting rod. The Connecting rod, which is a part of engine.



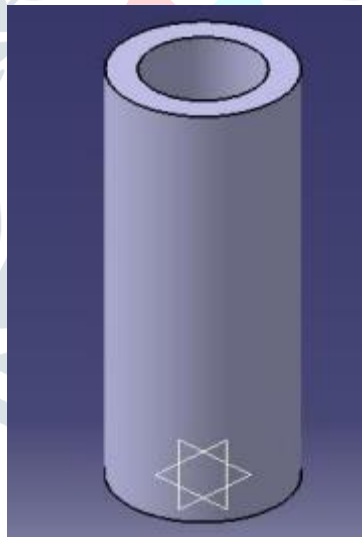
Connecting Rod

### The dimensions of the parts of connecting rod.

Parts	Units (mm)
Thickness of flange and web of the section T	3
Width of the section B	5.4
Width of the big end B1	14.72
Width of the small end B2	14
Height of the section H	12
Area of the section A (mm)	99
Length of the connecting rod L	92.27
Radius of crank r	27.2

### Design model of Gudgeon Pin

The finite element model of the piston pin is designed by using CATIA V5 R20 as per the specifications. Inner diameter of the section ( $d_1$ ) = 7.86 mm, Outer diameter of the section ( $d_2$ ) = 12 mm, length ( $l$ ) = 35.5 mm. Figure represents the Gudgeon pin, which is a part of engine.



The dimensions of Gudgeon pin

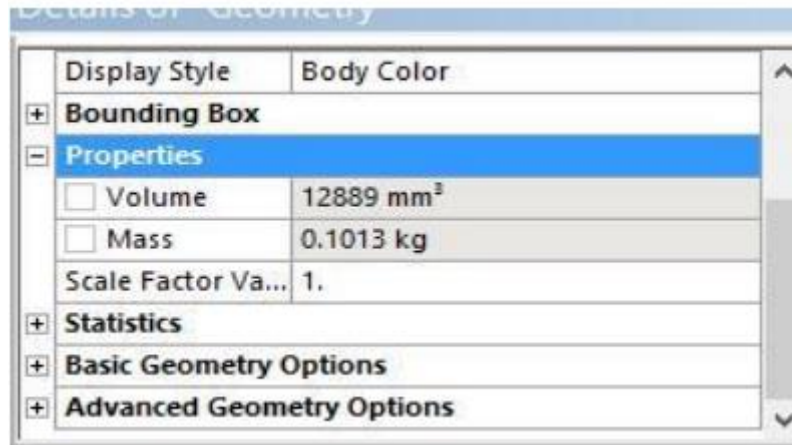
Parts	Units (mm)
Inner diameter of the section $d_1$	7.86
Outer diameter of the section $d_2$	12
Height of the section H	35.5
Layer thickness	0.5

## Design models of Modified Gudgeon Pin

To investigate the thermal expansion characteristics of piston pin, the dimensions of the piston pin considered2.

## RESULTS AND DISCUSSION

The weight of the connecting rod is 101.36grams, induced Equivalent stress obtained as 430.56MPa and total deformation as 0.15501mm.



## RESULTS OF EXPERIMENTAL MASS OF THE CONNECTING ROD

Mass of the connecting rod from Experimental analysis is 106 grams.



## Mass comparison of experimental and numerical Analysis

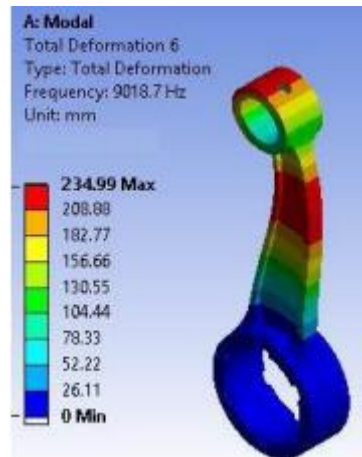
The comparison of mass obtained from the experimental and Numerical analysis using ANSYS. From the results observed that the mass of the connecting rod is 101.3 grams from ANSYS and 106 grams from experimentation. It shows that good agreement between the experimentation and ANSYS Results.

S.No	Mass(grams) of the connecting rod from experimentation	Mass(grams) of the connecting rod from Numerical Analysis	% Error
1	106	101.36	0.044

Natural Frequency Comparison

## Modal analysis results of existing connecting rod

The maximum deformation at mode-6 of connecting rod. It is observed that natural frequency at mode-6 is 9018.7Hz.



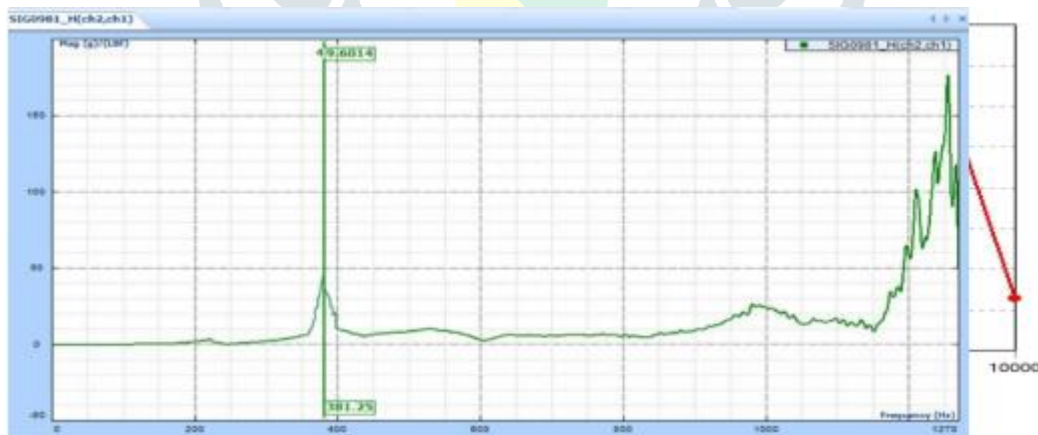
## HARMONIC ANALYSIS RESULTS OF EXISTING CONNECTING ROD

To find the rotational frequencies and determine the response of the structure under a steady-state sinusoidal (harmonic) loading at a given frequency. From the harmonic analysis, it is observed that maximum amplitude  $2.6964e-7$  mm for the connecting rod at natural frequency obtained as 9018.7Hz.

### Frequency response of connecting rod

### Results of experimental NFT test using FFT analyse

Experimental NFT test is carried out by using FFT analyzer with impact hammer and piezo electric sensor data was saved in it that saved data performed to using of EDM software frequencies are recorded. Natural frequency experimentally obtained as 381.25Hz.



### Natural Frequency Spectrum

Natural frequencies of the motor generator system are obtained using impact hammer method the sensitivity of the impact hammer 10.6 mV/g and maximum force can be applied 500 lb impact Set frequency range 0 to 1.14 KHz for NFT test and Impact force is applied on the motor generator system and vibration levels are measured using accelerometer and FFT analyzer. Fig. shows the frequency spectrum obtained from the NFT test.

It shows that good agreement between the FFT analyzer and ANSYS Results.

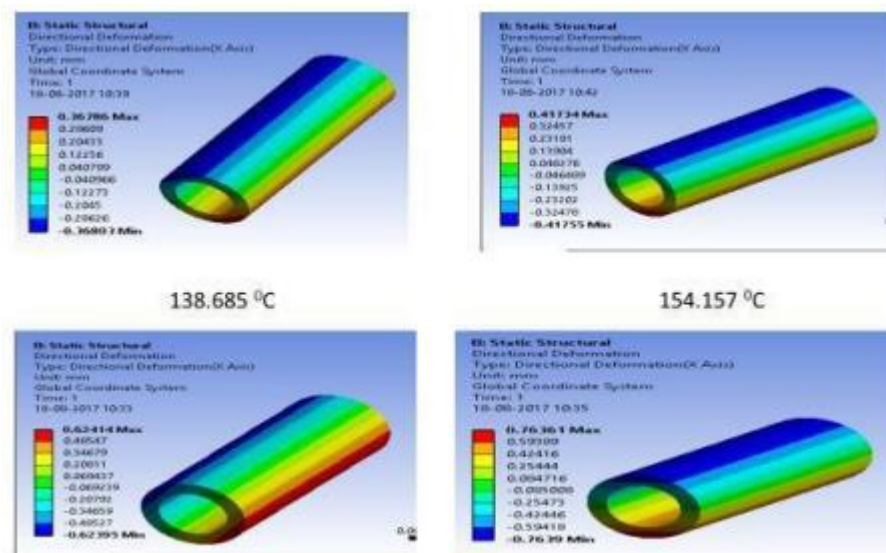
S.No	Frequency (Hz) from FFT analyzer	Frequency (Hz) from Numerical Analysis	%Error
1	381.25	396.52	3.851

### Results of Allowable thermal expansion of Gudgeon pin

The Allowable thermal expansion values obtained from the theoretical calculations of the thermal expansion at different temperatures and different loading conditions.

Full load conditions		Half load conditions	
Temperature (°C)	Allowable thermal expansion (mm)	Temperature (°C)	Allowable thermal expansion (mm)
138.685	0.0166422	131.720	0.015806
154.157	0.018498	148.012	0.017761
170.719	0.02048	156.098	0.018731
181.841	0.02182	172.987	0.020758

### Thermal analysis results of existing Gudgeon pin



## CONCLUSIONS

By using Vernier calliper the dimensions of the existing connecting rod is measured and using these dimensions modelled solid model of connecting rod by using CATIA software. NPT test is carried out experimentally by using impact hammer and FFT analyser instrument to finding out the natural frequency of existing connecting rod.

The analytical and experimental results of modal and harmonic analysis are compared and found that there is a good agreement. From the analysis, it is observed that Von misses Stress and deformation for 20CrMo was found to be 430.56 N/mm<sup>2</sup>, 0.15501mm which is greater than Aluminium Reinforced with Boron Carbide Metal matrix composite connecting rod i.e. 394.38 N/mm<sup>2</sup>, 0.077445 mm. Weight of the connecting rod is reduced by 37.123% by using the composite material. From the thermal analysis, it is observed that the thermal expansion of 20Cr alloy steel gudgeon pin has more expansion than allowable limit, so that existing gudgeon pin is failed. The gudgeon pin design is considered for redesigning.

CATIA software is used to model the gudgeon pin. Thermal analysis is carried out on gudgeon pin having the 0.5mm thickness layer of Inconel 718 material throughout the length of the pin at different temperatures and loading conditions. It is observed that For Inconel718, thermal expansion is lesser than compared to 20Cr alloy steel and also which is within the allowable limit. Finally, we conclude that compared to the conventional material, Aluminium Reinforced with Boron carbide MMC connecting rod have less stress and less weight and Inconel-718 have less thermal expansion for gudgeon pin. Hence Aluminium Reinforced with Boron Carbide Metal matrix composite material is selected as the most suitable material for Connecting rod and Inconel-718 material is selected as the most suitable material for Gudgeon pin.

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