Analysis and Validation of Engine Sub Assembly

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Abstract

Reverse Engineering technique (RE) is one of the working tools in the Integrated Engineering that Permits the optimization of the product's design and performance, so that the aim for a flexible production with minimum costs, high quality and offered to its beneficiaries as soon as possible, become more a tangible reality. Computer-aided design (CAD) is the use of computer technology for the design of objects, real or virtual. The design of geometric models for objects shapes, in particular, is often called computer-aided geometric design (CAGD). Solid modeling is a technique for representing solid objects suitable for computer processing. Primary uses of solid modeling are for CAD, engineering analysis, computer graphics and animation, rapid Prototyping, medical testing, product visualization, visualization of engineering research. Analysis and validation of static, dynamic behaviour of engine parts with respect to given various load and material conditions. The FE models of the Engine parts are suitable for a wide range of load and material conditions. As a conclusion, the validated model is reliable to foresee the static and dynamic behaviour without needing expensive physical tests.

Keywords: *Reverse Engineering technique (RE), solid modeling, FEA*

1. Introduction

Crankshaft could be a giant part with a complex geometry within the engine that converts the mutual displacement of the piston to a movement with a four link mechanism. Since the shaft experiences an outsizedrange of load cycles throughout its service life, fatigue performance and sturdiness of this study got to be thought of within the style method [1]. Style developments have invariably been a vital issue within the shaft production business, so as to manufacture a more cost-effective part with the minimum weight attainable and correct fatigue strength and alternative purposeful necessity [2, 3]. These enhancements lead to lighter and smaller engines with higher fuel potencyand better power output. This study was conducted on one cylinder four stroke cycle engines. Twocompletely different crankshafts from similar engines were studied during thisanalysis. The finite component analysis was performed in four static steps for everyshaft. Stresses from these analyses were used for superposition with regards to dynamic load applied to the shaft [4-6]. Any analysis was performed on the solid steel shaft so as to optimize the load and producing value. Figure 1 shows a typical image of a shaftand also thelanguageaccustomedoutline it’s completely differentelements.

1. Measurement of Real Time Model

Measurement of the model by using measuring instruments (Vernier caliper, micrometer, height gauge, radius gauge, profile projector, CMM)

II. Cad Modeling

Cad modeling of piston, connecting rod, crankshaft as per the measured dimensions, Components are assembled by giving constraints as per the real time model

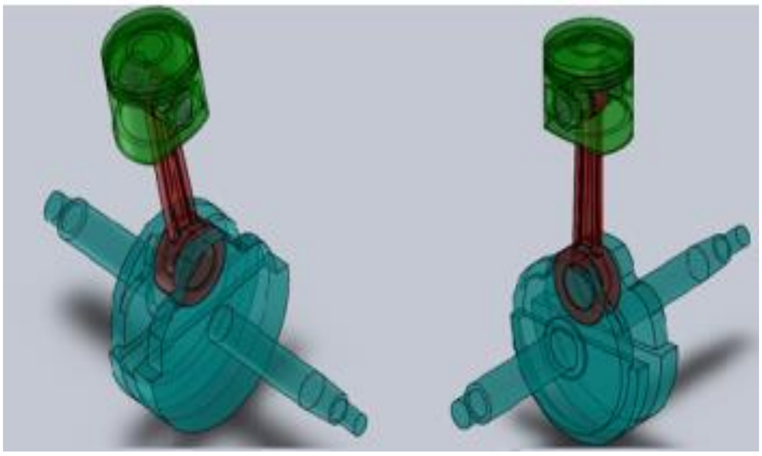
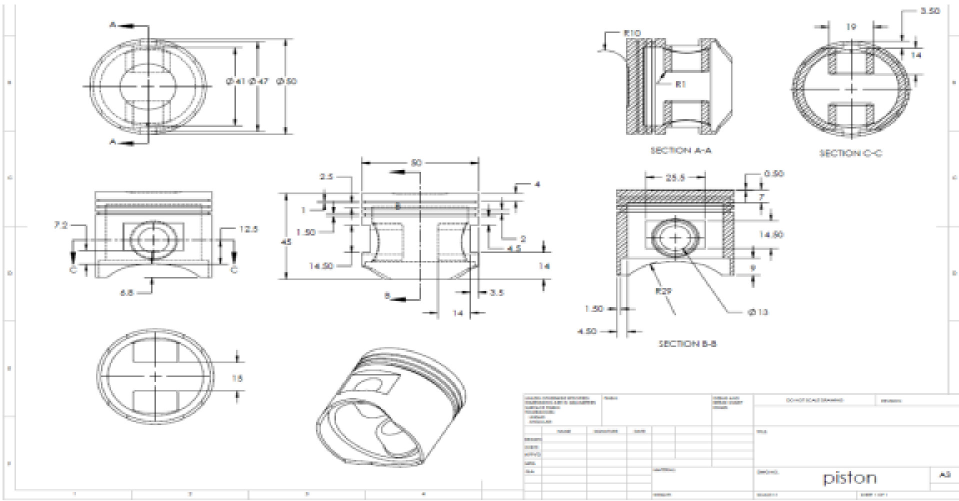


Figure 1: Assembled view



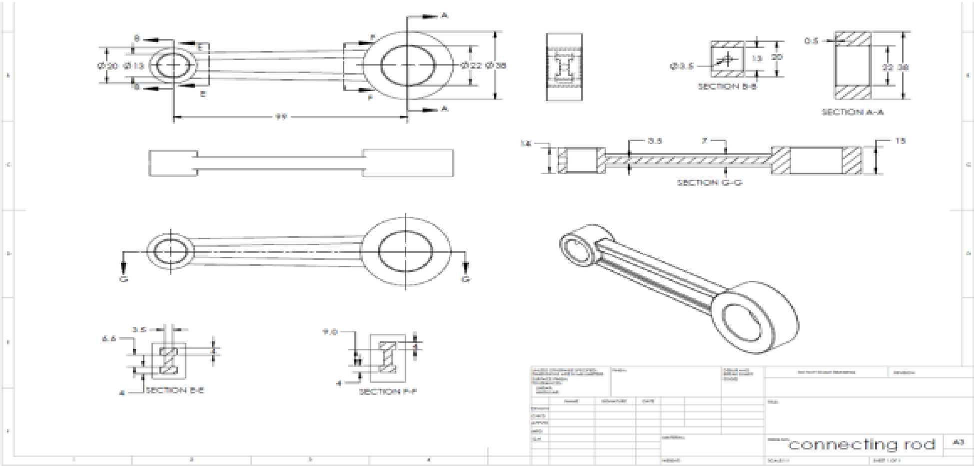


Figure 2 &3 Piston and connecting rod detailed drawings

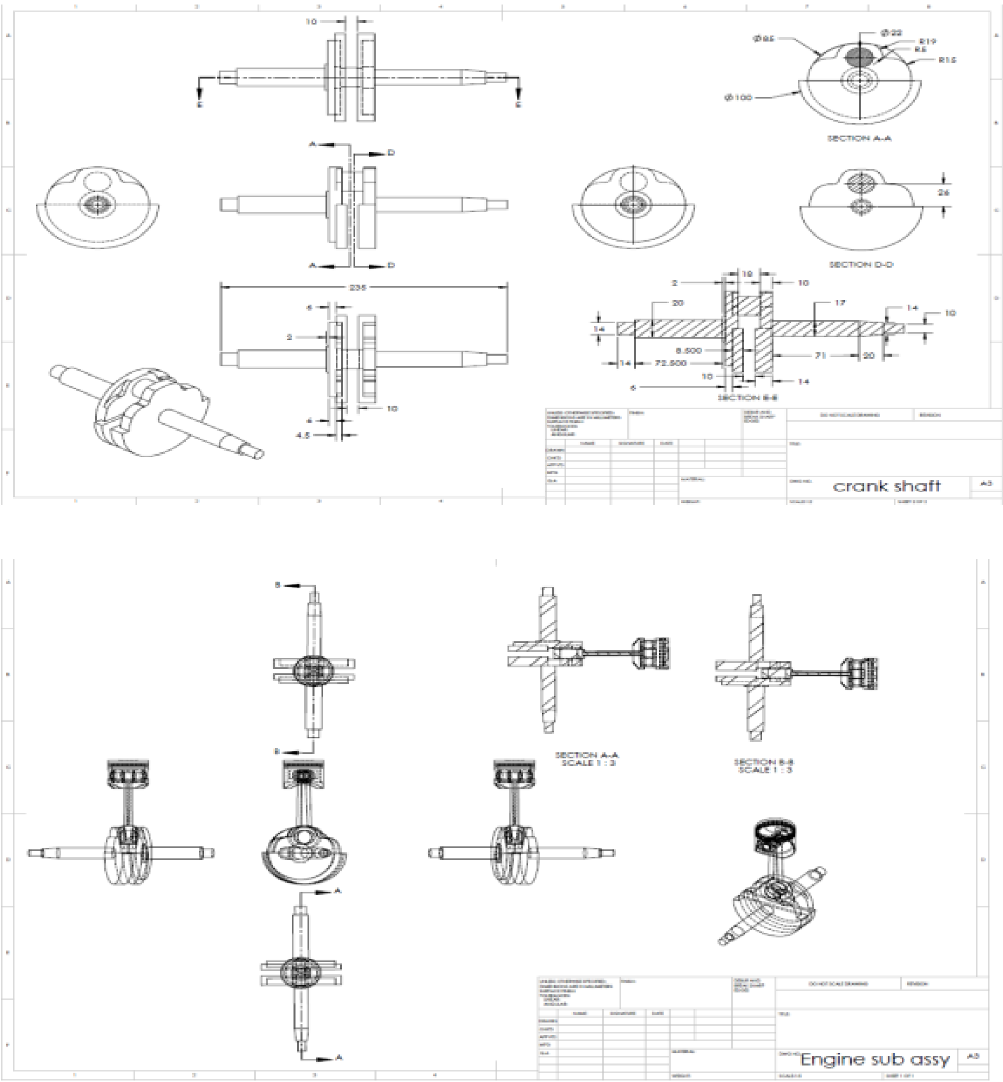


Figure 3&4 Section view of assembled drawing

III. MASS PROPERTIES

COMPONENTS	DENSITY Kg/m^3	VOLUME mm^3	MASS (g)
PISTON	2700	34348.58	93
CONNECTING ROD	7850	19759.77	155
CRANKSHAFT	7300	213877.04	1560

Table 1: Mass properties of components

IV. PARAMETERS

PARAMETERS	VALUES (mm)
Piston diameter	50
Connecting rod length	99
Connecting rod thickness	3.5
Crank shaft dia	20
Crank shaft length	235
Crank radius	26
Crank shaft pin dia	22

Table 2: Parameters of components

V. Dynamic Calculation

The diameter of the piston is 50 mm and the mass of the reciprocating parts is 0.093 kg. At a point during the power stroke, the pressure on the piston is 0.7 N/mm^2

N = 2000 rpm, or $\omega = 2\pi \times N/60 = 2\pi \times 2000/60 = 209.5$ rad/s ; r = 26 mm = 0.026 m; l = 99 mm ; D = 80 mm ; m_R = .093kg ; p = 0.7 N/mm^2 ;

1. Net load on the piston

Load on the piston, $F_L = \frac{\pi}{4} \times D^2 p = \frac{\pi}{4} \times 0.05^2 \times 5000 = 9800$ N

Inertia force on the reciprocating parts, $F_I = m_R . a_R = m_R \omega^2 r \left(\cos\theta + \cos\frac{2\theta}{2n}\right)$

$F_I = 0.093 \times 209.5^2 \times 0.026(\cos 40 + \cos 80/3.8)$ = 86.14 N

Net load on the piston, $F_P = F_L - F_I + m_R g$ = 9800-86.14+.9123 =9714.8N

2. Thrust in the connecting rod

φ = Angle of inclination of the connecting rod to the line of stroke

$\sin\varphi = \sin\theta/n = \sin 40/3.8 = 0.169$, $\varphi = 9.73^0$

Ratio of lengths of connecting rod and crank, $n = l/r = 99/26 = 3.8$

That resultant load on the gudgeon pin or thrust in the connecting rod, $F_Q = F_P/\cos\varphi = 9714.8/\cos 9.73 = 9856.5$ N

3. Crank pin effort= $F_p(\sin(\theta + \emptyset) / \cos\emptyset) = 9714.88 \times 0.77 = 7480.39$ N

V. CALCULATION FOR DIFFERENT LOAD

PRESSURE N/mm^2	NET LOAD ON PISTON F_P N	CONNECTING ROD-THRUST N	CRANK PIN EFFORT N
5	9714.8	9856.5	7480.3
6	11674	11845	8988.9
7	13833.7	13834	10499
8	15594.7	15822	12008

VI.STATIC ANALYSIS- PISTON

Mesh generation and its convergence arementioned. Using correct boundary conditions and sort of loading are necessary since they powerfully have an effect on the results of the finite component analysis acceptable boundary conditions and loading scenario also are mentioned. Finite element models of 2parts were analyzed; the forged iron shaft and therefore the solid steel shaft. Since these 2 crankshafts are from similar engines, identical boundary conditions and loading were used for each. This facilitates correct comparison of this part made up of 2 totally different producing processes.

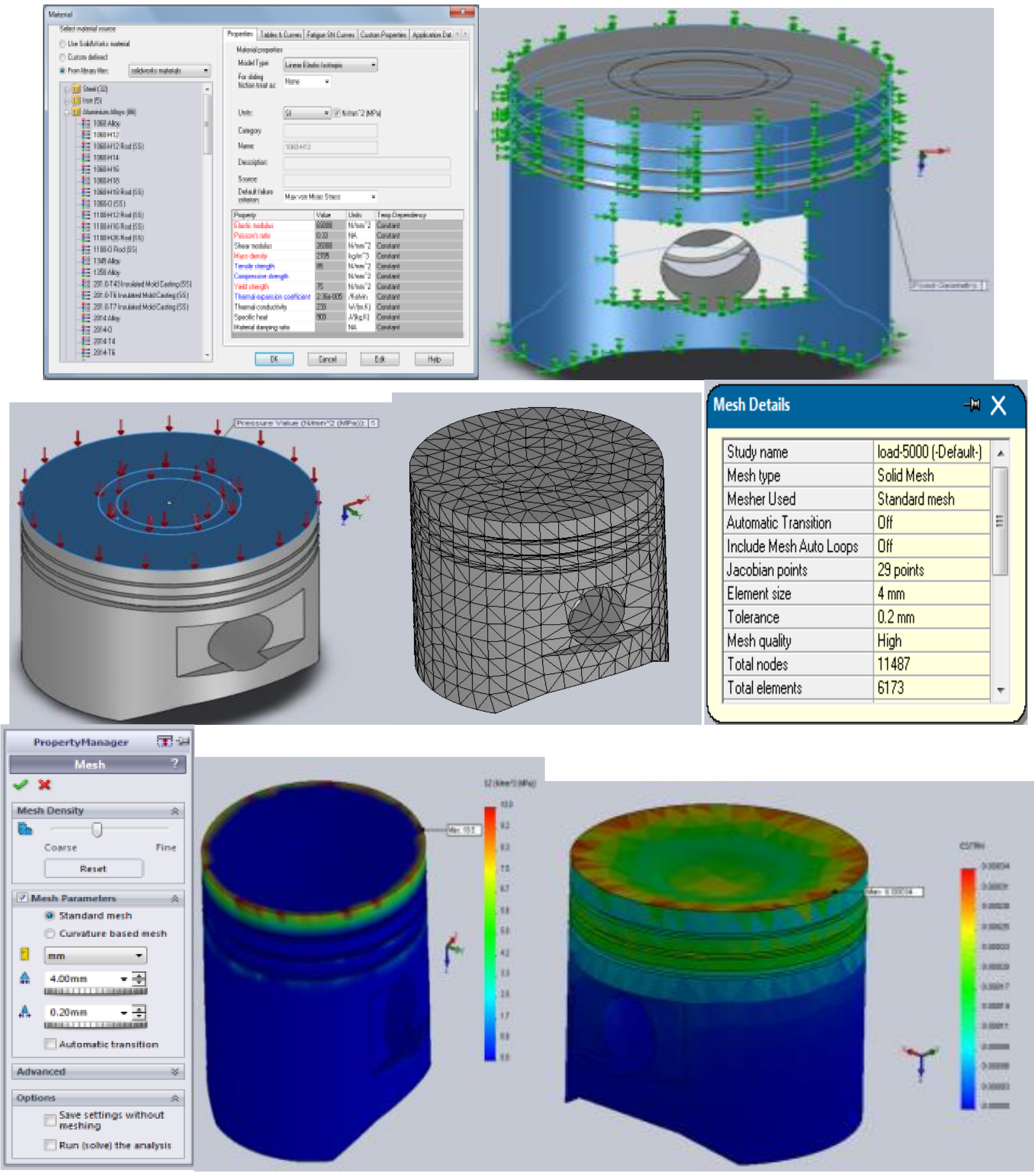


Figure 5 Static analysis of piston

VII. STATIC ANALYSIS- CONNECTING ROD

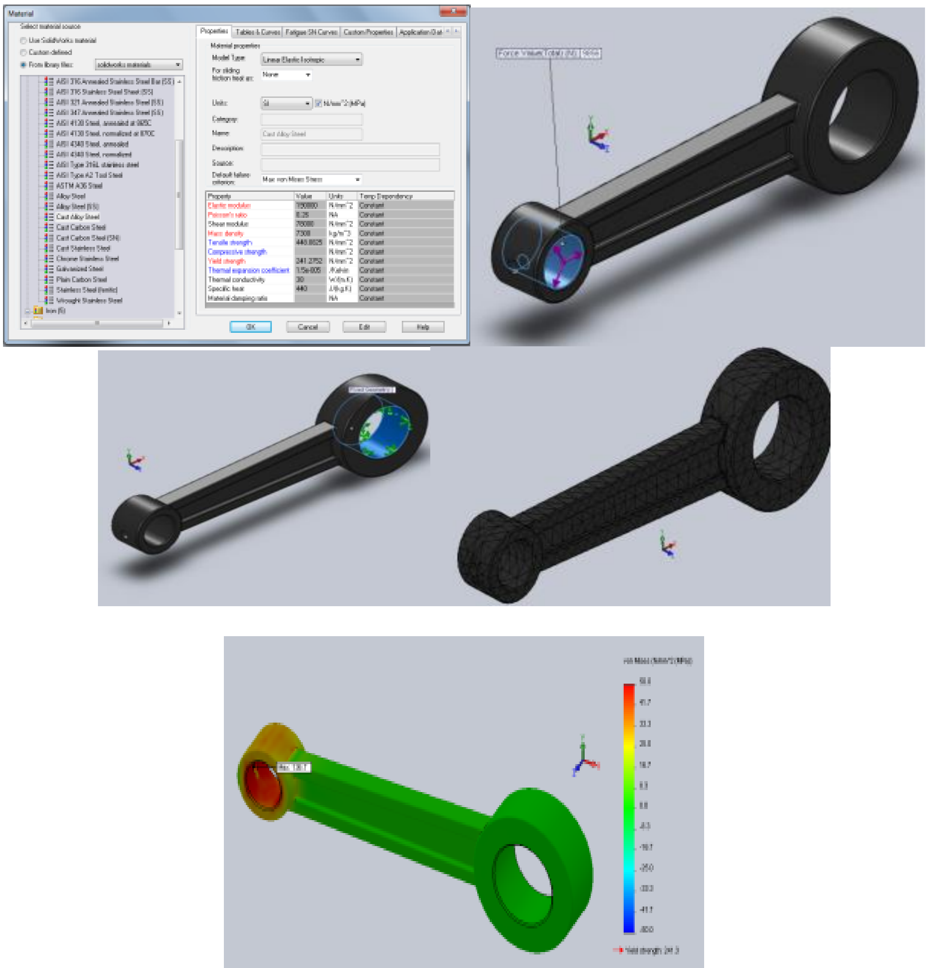


Figure 6 Static analysis of connecting rod

VIII. STATIC ANALYSIS- CRANK SHAFT

The crankshaft experiences a posh loading because of the motion of the rod that transforms 2 sources of loading to the shaft. the most objective of this study was the improvement of the cast steel shaftwhich needscorrect magnitude of the loading on this part that consists of bending and torsion. The importance of torsion throughout a cycle and its most compared to the overall magnitude of loading ought to be investigated to visualize if it's essential to think about torsion throughout loading or not. Additionally, there was a desire for gettingthe strain variation throughout a loading cycle and this needs FEA over the complete engine cycle.

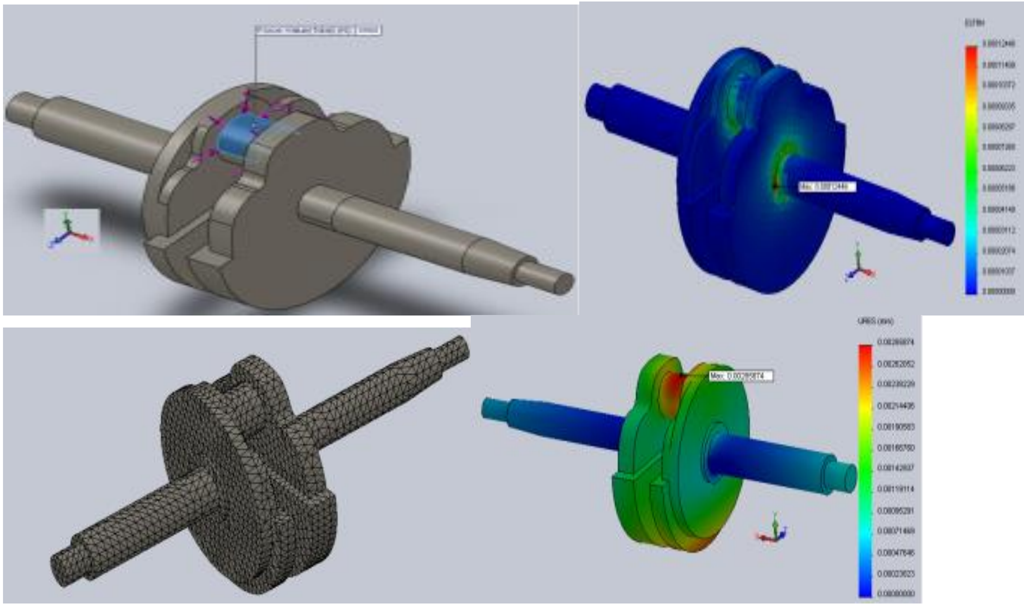


Figure 7 Static analysis of crank shaft

IX. NATURAL FREQUENCY AND MODE SHAPE-PISTON

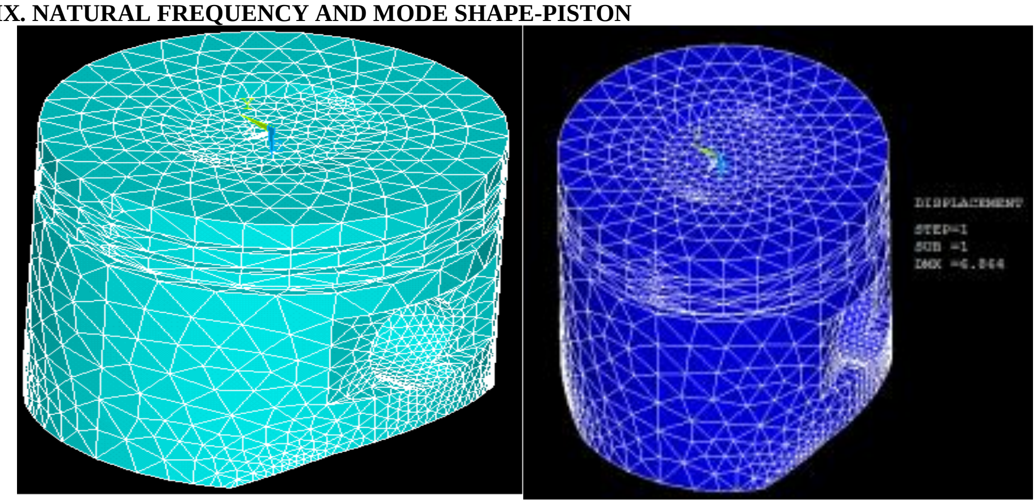


Figure 8 Natural frequency and mode shape of piston

NATURAL FREQUENCY AND MODE SHAPE- CONNECTING ROD

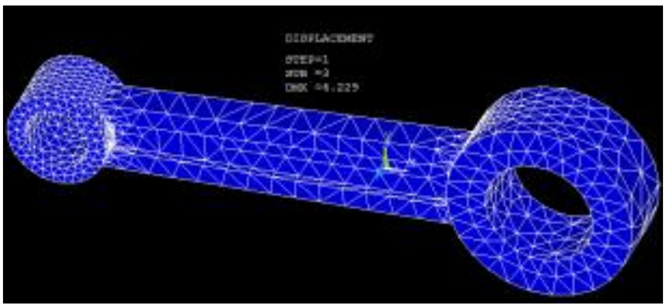


Figure 9 Natural frequency and mode shape of Connecting rod

XI.NATURAL FREQUENCY AND MODE SHAPE- CONNECTING ROD

An extensive study was performed on material alternatives for the automotive rotating shaftsupportedproducingeconomics [7]. They thought-about steel formation, nodular forged iron, micro-alloy formation, and austempered ductile iron casting as producing choices to guage the value effectiveness of exploitation these alternatives for crankshafts. Technical price modeling methodology was employed in their study to estimate the producingpricesof varied material alternatives. Over all assembly volume of the rotating shaftand therefore thenecessities of the engine are predominant factors in price effective production route for this application. The forged ironrotating shaft offered the foremostprice effective producingmethod, however the properties offered by this production methodologyneed to be comfortable for the engine style. If the look needs higher mechanical properties, then different alternatives should be thought-about. The choice of the most effectivevarious depends upon the assembly volume in a very year. At production volume on top of 1000 parts/year, microalloyed steel forgings offered the foremostprice effective high performance rotating shaft

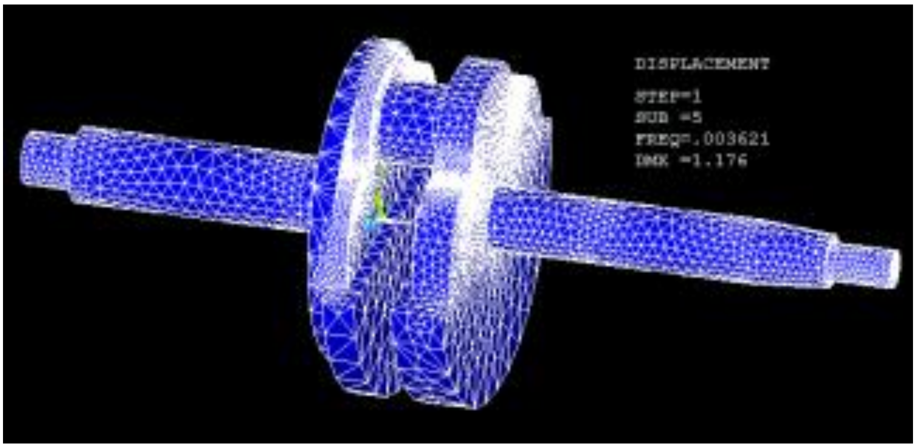


Figure 10 Natural frequency and mode shape of connecting rod

CONCLUSION

As a conclusion, the validated model is reliable to foresee the static and dynamic behaviour of Engine sub assembly without needing expensive physical tests. In order to hold out optimizationmethod, it's necessary to possessdata of the part dimensions, its service conditions, and material of construction, producingmethod, and alternative parameters that have an effect on its value. The service loading condition of this part was fixed. It absolutely was shown that the utmost bending load happens at very cheapin operation engine speed. Therefore, this loading condition was thought ofbecause the primary loading conditions for the optimization study.

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