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Design and Optimization of Connecting Rod

Dilip Verma[1], Mohit Juneja[2], Shubham Jain[3], Vinayak Rathore[4], Wahid Khan[5], Harshit Goyal[6]

[1, 2, 3,4,5,6] Hindustan College of science and technology, Mathura, India

Abstract: **In series of automobile engine components a connecting rod is highly critical and re-searchable one. Connecting rod is the intermediate link between the piston and the crank. And is responsible to transmit the push and pull from the piston pin to crank pin, thus converting the reciprocating motion of the piston to rotary motion of the crank. Generally connecting rods are manufactured using carbon steel and in recent days aluminium alloys are finding its application in connecting rod. In this work connecting rod is replaced by aluminium based composite material reinforced with silicon carbide and fly ash. And it also describes the modeling and analysis of connecting rod. FEA analysis was carried out by considering two materials. The parameter like von misses stress, von misses strain, displacements, and weight reductions were obtained from ANSYS software. Design of connecting rod which is designed by machine design approach is compared with actual production drawing of connecting rod as well as maintaining its cost effectively.**

Keywords: **Connecting rod, Fatigue, FEA, Composite.**

I. INTRODUCTION

The connecting rod is the connection between the piston and the crankshaft. It joins the piston pin with the crankpin; small end of the connecting rod is connected to the piston and big end to the crank pin. The function of the connecting rod is to convert linear motion of the piston into rotary motion of the crankshaft.

The lighter connecting rod and the piston greater than resulting power and less the vibration because of the reciprocating weight is less. The connecting rod carries the power thrust from piston to the crank pin and hence it must be very strong, rigid and also as light as possible. There are two types of small end and big end bearings. Connecting rods are subjected to fatigue due to alternating loads.

In many cases, the major reason behind or causing catastrophic engine failure is the occurrence of the connecting-rod failure and sometimes, such a failure can be attributed to the broken connecting rod's shank especially when there is a probability of being pushed through the side of the crank-case, thereby making the engine irreparable. Thus, the major aim of the current work is to analyze the connecting rod failure. The study applied a finite element analysis and metallographic examination. Based on the findings, it was found that it is possible for each casting defect to develop depending on the cyclic loading behavior of the connecting rod into the start point for crack initiation before the occurrence of catastrophic failure. The design consideration is traditional with the I-section which holds the base of designing of connecting rod. Moreover the design of connecting rod is based on the hand calculations which correlated with force of application and the type of engine (i.e. displacement-100cc).In the Analysis portion the analysis forces is 3x10^4 mpa which come out from the calculations for the analysis of connecting rod on which the displacement and deformation is measured after altering the design for n-number of times for getting the feasible results. In this research we even more conscious toward choosing a strengthen material which can resist the high applications of forces and even it should be light enough which can also reduced weight. In the sequence of literature review we find two material (i.e. (Al6061-9%SiC-15% fly ash) and (Al7075-T6)).Furthermore choice of material should be wise for the endurance of the part so material Al7075-T6 is a good choice because it's mechanical properties.

2. LITERATURE REVIEW

K. Sudarshan Kumar [1] et al, described modeling and analysis of Connecting rod. In his project carbon steel connecting rod is replaced by aluminium boron carbide connecting rod. Aluminium boron carbide is found to have working factory of safety is nearer to theoretical factory of safety, to increase the stiffness by 48.55% and to reduce stress by 10.35%.Compared to the former material the new material found to have less weight and better stiffness. It resulted in reduction of 43.48% of weight, with 75% reduction in displacement.

Vivek. C. Pathade [2] et al, he dealt with the stress analysis of connecting rod by finite element method using pro-e wild fire 4.0 and Ansys work bench 11.0 software. And concluded that the stress induced in the small end of the connecting rod are greater than the stresses induced at the bigger end, therefore the chances of failure of the connecting rod may be at the fillet section of both end.

Dr.Pushpendra Kumar Sharma [3] et al, performed the static FEA of the connecting rod using the software and said optimization was performed to reduce weight. Weight can be reduced by changing the material of the current forged steel connecting rod to crackable forged steel (C70). And the software gives a view of stress distribution in the whole connecting rod which gives the information that which parts are to be hardened or given attention during manufacturing stage. Therefore, this study has contain by two subjects, first, load and stress analysis of the connecting rod, and second, optimization for weight reduction.

In a published SAE case study (1997)[4], a replacement connecting rod with 14% weight savings was designed by removing material from areas that showed high factor of safety. Factor of safety with respect to fatigue strength was obtained by performing FEA with applied loads including bolt tightening load, piston pin interference load, compressive gas load and tensile inertia load.

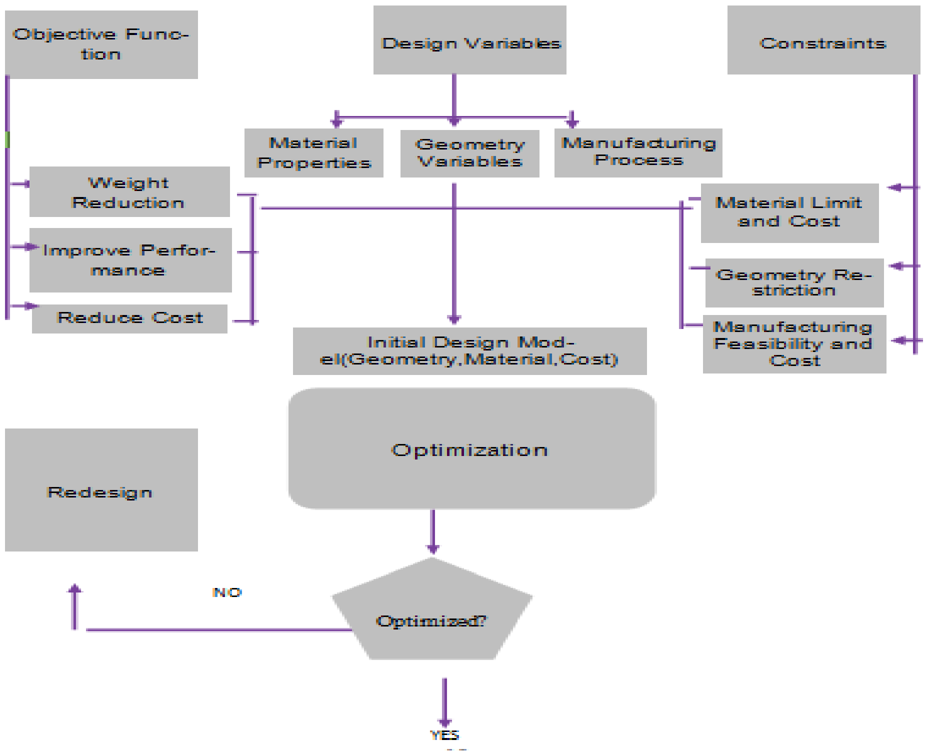
Kuldeep B (2013)[5], conducted a research on 150cc engine connecting rod by replacing the material from Al360 to AlFASic for the reduction of weight with the same connecting rod.

3. PROJECT WORK

3.1 Objective:

As today's engines, required to have higher speed and power, their connecting rods have higher strength and stiffness, but must be lighter in weight and size. In developing power output engine, importance is placed on the weight of the reciprocating and oscillating parts such as piston, connecting rod, valve trains etc. The overall performance of the internal combustion engine is affected by higher inertia forces, generated by the moving parts of the engine. Lighter connecting rods help to decrease lead caused by forces of inertia in engine as it does not require big balancing weight on crankshaft. Application of metal matrix composite enables safety increase and advances that leads to effective use of fuel and to obtain high engine power. Therefore, it should always be investigated to avoid any failure of the engine and determines the life of connecting rod in the long run. As the speed increases, the maximum tensile load (at 360° of crank revolution) increases whereas the maximum compressive load decreases at the crank end.

3.2 WORK PLAN:



3.3 METHODOLOGY:

TABLE I: Comparison of Old Material vs. New Material

S.No	Paramters	OLD MATERIAL (AL6061-9%SiC-15%flyash)	NEW MATERIAL(AL7075-T6)
1	Ultimate tensile Strength(Mpa)	422	580
2	Yield Strength(Mpa)	363	510
3	Young's Modulus(Gpa)	70	72
4	Poisson's Ratio	0.33	0.33
5	Density (gm/cm3)	2.61161	2.80

4. RESULTS AND ANALYSIS

4.1 SMALL END UNDER TENSION:

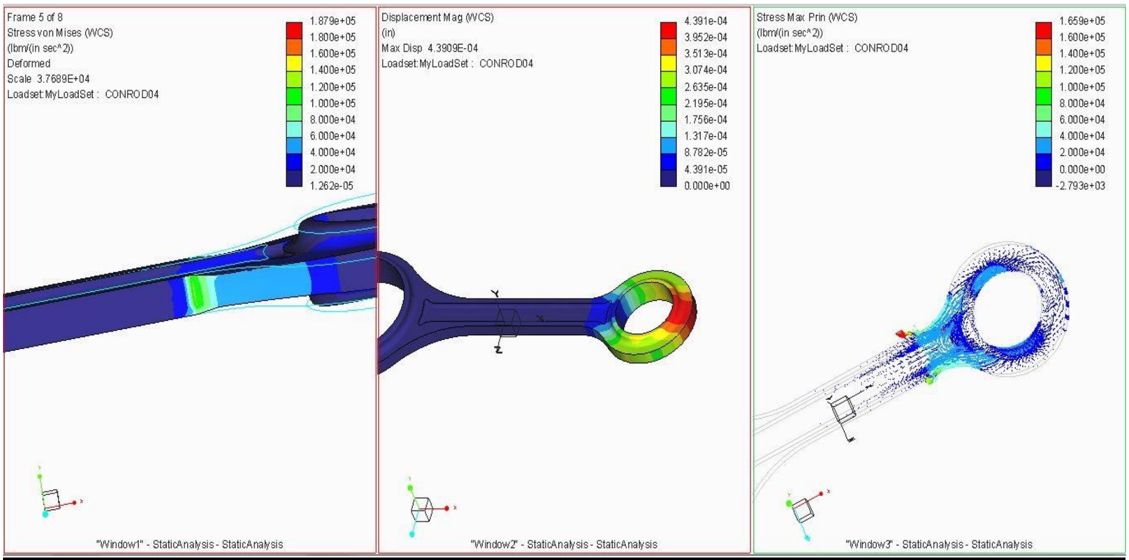


FIGURE 1

From the fig 1.5 the maximum stress occurs at the piston end of the connecting rod is 3.768xe^3 lb/in

4.2 SMALL END UNDER COMPRESSION:

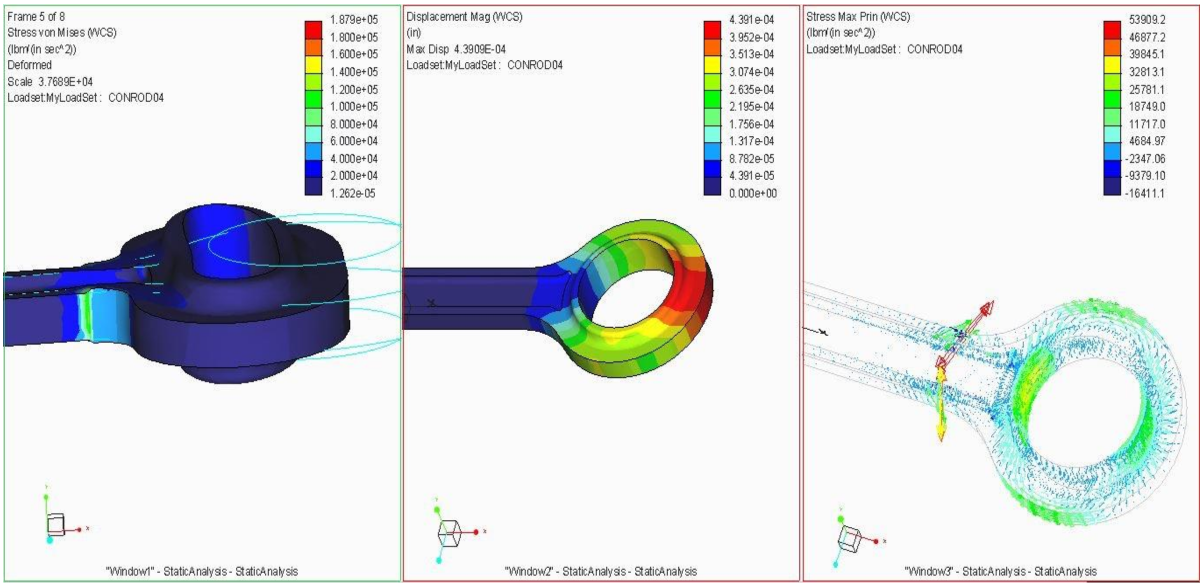


FIGURE 2

From the fig 1.6 the maximum stress occurs at the piston end of the connecting rod is 3.768xe^4 lb/in

4.3 CONNECTING ROD UNDER COUPLE:

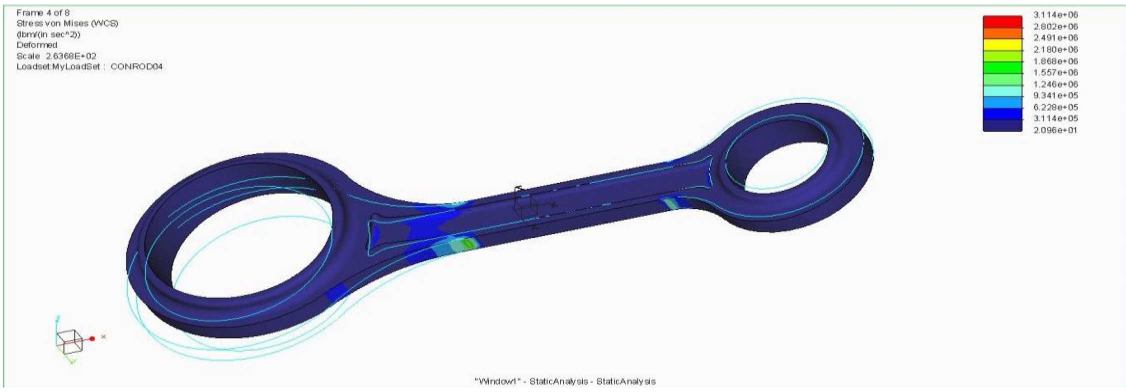


FIGURE 3

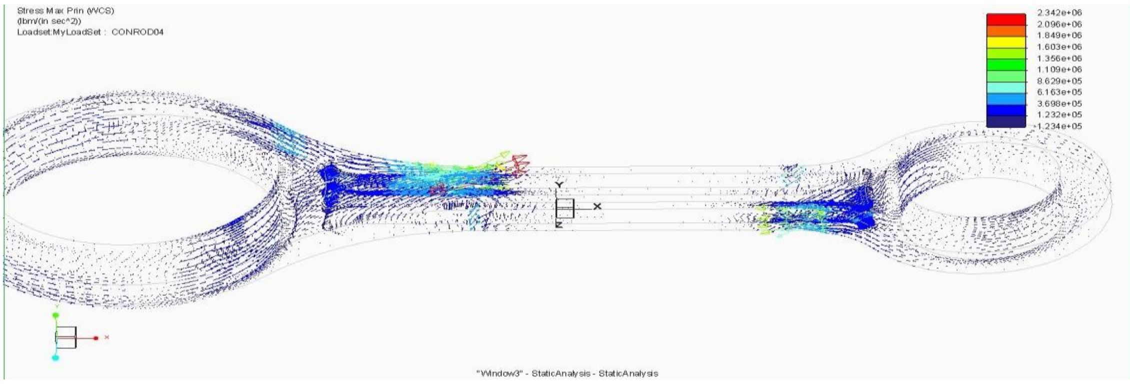


FIGURE 4

From the fig 1.7 the maximum stress occurs at the piston end of the connecting rod is 2.838x10^2 lb/in

4.4 CONNECTING ROD UNDER TORSION:

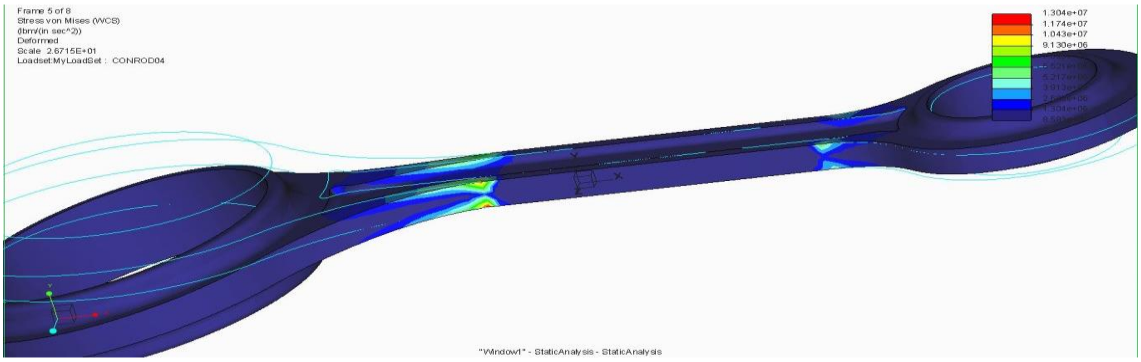


FIGURE 5

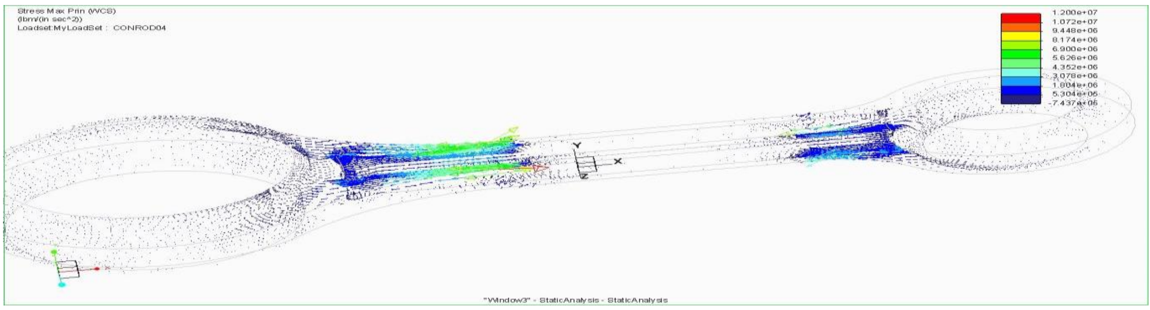


FIGURE 6

From the fig 1.8 the maximum stress occurs at the piston end of the connecting rod is 2.6715e^1 lb/in

4.5 CONNECTING ROD UNDER TENSION:

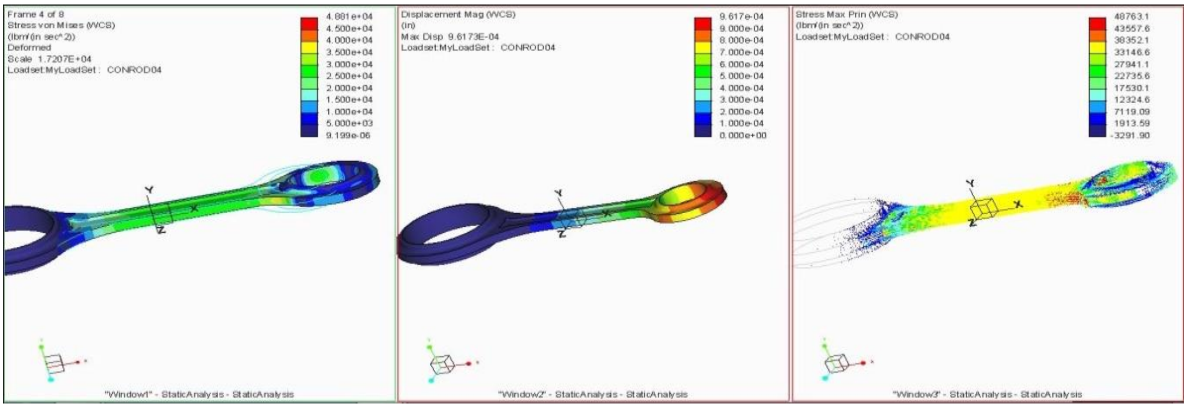


FIGURE 7

From the fig 1.9 the maximum stress occurs at the piston end of the connecting rod is 118.67mpa and displacement 0.024384mm.

4.6 CONNECTING ROD UNDER COMPRESSIVE LOAD:

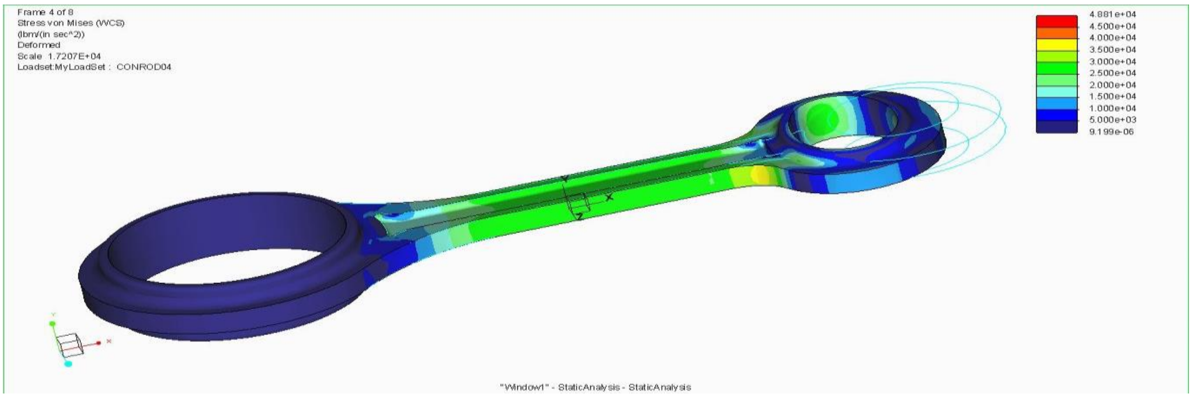


FIGURE 8

From the fig 1.10 the maximum stress occurs at the piston end of the connecting rod is 59.335mpa and displacement 0.01199mm.

4.7 BIG END UNDER COMPRESSION:

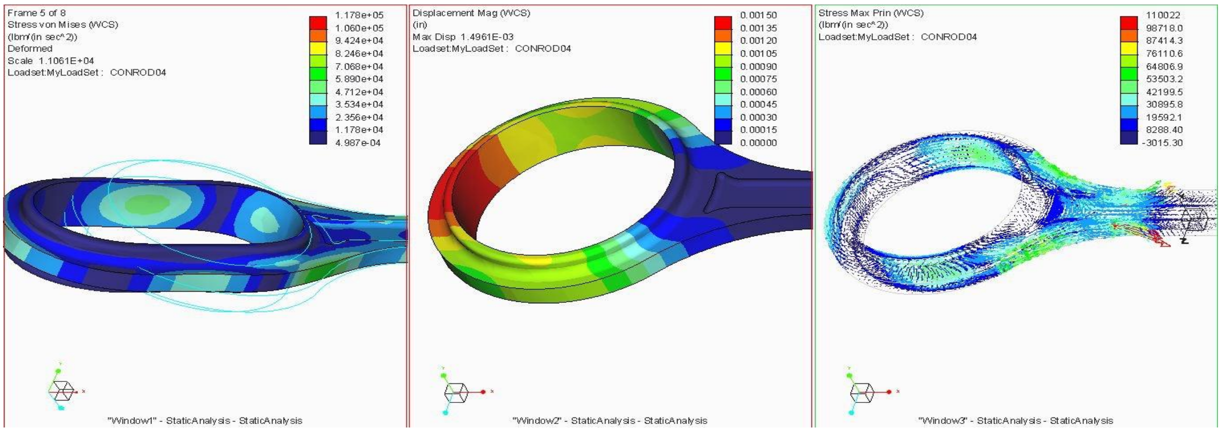


FIGURE 9

From the fig 1.11 the maximum stress occurs at the piston end of the connecting rod is 1.1061x e^4 lb/in and displacement is 1.496 x e^-3 in

4.8 RESULTS:

TABLE 2: Comparison of Tensile and Compressive Properties

S.NO	Material	TENSILE LOAD		COMPRESSIVE LOAD	
		Stress(MPA)	Displacement(MPA)	Stress(MPA)	Displacement(MPA)
1.	Al 6061	92.305	0.038435	46.1525	0.022087
2	Al7075T6	118.67	0.024384	59.335	0.01199
3	Difference	28.56%	37%	28.56%	45%

5. CONCLUSION

An optimized solution is the minimum or the maximum value that an objective function can take under a given set of constraints. The load cycle consists of compressive gas load corresponding to maximum torque and dynamic tensile load corresponding to maximum inertia load. A finite element routine is first used to calculate the displacements and the stresses in the connecting rod, which is further used in another routine to calculate the total life. For this optimization problem, high priority is given to the weight of the connecting rod. Change in the material, there by resulting in significant reduction in the machining cost is the key factor in the optimization process. During optimization, weight and cost are dealt separately.

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