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Research Note

FINITE ELEMENT ANALYSIS OF IC ENGINE CONNECTING ROD BY ANSYS

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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 aluminum alloys are finding its application in connecting rod. In this work we are comparing the von mises stress and total deformation of 2 different aluminium alloys with the forged steel. FEA analysis was carried out by considering three materials. The parameters like von misses stress, and displacement were obtained from ANSYS software. Then Compared the aluminium alloys with the forged steel. Then Al5083 alloy found to have less weight. It resulted in reduction of 63.19% of weight.

Keywords: Connecting rod, Reciprocating motion, Von mises stress, ANSYS

INTRODUCTION

The connecting rod connects the piston to the crankshaft and they form a simple mechanism that converts linear motion into rotary motion. The maximum stress occurs in the connecting rod near the piston end due to thrust of the piston. The tensile and compressive stresses are produced due to gas pressure, and bending stresses are produced due to centrifugal effect and eccentricity. So the connecting rods are designed generally of I-section to provide maximum rigidity with minimum weight. The maximum stress produced near the piston end can be decreased by increasing the material near the piston end.

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

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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 the case of four stroke engines, during compression and power strokes the connecting rod is subjected to compressive loads and during the last part of the exhaust and the beginning of the suction strokes, to tensile loads. In double acting steam engines, during the forward stroke the connecting rod is subjected to compressive load and during the return stroke, to tensile load. Connecting rod materials must have good fatigue and shock resistances. Connecting rods for automotive applications are typically manufactured by forging from either wrought steel or powdered metal. They could also be cast. However, castings could have blow-holes which are detrimental from durability and fatigue points of view. The fact that forgings produce blow-hole-free and better rods gives them an advantage over cast rods. Between the forging processes, powder forged or drop forged, each process has its own pros and cons. Powder metal manufactured blanks have the advantage of being near net shape, reducing material waste. However, the cost of the blank is high due to the high material cost and sophisticated manufacturing techniques. With steel forging, the material is inexpensive and the rough part manufacturing process is cost effective. Bringing the part to final dimensions under the tight tolerance results in high expenditure for machining, as the blank usually contains more excess material.

LITERATURE REVIEW

For the optimization study, Serag *et al.* (1989) developed approximate mathematical formulae to define connecting rod weight and cost as objective functions and also the constraints. The optimization was achieved using a Geometric Programming technique. Constraints were imposed on the compression stress, the bearing pressure at the crank and the piston pin ends. Fatigue was not addressed. The cost function was expressed in some exponential form with the geometric parameters.

Webster *et al.* (1983) performed three dimensional finite element analysis of a high-speed diesel engine connecting rod. For this analysis they used the maximum compressive load which was measured experimentally, and the maximum tensile load which is essentially the inertia load of the piston assembly mass. The load distributions on the piston pin end and crank end were determined experimentally. They modelled the connecting rod cap separately, and also modelled the bolt pretension using beam elements and multi point constraint equations.While investigating a connecting rod failure that led to a disastrous failure of an engine.

Hippoliti (1993) reported design methodology in use at Piaggio for connecting rod design, which incorporates an optimization session. However, neither the details of optimization nor the load under which optimization was performed were discussed. Two parametric FE procedures using 2D plane stress and 3D approach developed by the author were compared with experimental results and shown to have good agreements. The optimization procedure they developed was based on the 2D approach.

Sarihan and Song (1990), for the optimization of the wrist pin end, used a fatigue load cycle consisting of compressive gas load corresponding to maximum torque and tensile load corresponding to maximum inertia load. Evidently, they used the maximum loads in the whole operating range of the engine. To design for fatigue, modified Goodman equation with alternating octahedral shear stress and mean octahedral shear stress was used. For optimization, they generated an approximate design surface, and performed optimization of this design surface. The objective and constraint functions were updated to obtain precise values. This process was repeated till convergence was achieved. They also included constraints to avoid fretting fatigue. The mean and the alternating components of the stress were calculated using maximum and minimum values of octahedral shear stress. Their exercise reduced the connecting rod weight by nearly 27%.

Figure 1: Model of the Connecting Rod is Shown Below

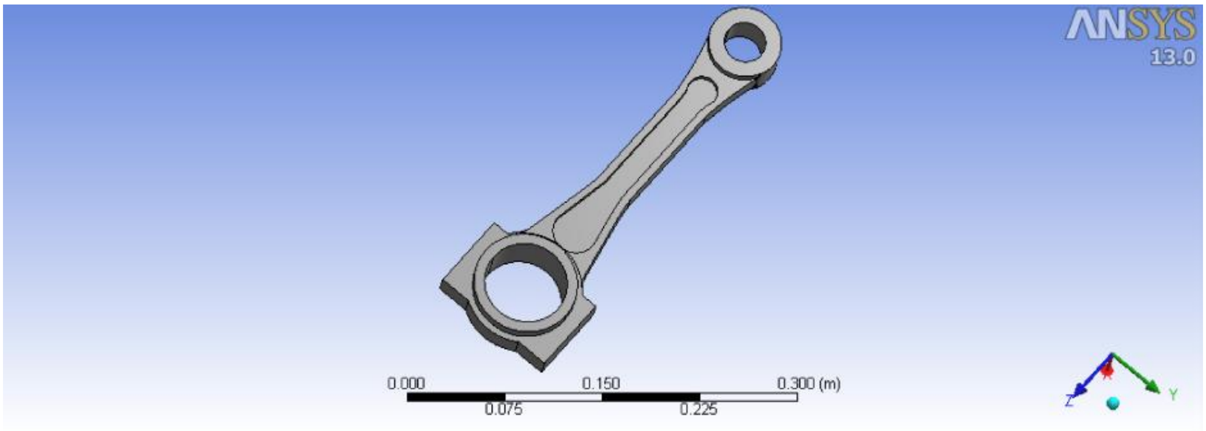


Figure 2: Fine Mesh Model is Shown Below

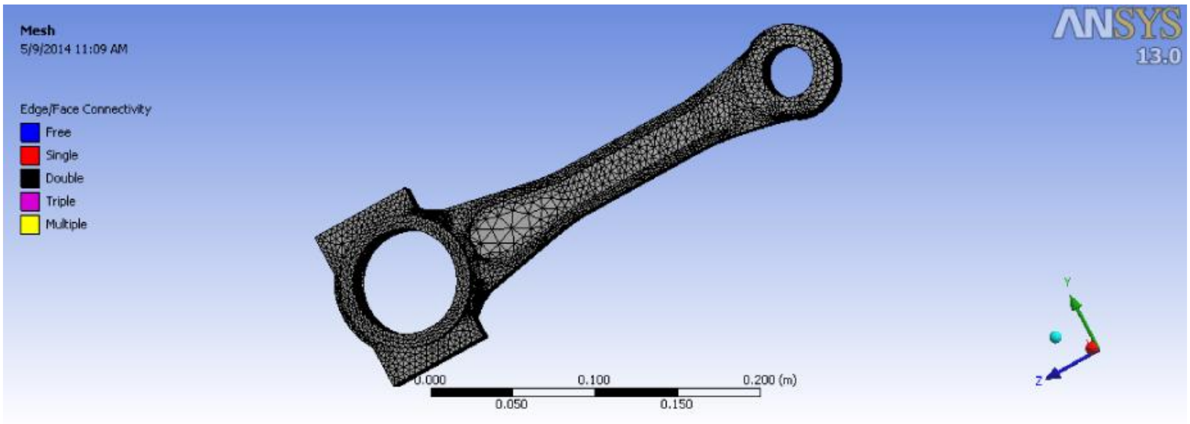


Figure 3: All the Degree of Freedom are Constrained at the Crank End

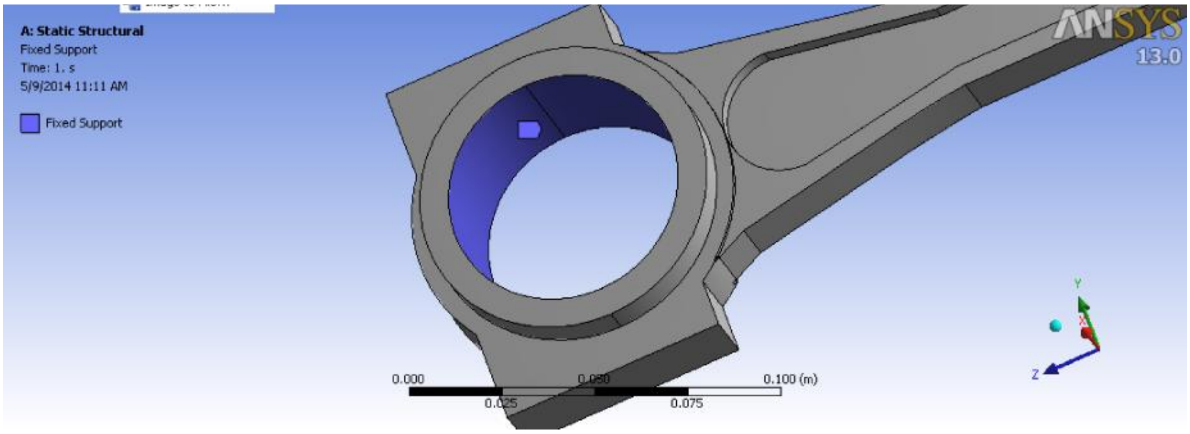


Figure 4: Loading is Done on Piston End (Compressive Loading)

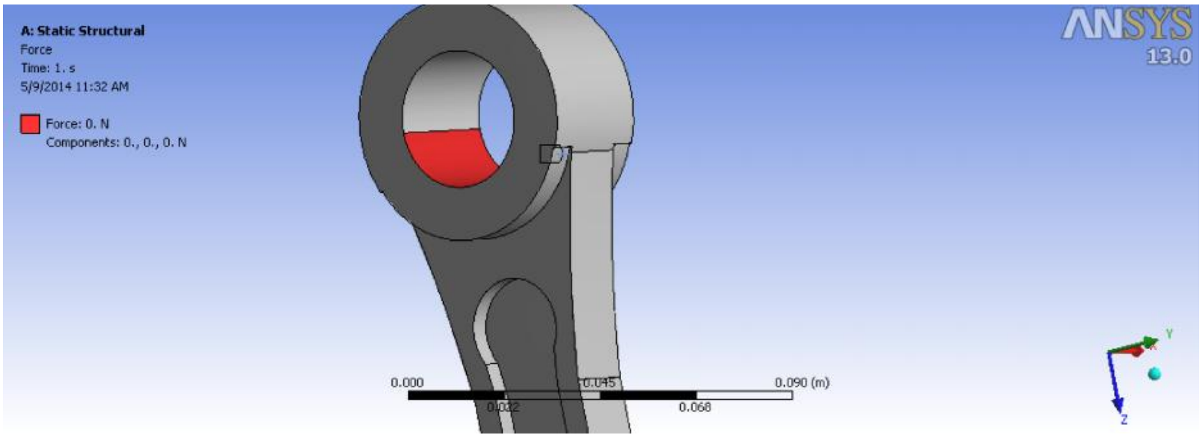


Figure 5: Von Mises Stress for 43926.42 N (Compressive) Al5083 Alloy

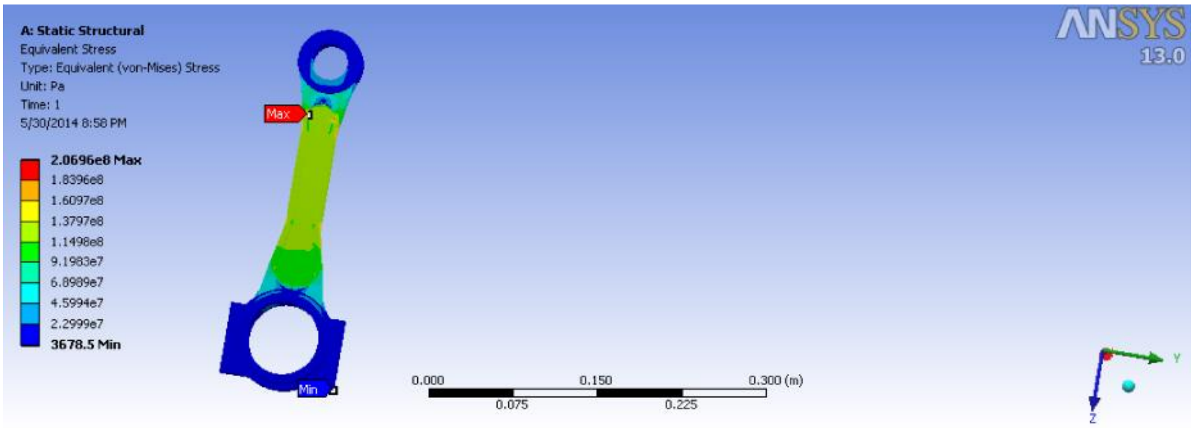


Figure 6: Von Mises Stress for 43926.42 N (Compressive) Al6061-T6

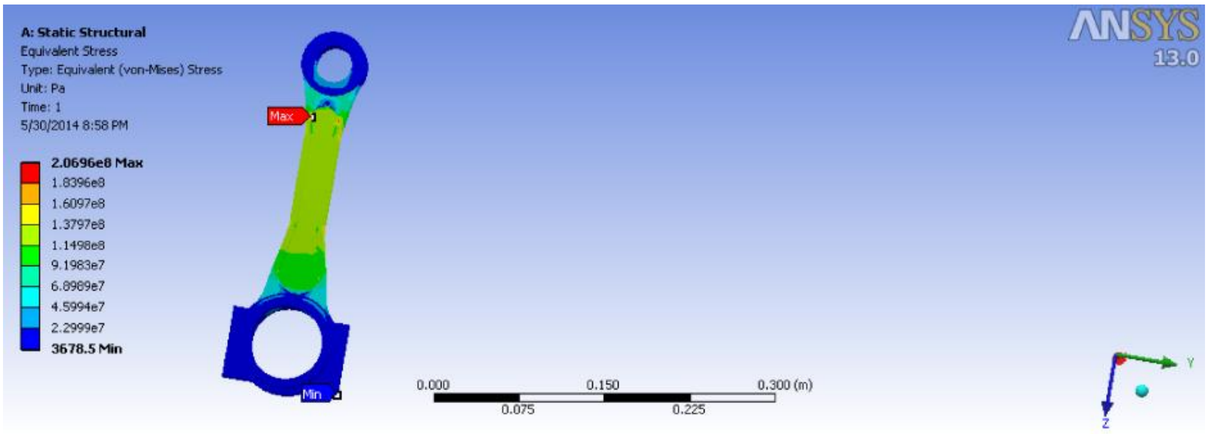


Figure 7: Von Mises Stress for 43926.42 N (Compressive) Forged Steel

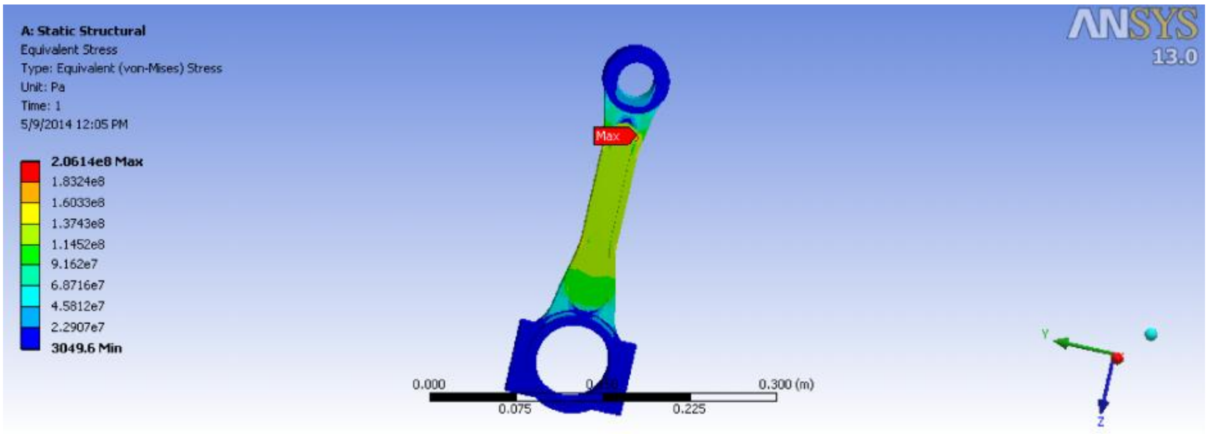


Figure 8: Total Deformation for 43926.42 N Al5083 Alloy

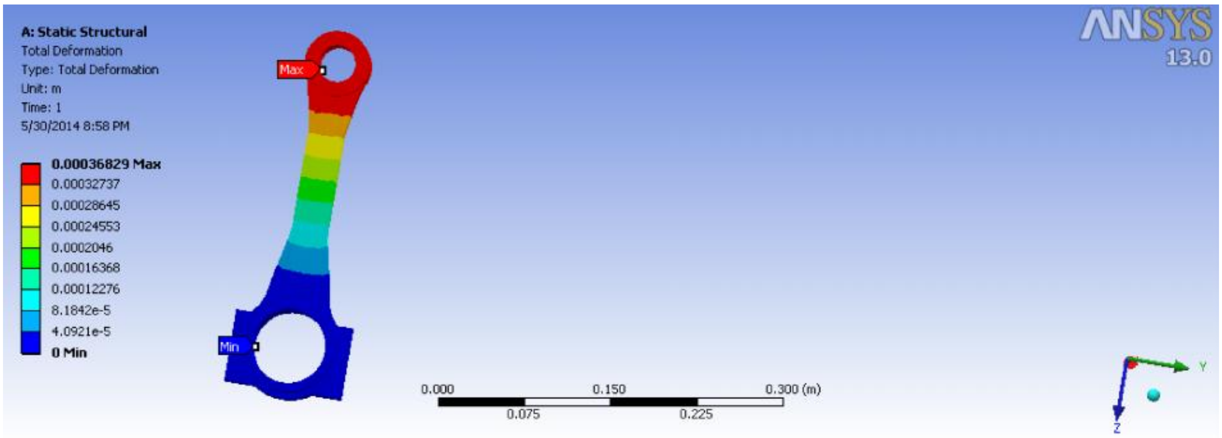


Figure 9: Total Deformation for 43926.42 N Al6061-T6

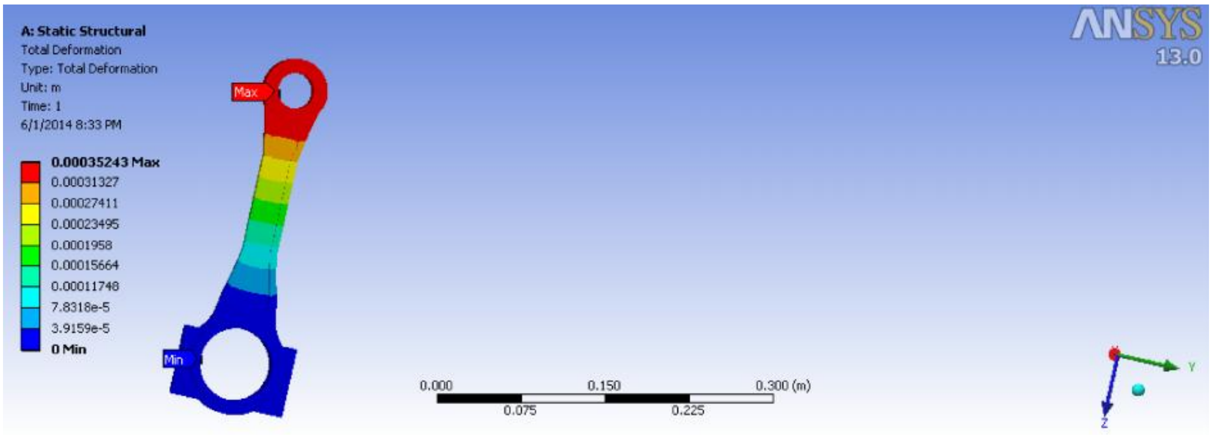
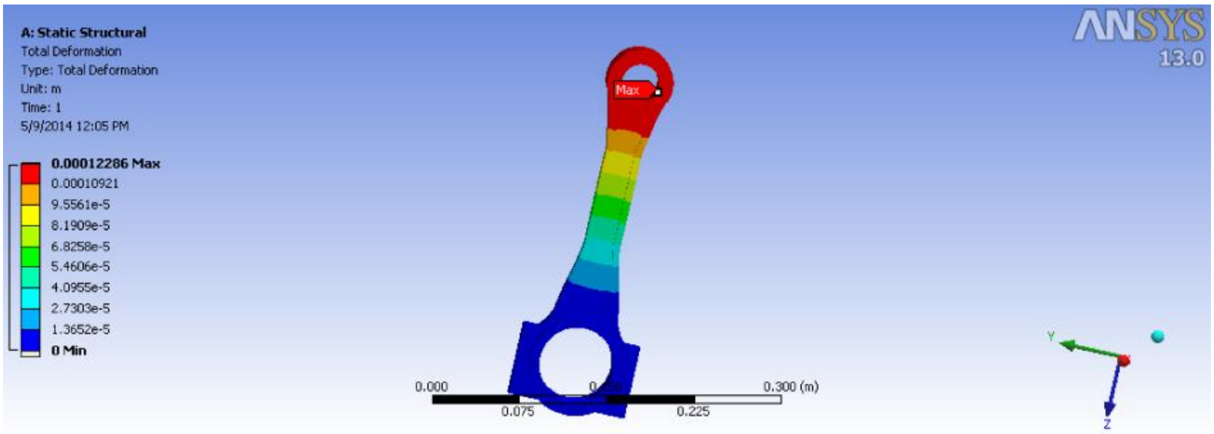


Figure 10: Total Deformation for 43926.42 N Forged Steel



CONCLUSION

- From the above analysis we can conclude that stresses of all the materials are almost comparable and also in safe limit, i.e., well below the yield stress.
- Weight of the connecting rod can be reduced by repacing currently using forged steel in kirloskar engine by aluminium5083 alloy.
- The section modulus of the connecting rod should be high enough to prevent high bending stresses due to inertia forces, eccentricities, as well as crankshaft and case wall deformations.
- Weight of connecting rod is reduced by 63.19%. Thereby reduces the inertia force.
- Comparison is also made between the three materials w.r.t. tensile stresses and al5083 alloy found least stresses.

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REFERENCES

1. Adila Afzal and Ali Fatemi (2003), "A Comparative Study of Fatigue Behavior and Life Predictions of Forged Steel and PM Connecting Rods", SAE International.
2. Augugliaro G and Biancolini M E (2010), "Optimisation of Fatigue Performance of a Titanium Connecting Rod", ISPESL, Italy.
3. Charkha P G and Jaju S B (2009), "Analysis & Optimization of Connecting Rod", 2nd International Conference on Emerging Trends in Engineering and Technology, ICETET-09.
4. Hippoliti R (1993), "FEM Method for Design and Optimization of Connecting Rods for Small Two-Stroke Engines", Small Engine Technology Conference, pp. 217-231.
5. Repgen B (1998), "Optimized Connecting Rods to Enable Higher Engine Performance and Cost Reduction", SAE Technical Paper Series, Paper No. 980882.
6. Sarihan V and Song J (1990), "Optimization of the Wrist Pin End of an Automobile Engine Connecting Rod with an Interference Fit", *Journal of Mechanical Design, Transactions of the ASME*, Vol. 112, pp. 406-412.
7. Serag S, Sevien L, Sheha G and El-Beshtawi I (1989), "Optimal Design of the Connecting Rod", *Modelling, Simulation and Control, B*, Vol. 24, No. 3, pp. 49-63, AMSE Press.
8. Shenoy P S (2004), "Dynamic Load Analysis and Optimization of Connecting Rod", May, Masters Thesis, University of Toledo.
9. Webster W D, Coffell R and Alfaro D (1983), "A Three Dimensional Finite Element Analysis of a High Speed Diesel Engine Connecting Rod", SAE Technical Paper Series, Paper No. 831322.
10. Yoo Y M, Haug E J and Choi K K (1984), "Shape Optimal Design of an Engine Connecting Rod", *Journal of Mechanisms, Transmissions, and Automation in Design, Transactions of ASME*, Vol. 106, pp. 415-419.