NOVATEUR PUBLICATIONS
INTERNATIONAL JOURNAL OF INNOVATIONS IN ENGINEERING RESEARCH AND TECHNOLOGY [IJIERT]
ISSN: 2394-3696
VOLUME 3, ISSUE 7, July-2016

ANALYSIS OF CONNECTING ROD USING REVERSE ENGINEERING METHOD AND MODIFY THE DESIGN USING POLYNOMIAL CURVE

MR. NILESH U. GUNJAL
P. G. Student, Production Department, Amrutvahini College of Engineering, Sangamner, Pune university Maharashtra-422608, India.

PROF. VILAS B. SHINDE
Professor, Production Department, Amrutvahini College of Engineering, Sangamner, Pune university,Maharashtra-422608, India.

ABSTRACT

Connecting rod is the most important part in the automobile sector it forms the link between piston and crankshaft. It is mostly used for the conversion of the reciprocation motion to rotary motion. Connecting rod receives the forces from the piston which are continuously varying in nature so stress on the connecting rod is continuously varying. So the design of the connecting rod is the most important criteria. The design changes of the connecting rod is not economical, because today's connecting rod is having cross section of I and the I cross section is having the largest load carrying capacity per unit weight of the connecting rod so the cross section change is not possible so only the corner radius of the connecting rod would be the option for the change without much more stress concentration.
The shape of the connecting rod is complicated so to generate the geometry of the connecting rod in any modelling software use of reverse engineering technique is essential. By using reverse engineering method scan the connecting rod which having complicated geometry so that we can easily import that geometry to create model. This model is used for the analysis purpose. The existing model of the connecting rod is takes various dynamic load so the connecting rod design is the critical criteria for the stress reduction in the connecting rod at the various corner point of the connecting rod like at the big end of the connecting rod sudden changes in geometry takes place.
The current investigation of the connecting rod model shows that the sudden change of the geometry of the connecting rod is design with the help of Bezier curve; the Bezier curve is the smooth curve of degree which is one less than the number of control point of the Bezier curve; and find out the result of the final connecting rod which having curvature with the Bezier curve.
The connecting rod design with the help of Bezier curve having less stress concentration as compare with the connecting rod which is design with the nominal curve.

KEYWORD: Analysis, Bezier Curve, Connecting Rod, Stress

INTRODUCTION

Connecting rod is used in reciprocating engine to connect the piston to the crank shaft. Together with the crankshaft it forms a simple mechanism which converts reciprocating motion to rotary motion. Mostly connecting rods are used in automobile sector. It has wide variety of application in automobile field. Basically connecting rods are manufacture with the forging operations; also connecting rods are to be manufacture with the casting process. The shape of the connecting rod is such that it can take the maximum variable load with minimum stress so that it can with stand the dynamic load.

The connecting rod takes the various forces like inertia forces, gas pressure force, and transmits that force to the crank shaft. The cranks produce the turning moment which cause the motion. A connecting rod in a high performance engine is subjected to inertial forces and bearing loads.

Connecting should be able to withstand these forces for a large number of cycles. In order to reduce the forces exerted during operation, the connecting rod should light weight as possible as and should have very high fatigue strength. The connecting rod undergoes cyclic tension, compression as well as bending. The connecting rod is subjected to a combination of axial and bending stresses.

Furthermore the connecting rod is subjected to a large compressive load so that it is imperative that buckling does not occur.

LITERATURE REVIEW

Giuseppe Sala of Italy (2001) presented research papers on technology driven design of MMC squeeze cast connecting rod. [1] He studied the continuous reinforcement MMC squeeze casting technology to produce the connecting rod for the racing car engines for the crucial aspects. He optimizes the shape of connecting for the placement of the fibre as efficient as possible. He then studied the load coming on the simple connecting rod and load coming on MMC composite rod. After load calculation the 3-D FEM analysis is carried out for the finite dimensions and stress calculation. He gives the final conclusion as the MMC connecting rod is 25% lighter than its steel counterpart while the both tensile and compressive overall inertial loads are reduced by 10%. The maximum Von misses equivalent stresses never overcome the values of MMC allowable. The specific characteristics of MMC connecting rod are remarkably higher (+20% strength, +29% stiffness) than those of its steel counterpart and could be improved through further optimization.

C. D. Zala, V. R. Patel(2014) L. D. College Of Engineering, Ahmadabad, India Presented the Paper of Finite Element Analysis And Weight Reduction Of H Beam Connecting Rod Through Composite Material Alsic Using Ansys [2] They compare the I section connecting rod with H section connecting rod and find out the strength for the two different cross section. And applying the boundary condition in ANSYS they give the result. The maximum tensile stress was obtained in lower half of pin end and between pin end and rod linkage. Here all above analysis carried out on the base of single piece connecting rod, but in actual condition it is in two pieces which are bolted together. H beam connecting rods are a little bit stiffer and rigid, that makes them ideal for higher horsepower and higher torque applications but have more weight for the same power developed compare to I beam connecting rod. Here to reduce the weight we are change the standard material of connecting rod to the composite material and optimizing with static analysis in ANSYS.

Moon Kyu Lee, Hyungyil Lee, Tae Soo Lee, Hoon Jang (2010)Buckling sensitivity of a connecting rod to the shank sectional area reduction [3] Yield, fatigue and buckling characteristics are often used as evaluation indexes for the performance of engine connecting rods in weight reduction design. There are, however, a limited number of studies on the buckling of connecting rods. Even the widely used field equations for the buckling have limitations in the application since they are derived from ideal support conditions. This study first presents an evaluation procedure for the buckling of a connecting rod via finite element analysis (FEA). The FEA approach allows us to treat the first and second modes of buckling collectively. The buckling stresses from the suggested FEA approach are closer to those measured in rig experiments than those from classical formula are. The stress sensitivities to the area reduction of rod shank are then examined in lights of yield, fatigue and buckling. The stress sensitivity in buckling indicates to be relatively higher than or comparable to those of yield and fatigue. Consequently, when weight reduction of connection rod shank is attempted, buckling should be considered as an essential factor along with the other criteria such as yield and fatigue.

W. Annicchiarico and M. Cerrolazafrom University of Venezuela (1999) presented paper on Finite elements, genetic algorithms and b-splines: a combined technique for shape optimization. [4] They represent the Shape optimization consists in changing the boundary shape of the structure to find the optimal design by verifying the prescribed constraints. The optimization technique proposed here is based on the parameterization techniques. The dimensions of the model also can be handled as Parameters. On the other hand, the geometric modeling in CAD systems can be carried out by using LaGrange polynomials, Bezier curves, B-splines and b-splines curves and surfaces and Coons patches Among these approaches, the b-spline curve properties can be easily controlled by using its parameters. The effect of these parameters is to change the parametric continuity between the curve segments while maintaining the geometry continuity. The geometric model generation is now considering for the optimization. In order to create this model the user has to divide the structure in super-elements and has to define the number of divisions in each direction of each super element, since the mesh generation module needs this information. The shape optimization problem consists in to find out the shape of the model which has a minimum weight and the Minimum stress concentration zones and finally, the search of a robust optimization algorithm, with good balance between efficiency and efficacy, necessary to survive in many different environments, has led to the use of Genetic Algorithms (GAs).The optimization technique used in this work was the Genetic Algorithms due to its great versatility, easy implementation and its ability to find out the optimum or quasi-optimum solution.

PROBLEM STATEMENT

The shape of the connecting rod is complicated so to generate the geometry of the connecting rod in any modelling software use of reverse engineering technique is essential By using reverse engineering method scan the connecting rod which having complicated geometry so that we can easily import that geometry to create model. This model is used for the analysis purpose. The existing model of the connecting rod is takes various dynamic load so the connecting rod design is the critical criteria for the stress reduction in the connecting rod at the various corner point of the connecting rod like at the big end of the connecting rod sudden changes in geometry takes place. The current investigation of the connecting rod model shows that the sudden change of the geometry of the connecting rod is design with the help of Bezier curve; the Bezier curve is the smooth curve of degree which is one less than the number of control point of the Bezier curve; and find out the result of the final connecting rod which having curvature with the Bezier curve.

NOVATEUR PUBLICATIONS
INTERNATIONAL JOURNAL OF INNOVATIONS IN ENGINEERING RESEARCH AND TECHNOLOGY [IJIERT]
ISSN: 2394-3696
VOLUME 3, ISSUE 7, July-2016

METHODOLOGY

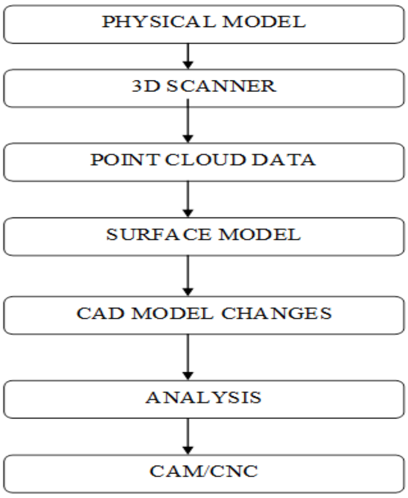

Fig -1 METHODOLOGY

ANALYTICAL FEA OF CONNECTING ROD

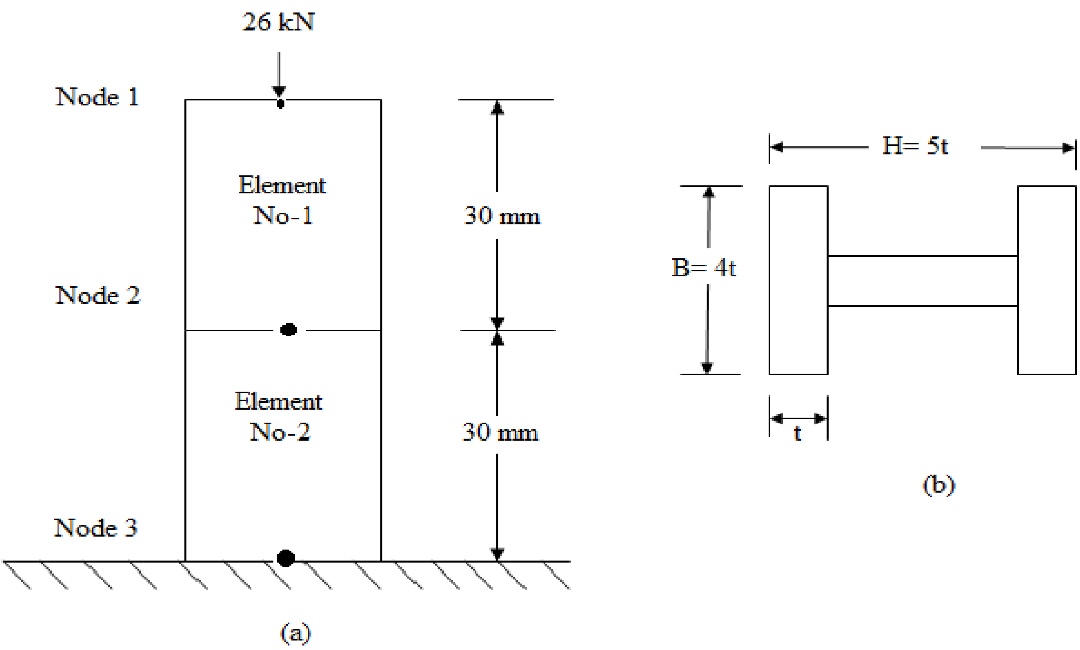

Figure -2 Analytical FEA of connecting rod

Material-20CrMo alloy steel
Modulus of Elasticity E=210 GPa = 200 x 103 MPa
ρ=7800 kg/ m3 =76518 × 10 -9 N / mm3
Cross sectional area=2×4t×t+3t×t=
11t2 = 11 × 152 =2475 mm2
Elemental stiffness matrix
For element no1
F2 = (A l ρ)/2

F2 = (2475 ×30×76518×〖10〗^(-9))/2
F2 = (2475 ×30×76518×〖10〗^(-9))/2
For element no 2
F3= (A l ρ)/2
F3 = (2475 ×30×76518×〖10〗^(-9))/2
F3 = (2475 ×30×76518×〖10〗^(-9))/2
Total load vector is calculated by
F=F1+F2+F3
Total nodal displacement
Writing relation [K] [UN]=[F]
Node 3 is fixed so eliminating row three 7 column 3 we get following two equations
17.32 × 106 U1 -17.32 × 106 U2 =26 × 103 +2.84….. (1)
-17.32× 106 U1 + 34.64 × 106 U2 =5.64…………… (2)
By solving these two equations we get
U1= 1.50 × 10-3 mm
U2=2.999 × 10-3 mm
U=4.49× 10-3 mm
& Reaction at support
R=-25.98 Kn
Stress in Element
σ= E/l
σ= (210 ×〖10〗^3)/30
= -10.5+20.99
σ=10.49 N/mm2
σ= 10.49 × 106 N/m2
σ= 1.049 × 107 N/m2
Result
Maximum stress in Element is 1.049 × 107 N/m2
Total Deflection of = 4.5 × 10-7 m

COMPRESSIVE TESTING USING UTM

Fig -3 Connecting rod with V-block

Fig -4 Load on connecting rod during bending

From the UTM test conclude that at 26.9kN load connecting rod start bending.
So Maximum stress is found by

$$\sigma = P/A$$

where

P= compressive force required to bend the rod = $26.9\times[10]^3$ N

A = cross sectional area of rod = 11t2 = 11 X 0.0152=2.745 $\times[10]^{(-3)}$ m2

$$\sigma = (26.9 \times[10]^3)/(2.475\times [10]^{(-3)})$$

$$\sigma = 1.090 \times [10]^7 \text{ N/m2}$$

Maximum stress is $1.090 \times[10]^7$ N/m2
Maximum Strain is $5.19 \times[10]^{(-5)}$

ANALYSIS OF CONNECTING ROD

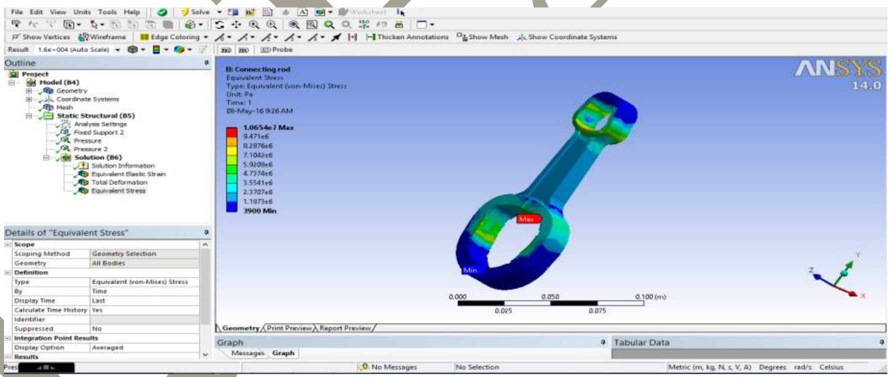

Fig -5 Equivalent stress of actual connecting rod

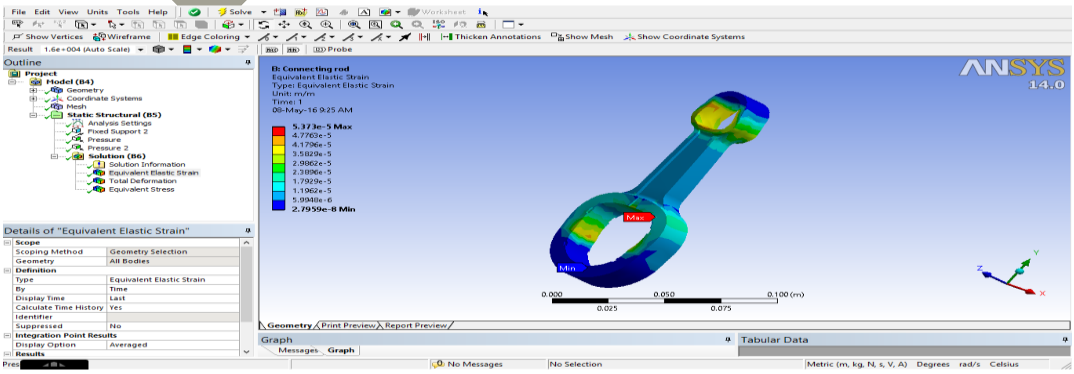

Fig -6 Equivalent elastic strain of actual connecting rod

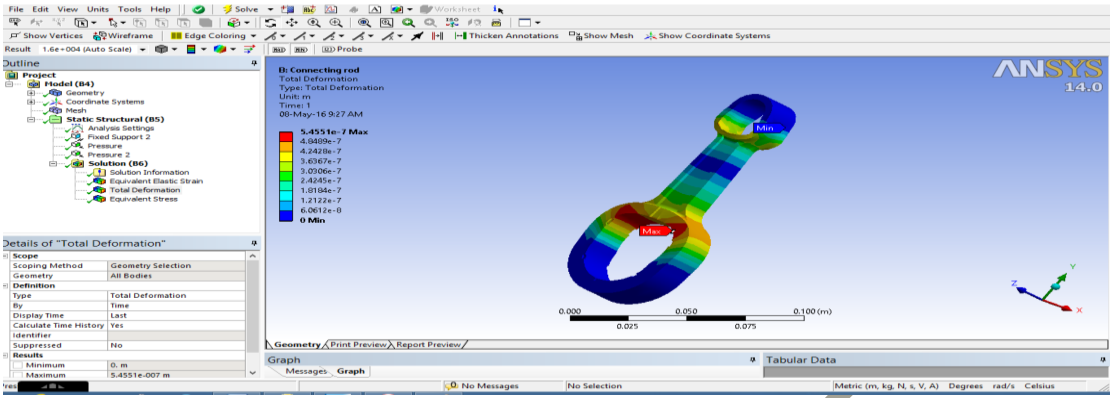

Fig -7 Total deformation of actual connecting rod

RESULTS

Table -1 Result of analysis of actual connecting rod

Parameters	**Results of Actual Connecting Rod**		
	By Ansys Software	**By Analytical Procedure**	**By Experimental Procedure**
Maximum Stress(N/m^2)	1.0654×10^{7}	1.0400×10^{7}	1.0901×10^{7}
Maximum strain	5.373×10^{-5}	4.990×10^{-5}	5.191×10^{-5}
Total Deformation (m)	5.455×10^{-7}	4.500×10^{-7}	4.981×10^{-7}

Table -2 Result of analysis of different curvature of connecting rod By Ansys

Parameters	**Maximum** Stress(MPa)	**Maximum strain**	**Total Deformation (mm)**
Third Order curve	1.103×10^{7}	5.5575×10^{-5}	5.478×10^{-7}
Fourth order curve	1.210×10^{7}	5.415×10^{-5}	6.0749×10^{-7}
Fifth order curve	9.5118×10^{6}	5.1164×10^{-5}	4.761×10^{-7}

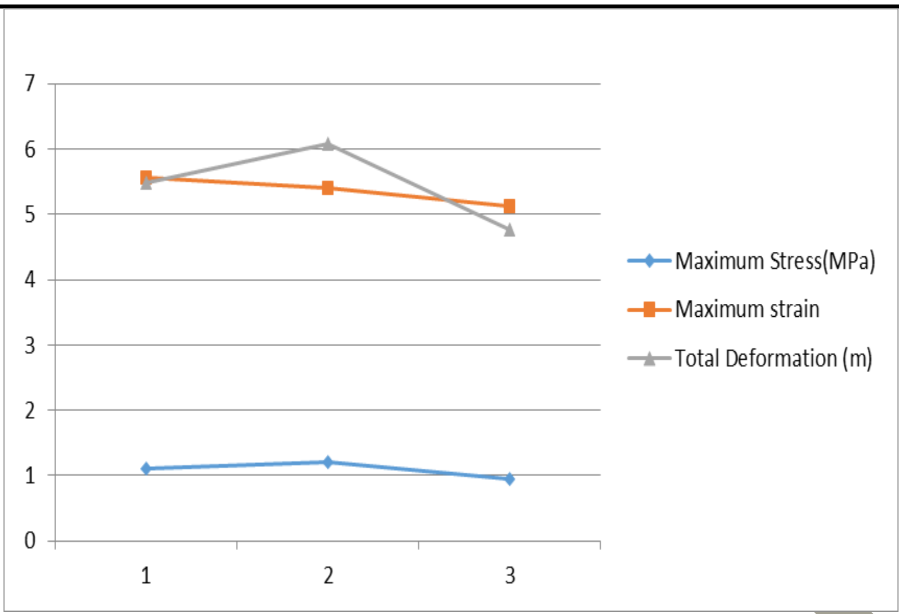

Chart -1: Graphical representation of the results from analysis

CONCLUSIONS

By using Analysis of Data We Are Making Observation table for the different design of the connecting rod

In that for the fifth order polynomial we get the minimum value than the original circular curve so that our selection must be fifth order polynomial to design the curvature of the connecting rod

The total deformation is minimum for the fifth order polynomial. Also the maximum principal stress is also minimum for the case of the fifth order polynomial.

ACKNOWLEDGEMENT

I express my sincere gratitude to my guide dept **HOD Prof. Shinde V. B.** (PG Coordinator) for his technical support which made this seminar III possible. His constant encouragement, suggestions and ideas have been in valuable to this work. I immensely appreciate the time he devoted reviewing my writing and vastly improving my technical writing skills. His thoroughness, discipline and work ethic are laudable and worthy of emulation.

I am also grateful to **Prof. Borkar B. R**. (Head Department of Production Engineering) for constant support and for providing me with all possible facilities in the college.

I am thankful to my fellow colleagues AVCOE, Sangamner for their technical help in shaping this seminar. My interactions with them greatly improved my technical knowledge and research skills. I shall always be indebted to my family for their unconditional love, support and trust on my judgments during good and bad times.

The dedication by my parents to provide the best of educational opportunities to me. They imbibed in us the importance of education, hard work and perseverance in attaining one's goals.

REFERENCES

1) *Analysis and optimization of connecting rod using ALFASiC composites, International Journal of Innovative Research in Science*, Engineering and Technology Vol. 2, Issue 6, June 2013
2) *Materialized Optimization of Connecting Rod for Four Stroke Single Cylinder Engine, International Journal of Computational Engineering Research*||Vol, 03||Issue, 10||
3) *Design Evaluation and Optimization of Connecting Rod Parameters Using FEM, International Journal of Engineering and Management Research*, Vol.-2, Issue-6, December 2012
4) *Static Stress Analysis of Connecting Rod Using Finite Element Approach, IOSR Journal of Mechanical and Civil Engineering* (IOSR-JMCE) e-ISSN: 2278-1684,p-ISSN: 2320-334X, Volume 10, Issue 1 (Nov. - Dec. 2013), PP 47-51
5) *Fatigue Analysis of Connecting Rod Using Finite Element Analysis to Explore Weight and Cost Reduction Opportunities for a Production of Forged Steel Connecting Rod, International Journal of Advanced Mechanical Engineering*. ISSN 2250-3234 Volume 4, Number 7 (2014), pp. 782-802
6) *Stress Analysis of I.C.Engine Connecting Rod by FEM*, International Journal of Engineering and Innovative Technology (IJEIT) Volume 1, Issue 3, March 2012
7) *Stress Analysis of Connecting Rod for Weight Reduction-A Review*, International Journal of Scientific and Research Publications, Volume 3, Issue 2, February 2013 1 ISSN 2250-3153
8) *Static Structure Analysis of Diesel Truck Engine Connecting Rod, IJSR - international journal of scientific* research Volume : 2 | Issue : 6 | June 2013
9) *Design optimization of connecting rod for internal combustion engine,* , International Journal of Scientific and Research Publications
10) *Design And Analysis of Connecting Rod Using Forged steel, International Journal of Scientific & Engineering Research*, Volume 4, Issue 6, June-2013