International Journal of Research in Engineering, Science and Management
Volume-2, Issue-3, March-2019
www.ijresm.com | ISSN (Online): 2581-5792

A Review on Shape Optimization and Analysis of Connecting Rod using Different Materials

A. Vimal[1], M. Ponmudi Srinivasan[2], P. Radha Krishnan[3], R. Vidyakar[4]
[1]*Assistant Professor, Dept. of Mechanical Engineering, Sri Eshwar College of Engineering, Coimbatore, India*
[2,3,4]*Student, Dept. of Mechanical Engineering, Sri Eshwar College of Engineering, Coimbatore, India*

***Abstract*: The connecting rod is a component which converts reciprocating motion from piston to rotary motion of crankshaft. The connecting rod undergoes cyclic load for its life time. As a result of this process it tends to various stresses and strain within it. This project is to attempt the designing of connecting rod using CREO software and subsequently to perform the analysis of various load and force actuation in it. The main objective of this present work is to improve the strength to weight ratio, its optimization by weight reduction in connecting rod, to do analysis of stress at varying load stress conditions of forged steel, aluminum, grey cast iron, titanium connecting rod.**

***Keywords*: shape optimization, connecting rod**

1. Introduction

The IC engines converts heat energy into mechanical energy with facilitate of piston, connecting rod and crank shaft. The work of connecting rod is to convert reciprocating motion into rotary motion. The two different force impacts over (CR) connecting rod one is buckling load due to gas pressure, another one is lateral bending due to inertia force. Whipping stress is produced because of the bending of connecting rod it is due to inertia force. By using FEA lateral bending connecting rod can be evaluated for each material. The modeling was done using CREO software.

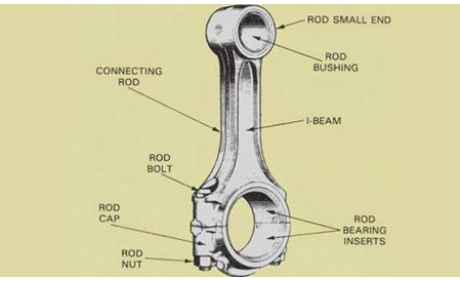

Fig. 1. Connecting rod

2. Research problem definition

The present work provides associate insight of bending stress acting along the body of rod because of inertia forces performing on the rod that square measure well-known by name of whipping stress. The bending moment relies on material elect for rod and is employed to gauge the bending stress acting on steel, Al7075, Al6061 and high strength carbon fiber. The comparative study of bending stress parameter provides the best material to be elect for rod of diesel engine.

3. Failure of rod

The rod is expanded or compressed for at each stage. The rods break due to this pressure and different accountable factors. The malformed connecting will block the engine and this destruction is referred as “throwing a rod”.

A. Fatigue

Fatigue is the cause for broken connecting rod in engines of olden days. The constant compression throughout power stroke and constant expansion throughout exhaust stroke over an N number of times per minute. So the metal wears out and become brittles and gradually stops.

B. Over revving

Over revving is that the primary reason of rod failures in new and high performance engines. If the measuring system hits the red even briefly the connecting rods square measure in peril of falling apart. This is often as a result of the forces working on a connecting rod increases dramatically at high revolutions. It does not count if the measuring system goes into the red because the machine is traveling at a high fastness.

C. Hydro lock

Connecting rod gets distorted when water enters into piston chamber through deep water drowning in flooded time

D. Pin failure

Gudgeon pin or piston pin links the connecting rod to the piston head due to repeating motion wearing occurs. It means connecting rod to walk over of this pin. So connecting rods dismantle from the engine. It results in catastrophic failure in engine.

4. Analysis of system

The term combustion engine refers to the engine in which operating fluid is within the work manufacturing chamber and in most of IC engines. This air fuel mixture is inducted throughout suction stroke additional explosion of the mixture ends up in generating of assorted gases and subsequent pushing of piston in downward direction. This downward motion is

transmitted to the crank shaft by suggested connecting rod and therefore sending member that is connecting rod should be a rigid link ideally.

5. Material selection

Connecting rod can be produced by casting, forging. Connecting rod should withstand complex state of loading. it undergone cyclic load of order 10^8 to 10^9 cycles. This ranges from high compressive load due to compression to high tensile load due to inertia. The durability of connecting rod is vital. Aluminum can also be employed because it is lighter than steel. the main objective of reducing the weight of engine component there by reducing inertia load, reducing engine weight and improve performance and fuel economy.

6. Literature survey

Ramesh B. T. and yet others study in "Analysis and Optimization of Connecting Rod with Different Materials" To select connecting rod of better performance for engine is toughest task. The material for connecting rods should be chosen carefully considering their manufacturing process, heat treatment process for better strength and stiffness. They selected high carbon connecting rod and compared with stainless steel, alloys of aluminum optimized the shape with the result. Considering factors of aluminum and steel they came to a conclusion that forged steel is better than carbon fiber and aluminum alloy in terms of handling stress, undergoing deformation, manufacturing feasibility, availability and cost.

Mohamed Abdusalam Hussin and yet others did a study in "Design and analysis of connecting rod using aluminum alloy 7068 t6, t6511" modeling of connecting rod using Solid Works tool and further analysis is done in ANSYS 15.0 tool. They considered von messes stress and strain, FOS (factor of safety), deformation etc. Since Al alloy has good factor of safety, less weight, less stress and stiffer. They have chosen AL alloy through fatigue analysis they found the life time of CR (connecting rod) and came to conclusion that by removing materials from no or minimum stress areas that material cost is reduced and shape is optimized. The reason why they consider ANSYS was it is the better software to analysis by considering finite elements. They mentioned that for more optimization Dynamic analysis is required.

Prateek Joshi and two others did a thesis about "FEM Analysis of Connecting Rod of different materials using ANSYS" CR (connecting rod) is responsible for up and down motion between crankshaft and piston of engine which converts reciprocating motion into rotary motion this thesis aimed to study the load, stress and strain of CR (connecting Rod) using various materials. The modeling was done in Pro E software and analysis was done in Ansys software. They aimed to use the result for long lasting life and better performance. They came to a conclusion that stress, displacement and strain generated in carbon fiber CR is higher than stainless steel CR. The Stress generated in Aluminum is higher than Carbon fiber so it is good to replace carbon fiber instead of Aluminum. Finally, they said that connecting rod made of carbon fiber will be a good for future use since it has comparable properties like strength with stainless steel and lighter than aluminum alloy.

Mansi S. Satbhai, P. S. Talmale they both researched on "Review on design and analysis of two wheeler connecting rod" connecting rod of Bajaj pulsar 220CC (cubic capacity) engine. They considered weight reduction and attempted to modify the current design of connecting rod using design parameters. They came to a conclusion that C70 material is designed by considering pressure of 38.67 KN.

Prakash Shanker Kumar and Kaushik Kumar both studied in "Stress Analysis and Shape Optimization of Connecting Rod using Different Materials" they said that forged steel is used to make connecting rod due to its good mechanical properties like tension, toughness, comparison fatigue. The main objective of the present work is to improve the strength to weight ratio, its optimization by weight reduction in connecting rod, to do Analysis of stress at varying load and stress conditions and optimization of shape for the production of forged steel, aluminum, and grey cast iron, titanium connecting rod. The connecting rod should have sufficient stiffness, strength to undergo the tension load, compression load, bending and so on. In every cycle connecting rod will undertake a different alternating load.

Dr. N. A. Wankhade and Suchita Ingale review on "Design and Analysis of Connecting Rod Using Different Material" mention that Forces excreted on the connecting rod are usually by weight and combustion of fuel in cylinder, which impacts upon piston and on the CR (connecting rod). Thereby results in both the axial stresses and bending stresses. This paper attempt to design and analyze the connecting rod used in a diesel engine. The material is steel modeled using CAD tool which is CATIA V5. There it is analyzed for bending stress of finite element analysis using ANSYS workbench 14.5. This method is followed for different material which is aluminum 7075, High Strength Carbon and aluminum 6061. They came to a conclusion that the geometric modeling generated with the Help of specification of design procedure is analyzed for bending stress which is caused by bending moment due to inertia of connecting rod. The FEA helps to correct the approximate values of bending stress. Impacts on different material such as High strength carbon fiber, Al6061 and Al 7075, which are used to compare with the typical material employed is steel. The connecting rod of high strength carbon fiber is lesser in bending due to inertia and can be better suited for connecting rod of diesel engine.

Yong-Fei WANG, Sheng-dun ZHAO, Chen-yang ZHANG worked in "Microstructures and mechanical properties of semi-solid squeeze casting ZL104 connecting rod" said that liquid squeeze casting (LSC) and Semi-solid squeeze casting (SSSC) processes are used to fabricate a ZL104 connecting rod. The impact of the process parameters on the mechanical properties and microstructures were investigated. The result says that the

tensile strength and elongation of the SSSC-fabricated rod were increased by 17% and 22% compared with those of the LSC-fabricated rod. They concluded that the connecting rod analysis is done to check out to the fatigue life and alternating stress development.

R. J. Yang, D. L. Dewhirst, J. E. Allison and A. Lee Ford Motor Company work about "Shape optimization of connecting rod pin end using a generic model" by finite element based project on structural optimization and gave a special attention to modeling issues. They considered upper end or pin end for optimization by using different commercial modules. They ended up with six iterations for modeling pin end as accurate.

D. Gopinatha, Ch. V. Sushmab studied about "Design and Optimization of Four Wheeler Connecting Rod Using Finite Element Analysis" said that their main objective is to find weight reduction opportunities for aluminum, forged steel and titanium CR (connecting rods).

From conclusion they stated that Mass of the optimized CR (connecting rod) is 483 grams and the optimized geometry is 10.38% lighter than the current connecting rod for the same strength.

G. Gopala, Dr. L. Suresh Kumar, K. Vijaya Bahskar Reddy, M. Uma Maheshwara Rao, G. Srinivasulu ICAAMM-2016 "Analysis of Piston, connecting rod and Crank shaft" they did a study on piston, crankshaft, and connecting rod assembly of four wheeler engine. They performed FEA using Ansys software for above components.

7. Conclusion

The shape of connecting rod is optimized by considering various stress and strain factors. The material is removed on basis of removing no stress or minimum stress areas to reduce the weight of connecting rod. The FEA approaches helps to judge the approximate value acting on connecting rod using different material like AL7075, AL6067, high strength carbon fiber that area unit accustomed compare with conventional material utilized is steel. The connecting rod of high strength carbon fiber suffer lesser in context of bending thanks to inertia and therefore will be best fitted to connecting rod.

References

[1] Ramesh B. T, Vinayaka Koppad, Hemantha Raju T, "Analysis and Optimization of Connecting Rod with Different Materials," World Journal of Research and Review (WJRR), Volume 4, Issue 1, January 2017, Pages 33-39.

[2] Mohamed Abdusalam Hussin, Prabhat Kumar Sinha, Arvind Saran Darbari, "Design and Analysis of Connecting Rod Using Aluminum Alloy 7068 T6, T6511," Volume 5, Issue 10, October (2014), pp. 57-69.

[3] Prateek Joshi, Mohammed Umair Zaki "FEM Analysis of Connecting Rod of Different Materials Using ANSYS," Journal of Engineering and Technical Research, Volume 1, Issue 3, May/June 2015.

[4] Mansi S. Satbhai, P. S. Talmale "Review on Design and Analysis of Two Wheeler Connecting Rod," in International Research Journal of Engineering and Technology, Volume 4, Issue 9, September 2017.

[5] Prakash Shanker Kumar and Kaushik Kumar "Stress Analysis and Shape Optimization of Connecting Rod Using Different Materials," in REST Journal on Emerging trends in Modelling and Manufacturing, Vol. 1 (2), pp. 20-28, 2015.

[6] Afsal A and Fatemi A "Selection of Material, Shape and Manufacturing Process for A Connecting Rod" SAE Technical, 2004.

[7] Shweta Ambadas Naik "Design & Shape Optimization of Connecting Rod Using FEA: A Review," International Journal of Engineering and Technical Research (IJETR), Volume 2, Issue 8, August 2014.

[8] R. J. Yang, D. L. Dewhirst, J. E. Allison and A. LeeFord Motor Company, Shape optimization of connecting rod pin end using a generic model 23400 Michigan Acenue, VPl l00, Dearborn, MI 48124, USA.

[9] D. Gopinatha, Ch. V. Sushmab, "Design and Optimization of Four Wheeler Connecting Rod Using Finite Element Analysis," in 4th International Conference on Materials Processing and Characterization.

[10] Assembly G. Gopala, L. Suresh Kumar, K Vijaya Bahskar Reddy, M Uma Maheshwara Raod, G. Srinivasulu, "Analysis of Piston, Connecting rod and Crank shaft," ICAAMM-2016.

[11] R. Suresh Kumar S. Ganesh Kumar, V. Thirunavukkarasu, "Investigation of wear behabiour of Silicon Carbide tool inserts and Titanium Nitride Coated tool inserts in machining of EN8 Steels," in International Journal of Mechanical Engineering & Technology, Volume 10, Issue 01, 1862-1873, 2019.

[12] R. Sureshkumar, John Alexis, V. S. Thangarasu, "Optimization of high speed CNC end milling process of BSL 168 Aluminium composite for aeronautical applications," in Transactions of the Canadian society for Mechanical Engineering, Volume 44, Issue 04, 610-625, 2017.

[13] S. Venkatesh "Energy analysis in IC Engine using diesel blends as a fuel," in International journal of applied engineering research, Volume 10, Issue 08, pp. 5831-5836, 2015.

[14] T. Ramakrishnan, K. Sathish, P. S. Sampath, "Experimental Investigation and optimization of surface roughness of AISI 52100 Alloy steel material by Using Taguchi method," Volume 10, Issue 06, 2016.

[15] N. Manigandan, V. Naveen Prabhu and M. Suresh, "Experimental Investigation of a Brazed Chevron Type Plate Heat Exchanger," in International Journal of Science Technology & amp; Engineering, Vol. 1 (12), (2015), pp.1-7.

[16] V. Naveen Prabhu and N. Manigandan, "Design and Fabrication of Solar Transport Vehicle" IOSR Journal of Mechanical and Civil Engineering," pp.14-19.

[17] Y. Sureshbabu and P. Ashoka Varthanan, "Study the emission characteristics of catalytic coated piston and combustion chamber of a four stroke spark ignition (SI) engine," in Journal of Chemical and Pharmaceutical Sciences, JCHPS Special Issue 4, December 2014, pp-126-127.

[18] F. Justin Dhiraviam, V. Naveen Prabhu, T. Suresh, and C. Selva Senthil Prabhu, "Improved Efficiency in Engine Cooling System by Repositioning of Turbo Inter Cooler," Applied Mechanics and Materials, vol. 787, (2015), pp. 792–796.