REVIEW ON DESIGN AND ANALYSIS OF TWO WHEELER CONNECTING ROD

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Abstract - *A Connecting rod is the link between the reciprocating piston and rotating crank shaft. Small finish of the connecting rod is hooked up to the piston by the use of gudgeon pin. The operation of the connecting rod is to convert the reciprocating movement of the piston into the rotary movement of the crankshaft. This work focus on the experimental investigation of connecting rod of Pulsar-220 for weight optimization with enhancement in existing design. In this work the attempt is to modify the existing design of connecting rod by satisfying the desired design and application constraints by the brief literature review. With the brief literature review methodology is formulated and the modified connecting rod design is proposed for the modification of connecting rod for the Pulsar.*

***Key Words*: chemical composition, desired constraints.**

1. INTRODUCTION

A Connecting rod is the link between the reciprocating piston and rotating crank shaft. Small finish of the connecting rod is hooked up to the piston by the use of gudgeon pin. The operation of the connecting rod is to convert the reciprocating movement of the piston into the rotary movement of the crankshaft. A blend of axial and bending stresses act on the rod in operation. The axial stresses are produce due to cylinder fuel strain and the inertia force bobbing up on account of reciprocating motion. Whereas bending stresses are triggered due to the centrifugal effects. To furnish the highest stress with minimal weight, the move element of the connecting rod is made as I – part. Small finish of the rod is a superior eye or a break up eye, this end holds the piston pin. The big finish relaxation on the crank pin and are continuously cut up for heavy engines. In some connecting rods, a hole is drilled between two ends for carrying lubricating oil from the big finish to the small finish for lubrication of piston and the piston pin. The intermediate component between crank and piston is known as connecting rod. The objective of CR is to transmit push & pull from the piston pin to the crank pin and then converts reciprocating motion of the piston into the rotary motion of crank

1.1. OBJECTIVE

This paper focus on the literature review associated with the design and analysis of connecting rod.

2. LITERATURE SURVEY

This chapter sets the background for up-coming sections. It is an assessment of the present state of art of the wide and complex field of optimization of electro discharge machining by design of experiment and its application. In addition, this chapter separately reviews what did in the past in the area of application.

Sarkate et al [1] had carried out the study concluded that the stress analysis of connecting used in engine has been presented and discuss in this paper. The results obtain by FEA for both Aluminum 7068 alloy and AISI 4340 alloy steel are satisfactory for all possible loading conditions. By using Aluminum 7068 alloy instead of AISI 4340 alloy steel can reduce weight up to 63.95%. Also equivalent stresses for Aluminum 7068 alloy is less by 3.59%. The factor of safety of connecting rod will reduce by 9.77% in case tensile load applied at crank end but it will increase in all other load conditions if Aluminum7068 alloy is used instead of AISI 4340.

Anusha et al [2] had carried out study on "Comparison of Materials For Two-Wheeler Connecting Rod Using Ansys" The modeled connecting rod imported to the analysis software i.e. ANSYS. Static analysis is done to determine von-misses stresses, strain, shear stress and total deformation for the given loading conditions using analysis software i.e. ANSYS. In this analysis two materials are selected and analyzed. The software results of two materials are compared and utilized for designing the connecting rod.

Kumar et al. [3] analyzed Two Wheeler Connecting Rod. In this work connecting rod was replaced by Aluminum reinforced with Boron carbide for Suzuki GS150R motorbike. A 2D drawing was drafted from the calculations. A parametric model of connecting rod was modeled using PRO-E 4.0 software. Analysis was carried out by using ANSYS software. Finite element analysis of connecting rod was done by considering two materials, viz. Aluminum Reinforced with Boron Carbide and

Aluminum 360. The best combination of parameters like Von misses stress and strain, Deformation, Factor of safety and weight reduction for two wheeler piston were done in ANSYS software. Compared to carbon steel, aluminum boron carbide and aluminum 360, Aluminum boron carbide is found to have working factor of safety is nearer to theoretical factor of safety, 33.17% to reduce the weight, to increase the stiffness by 48.55% and to reduce the stress by10.35% and most stiffer.

Sahu & Jayant [4] had carried out study for a contact analysis is to be carried out to analyze the stresses arising from the interference of the connecting-rod bearing and the piston-pin bushing.. It's been found that most of the connecting rod of IC Engine are made of Cast iron. But on comparison of different materials for similar boundary conditions & loading conditions it's been observed that out of the three materials Aluminum alloy is the most suitable material on the basis of Stress, Safety factor, Life, Thermal Resistivity, fatigue & damage because such connecting rod does not fails even at varying loads unlike Cast iron rod And by using aluminum alloy we can also reduce the weight of the connecting rod.

Ramakrishna & Venkat esh [5] had carryout study of connecting rod of LML freedom is studied for the optimization of the material can be reduced by changing the material of the current 4340 alloy steel connecting rod to AlSiC-9. The optimized connecting rod is 61.6560% lighter than the current connecting rod.

Reddy et al [6] had carried out study to determine Von misses stress and pressure, deformation, aspect of defense and weight discount for two wheeler pistons and concluded that Fatigue strength is the principal driving factor for the design of connecting rod and it's determined that the fatigue results are in good agreement with the present outcomes. The stress is determined maximum on the piston finish so the material is improved within the stressed portion to shrink stress.

Jaganathan & Dinesh [7] studied the Modal analysis method is used to determine natural frequencies of a connecting rod and compare results with FFT analyzer. This work investigated suitable better fabric for connecting rod. Modal evaluation used to be performed to the connecting rod with laptop centered FEA simulation instruments. EMA used to be then carried out using FFT analyzer to search out ordinary frequencies of connecting rod. The following conclusions may also be drawn from this be taught. The natural frequencies decided with the aid of utilizing FEA procedure are almost much like the common frequencies decided via utilizing EMA approach for current carbon metal (16MnCr5) connecting rod. The common frequencies determined by utilizing FEA process are nearly just like the traditional frequencies decided by utilizing EMA method for Aluminium LM9 connecting rod. It is found that, traditional frequency of Aluminium LM9 connecting rod is bigger than current carbon steel (16MnCr5) connecting rod. Additionally it is located that the Aluminium LM9 connecting rod is gentle in weight than present carbon metal (16MnCr5) connecting rod.

Herakal & Goud [8] carry out study in order to analyze the rod under the fatigue load by using the fully reversed loading condition. To check out the behavior of rod under the fatigue load with Goodman's criteria &to check out the up to how many cycle it can work without failure. From the experiment it s concluded by the stress analysis that, maximum stress is at the small region. Also maximum stress is at the small region. The connecting rod is operating within the S-N curve of the structural steel so it's never fail as it is working under the 105 cycles.

Singh[9] had conducted study replace the conventional material of connecting rod i.e., steel with the Composite material (E-Glass/ Epoxy). In this study von misses stresses, deformations and other parameters are ascertained which has been done by doing the FEA of the connecting rod. Linear static analysis was performed on MSC.PATRAN of the connecting rod for the conventional as well as for the E-Glass/Epoxy to get the varied results. On comparing the von-misses stresses in the two materials it was found that there is reduction of 33.99% of stresses when convention steel was replaced with the orthotropic E-Glass/Epoxy. For connecting rod it is suggested to replace Conventional steel with E-Glass/Epoxy. When the Displacement component was compared, again there was reduction of 0.026% displacement when material used was E-Glass/Epoxy

Agarwal et al [10]The objective of present study is carried out the analysis of a two wheeler connecting rod of different materials and making a meaningful comparison among results of analysis, which can be helpful for getting suitable material for the manufacturing of connecting rod. Study also incorporates the fabrication of material by changing the chemical constituents to find the new material. A comparative study is made between Forged Steel, Titanium Alloy, and Aluminium Alloy 7075. The results show that Aluminium Alloy 7075 is having lesser value of Von-Mises Stress and Strain, so it is chosen for further study. Next the fabrication of materials by changing the Silicon and Aluminium percentage in Aluminium 7075 is done and mechanical properties are find out using tensile testing. Then analysis is performed to evaluate Von-Misses stress and Strain against the mechanical properties increasing the Silicon percentage to some extent in Aluminium Alloy, the Stress and Strain get reduced

Gupt & Nawajis [11] in this work existing connecting rod material is replaced by beryllium alloy and magnesium alloy. Maximum von misses strain and Maximum displacement is minimum in connecting rod of Beryllium alloy in comparison of rest of two materials comparing the different results obtained from the analysis. The stress induced in the Beryllium alloy is less than other for the present investigation. Here beryllium alloy can be used for production of connecting rod for long durability.

Aishwarya and Ramanamurthy [12] paper describes about a real time problem of using Cast Iron connecting rod in Hero Honda Splendor + motorbike it's modeling and analysis and optimization of connecting rod. Here, the connecting rod is replaced by various materials like stainless steel, aluminium, C70 steel and also a design change by inducing truss member is suggested. This work also tends to optimize the design by calculating weight and stiffness for various materialistic designs by using the output values of mass and volume of the connecting rod. From that they concluded that A truss type connecting rod modeling is done using CATIA software and the feasible parameters are been obtained. From the analysis it is clear that the stress and strain obtained by the modified design is less when compared to the existing design. Weight reduction can be clearly viewed in the comparison graph between the solid and truss design.

Ram et al [13] in this Static analysis is carried out on the piston pin end and crank pin end of connecting rod then further study was show to explore weight reduction possibility. It was concluded that The Peak stresses mostly occurred in the transition area between pin end, crank end and shank region. Forces at pin end are lower in comparison to the forces in crank end so strength of pin end should ideally be lower in comparison to the strength of crank region. Factor of safety was greater than 3.7 in both tensile as well as compressive loading cases for both original as well as optimized model. Percentage weight reduction was about 13% which will save material directly to reduce the manufacturing cost with increased engine efficiency.

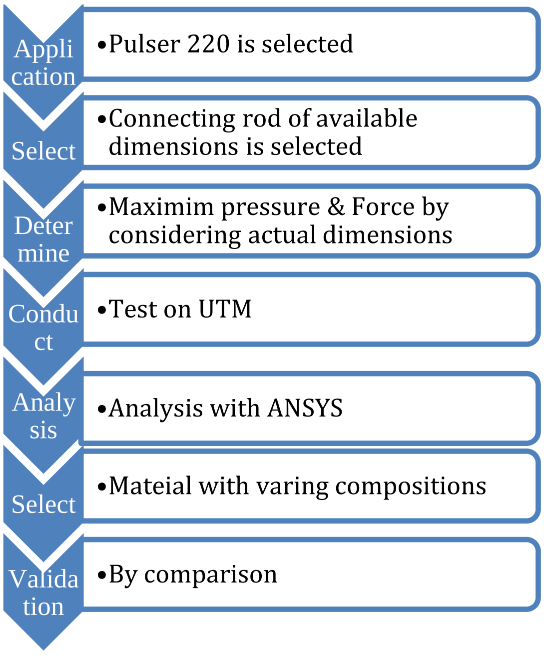
Sushant, & Gambhir [14] had carried out study on aluminum and carbon steel by FEA, When force is applied at small end, von-misses stress for C-70 connecting rod is 398.52 MPa and Al-7068 connecting rod having von-misses stress is 380.83 MPa. The reduction of von-misses stress is 4.43 %. The equivalent elastic strain for C-70 connecting rod is 0.0021785 mm/mm and Al-7068 connecting rod is 0.0053424 mm/mm. Shear stress for C-70 connecting rod is 212.87 MPa and Al-7068 connecting rod is 200.93 MPa. The reduction of shear stress is 5.60%. The bending stress for C-70 connecting rod is 205.69 MPa and Al-7068 connecting rod is 202.58 MPa. The reduction in bending stress is 1.5%. When force is applied at big end, von-misses stress for C-70 connecting rod is 399.6 MPa and Al-7068 connecting rod is 381.48 MPa. The reduction of von-misses stress is 4.53 %. The equivalent elastic strain for C-70 connecting rod is 0.0020713 mm/mm and Al-7068 connecting rod is 0.0052979 mm/mm. Shear stress for C-70 connecting rod is 214.51 MPa and Al-7068 connecting rod is 202.08 MPa. The reduction of shear stress is 5.79%. The bending stress of C-70 connecting rod is 230.63 MPa and Al-7068 is 229.47 MPa. The reduction in bending stress is 0.5%. The reduction of mass is 63.61% by using Al-7068 material connecting rod.

Peeyush & Sethi [15] had carried out study on the design evaluation of connecting rod using FEM for high cycle fatigue strength. From the study that the following conclusions are drawn from high cycle fatigue behavior of connecting rod, Mean and alternating stresses calculated for the connecting rod are on a moderate level. Resulting factors of safety are uncritical at shank of Connecting rod. The required minimum factor of safety is 1.5. The occurring minimum is 1.71 at the connection between shank and big end. The results obtained are logical and can be used to improve or modify the parts, shapes and performance of the whole

Bagri & Telang [16] Focus on optimized value for shank fillet radius to reduce maximum equivalent von misses stress by Parametric optimization it is found that shank fillet radius has big influence on the stress distribution on the shank portion of the connecting rod. It was found that at shank fillet radius of 20mm get the minimum von misses stress of 747 MPa compared to other parametric studies. Modal analysis is performed with changed shank fillet radius and reduced deformation was observed in the model and compared with the initial model.

Webster et. al. [17] was explained the loading of connecting rod in diesel engine. The Tension and compression loadings were used based on experimental results. It is highest stress occurred at four location of connecting rod. The upper area of cap end on the axis of symmetry, the transition region of bolt section and the lower rib, the transition region of the lower rib and connecting rod's bolt head. Pranav et. al. [18] carried out the FEA and optimization of connecting rod using ANSYS Workbench. The study two type of analysis, static analysis and fatigue analysis. The main objective of this study was explore the weight of connecting rod. The weight reduction of achieved by 9.24% under static loading conditions of existing connecting rod. Pravardhan et. al. [19] presented the FEA procedure for optimization for connecting rod weight and cost reduction. Weight reduction forged steel connecting rod by iterative procedure. This study result was in an optimized connecting rod 10% lighter and 25% less expensive as compared to existing connecting rod. Vasile et.al.[20] Was presented a method used to verify the stress and deformation of connecting rod using FEM with ANSYS. The obtained results by this method to compared results obtained by classic calculation, in similar conditions of application, and after wards conclusion were drawn.

3. Methodology



4. Dimensions of I Section For Connecting Rod

Check section chosen is satisfactory or not is very important, Connecting rod is considered like both ends hinged for buckling about X-axis and both ends fixed for buckling about Y-axis. So connecting rod should be equally strong in buckling about both axes. So Ixx = 4Iyy, Where Ixx = Moment of inertia of the section about X-axis
Iyy = Moment of inertia of section about Y-axis, Ixx is kept slightly less than 4Iyy

$$A_s = 2(4t \times t) + 3t \times t = 11t^2$$

$$I_{XX} = \frac{1}{12}[4t(5t)^3 - 3t \times (3t)^3] = \frac{419}{12}t^4$$

$$I_{YY} = 2 \times \frac{1}{12} \times t(4t)^3 + \frac{1}{12} \times 3t \times (t)^3 = \frac{131}{12}t^4$$

$$\frac{I_{XX}}{I_{YY}} = \frac{419}{12} \times \frac{12}{131} = 3.2$$

$$\frac{I_{xx}}{I_{yy}} = 3.2$$

$$I_{xx} = 3.2 I_{yy}$$

So Section is satisfactory.
Now for dimension of I- section. The connecting rod is designed by taking the force on the connecting rod (Fp) equal to the maximum force on the Piston (FL) due to gas pressure of 38.87kN

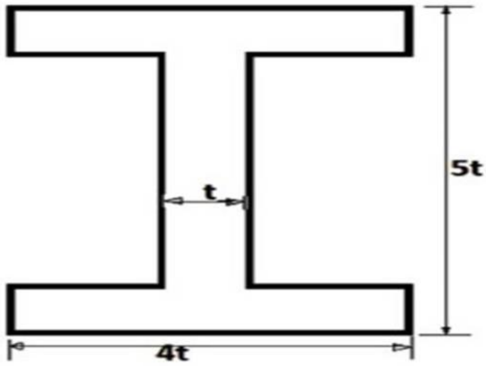


Fig 4.1 Dimension of I section of Connecting rod

4.1 Determination of Thickness of Connecting Rod

38870 = (415×11t2)/[(1)+(1/7500(124.4/1.78)2)]
By solving above equation t = 2.94 mm
Where Kxx = (Ixx/A)(1/2)
= [(419/12)×(t4)×(1/11t2)](1/2) = 1.78t
For C-70 σc = 415N/mm2, $\alpha = \frac{1}{7500}$.
Thus the dimensions of I section connecting rod by considering bearing pressure of other geometrical consideration are as follows

Table 1: Dimensions of connecting rod for C-70 material

Thickness of flange(t)	2.94 mm
Width of section(B)	4*t = 11.76 mm
Depth of Ht.(H)	5*t = 14.7
Depth near beg end(H1)	1.1*H = 16.6
Depth near Small end(H2)	0.8*H = 11.76 mm
Outer diameter of Big End	44.7 mm
Inner diameter of big end	37.16 mm
Outer diameter of Small end	22.41 mm
Inner diameter of small end	16.41 mm

5. CONCLUSIONS

1. Thus in this paper state of art literature review is carried out, methodology is formulated.
2. Based on the methodology connecting rod with the C-70 material is design subjected to the gas pressure of 38.87KN.

REFERENCES

[1] Tukaram S. Sarkateet. al, (2013). "Optimization of Steel Connecting Rod by Aluminum Connecting Rod Using Finite Element Analysis", IRD INDIA, Vol. 1, Issue 1, October, 2013

[2] B. Anusha, C.VijayaBhaskar Reddy, "Modeling and Analysis of Two Wheeler Connecting Rod by Using Ansys",

IOSR-JMCE, Volume 6, Issue 5, e-ISSN: 2278-1684, May 2013.

[3]K. Sudershn Kumar, Dr. K. Tirupathi Reddy, Syed AltafHussain“ Modeling and Analysis of Two Wheeler Connecting Rod” International Journal of Modern Engineering Research Vol.2, Issue.5, Sep- Oct. 2012 pp-3367-3371.

[4] Haripriya M & Reddy K.M. “Materialized optimization of connecting rod for four stroke single cylinder engine” 3 Volume 3.

[5] Ramanpreet Singh, Stress analysis of orthotropic and isotropic connecting rod using finite element method, International Journal of Mechanical Engineering and Robotics Research, 2, 2013.

[6] Om prakash,vikas gupta,vinodmittal. Optimizing the design of connecting rod under static and fatigue loading,vol 1,ISSN:2321-3264,june2013

[7] Ram Bansal, “Dynamic simulation of connecting rod made of aluminum alloy using finite element analysis approach”, IOSRJournal of Mechanical and Civil Engineering, Volume 5.

[8] 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

[9] Pranav G. Charkha and Dr. Santosh B. Jaju “Analysis and optimization of a connecting Rod” Second International Conference on Emerging Trends in Engineering and Technology, ICETET-09.

[10] Pravardhan S. Shenoy and Ali Fatemi “Connecting Rod Optimization for Weight and Cost Reduction”, The University of Toledo SAE International 2005-01-0987, 2005.