DESIGN AND WEIGHT OPTIMIZATION OF COMPOSITE CONNECTING ROD

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ABSTRACT- Connecting rod is one of the most important part in automotive engine. Connecting rod is the link between piston and crank shaft. Which it converts reciprocating motion of piston into rotary motion of crank shaft.In internal engines connecting rod is mainly made of steel and aluminum alloys (for light weight and absorb high impact loads) or titanium (for higher performance engines and for higher cost).As a connecting rod is rigid, it may transmit either a push or a pull and so the rod may rotate the crank through both halves of a revolution, i.e. Piston pushing and piston pulling. Earlier mechanisms, such as chains, could only pull. In a few two-stroke engines, the connecting rod is only required to push.

In which it undergoes structural deformations. Thus in this project we are modeling a connecting rod in solid works 2016 design software and doing static structural analysis in ansys work bench

14.5 software.

Thus the part which is modeled is converted into igs file to import in ansys work bench and static structural analysis is carried out at 3MPa of pressure load by applying various materials including composite materials, materials used in this project are such as aluminum alloy (which is already existing), 42crmo4, aluminum based composite material reinforced with Boron carbide (Al6061+B4C).

By applying these boundary conditions on connecting rod the unknown variables such as stress, deformation, strain, and maximum shear stress are found using the FEA based software (ANSYS).

I. INTRODUCTION

In a reciprocating position engine to the connecting rod or conrod connects the piston to the crank or crankshaft, alongside the crank they form a simple mechanism converts reciprocating motion into rotating motion.

Connecting rod might also converts rotating motion into reciprocator motion. Traditionally to development of engines they were first using this manner.

Figure1.1 connecting rod with piston

History

The earliest proof of a connecting rod seems within the late third century ad roman Hierapolis sawmills. It additionally seems in two 6th century eastern roman saw mills excavated at Ephesus respectively gerasa.

Fig: Connecting rods in engine

The crank and connecting rod mechanism of those roman watermills regenerate the rotary motion of the waterwheel into the linear movement of the saw blades. Someday between 1174 and 1206, the arab inventor and engineer al-jazari described the machine that incorporated the connecting rod with a crankshaft to pump water as a part of a water-raising machine, however the device was unnecessarily complicated indicating that he still failed to fully understand the concept of power conversion. Compound crank and connecting-rod is found within the sketch books of taccola. A sound understanding of the motion concerned displays the painter pisanello (d. 1455) world health organization showed a piston-pump driven by a water-wheel and operated by two simple cranks and two connecting-rods. By the sixteenth century, evidence of cranks and connecting rods within the technological treatises and design of renaissance europe becomes abundant; agostino ramelli's the various and art factitious machines of 1588 alone depicts eighteen examples, a number that rises within the theatrum machinarum novum by georg Andréa's buckler to 45 different machines.

II. LITERATURE REVIEW

The connecting rod is subjected to a complex state of loading; it undergoes high cyclic loads and the order of 108 - 109 cycles range from high compressive loads three due to combustion and high tensile loads due to inertia. Therefore, durability of this component is of critical importance. Due to above factors the connecting rod has been the topic of research for different aspects such as production technology, materials, performance simulation, fatigue, etc. For the current study it was necessary to investigate finite element modeling techniques, optimization techniques, developments in production technology, new materials, fatigue modeling, and manufacturing cost analysis. This brief literature survey reviews some of these aspects.

Webster et al. (1983) performed three dimensional finite element analysis of a high-speed diesel engine connecting rod. In this analysis there used the maximum compressive load how much was measured experimentally, and the maximum tensile load which is essentially in the inertia load of the piston assembly mass and the load distributions on the piston pin end and crank end were determined experimentally. They modeled the connecting rod cap separately, and also modeled the bolt pretension using beam elements and multi point constraint equations.

repgen (1998), based on fatigue tests carried out on identical components made of powder metal and c-70 steel (fracture splitting steel), in this paper he writes the fatigue strength of the forged steel part is 21% higher than the powder metal component and using the fracture splitting technology results in a 25% cost reduction over the conventional steel forging process. These main factors suggest that a fracture splitting material would be the material of choice for steel forged connecting rods and also mentions two other steels are tested, a modified micro-alloyed steel and a modified carbon steel. Other issues discussed by repgen are the necessity to avoid jig spots along the parting line of the rod and the cap, need of 4 consistencies in the chemical composition and manufacturing process to reduce variance in microstructure and production of near net shape rough part.

Park et al. (2003) investigated microstructural behavior at various forging conditions and recommend fast cooling for finer grain size and lower network ferrite content. From their research they concluded that laser notching exhibited best fracture splitting results, when

Compared with broached and wire cut notches. They optimized the fracture splitting parameters as, applied hydraulic pressure, jig set up and geometry of cracking cylinder based on delay time.they compared fracture splitting high carbon micro-alloyed steel (0.7% c) with carbon steel (0.48% c) using rotary bending fatigue test and concluded that the former has the same or better fatigue strength than the later and comparison of these fracture splitting high carbon micro- alloyed steel and powder metal and based on tension-compression 18% higher than the later fatigue.

III. PROBLEM STATEMENT

Connecting rod is one of the most critical components internal combustion. Connecting rod is connected in between the piston and crank shaft. While the crank shaft rotates piston moves from bottom dead centre to top dead centre vice versa. In this process connecting rod undergoes stress and deformation. Hence for the connecting rod when the load is applied, how the stresses and strain are induced in the component and deformation value, due to applied load are analysed.

Decreasing these stresses and increasing stability depends upon the materials applied. Thus in industrial purpose optimization of connecting rod had already started. Optimization is really important for automotive industry especially. Optimization of the component is to make the less time to produce the product that is stronger, lighter and less total cost productions. The design and weight of the connecting rod influence on car performance. Hence, it effects on the car manufacture credibility. Change in the design and material results a significant increment in weight and also performance of the engine. The structural factors considered for weight reduction during the optimization include the buckling load factor, stresses under the loads, bending stiffness, and axial stiffness. Thus, the component can give the higher strength, efficient design and lighter that would create a major success in the automotive and manufacturing industry. Among the main objectives are to improves the engine performance and also to strengthen the product that is ensure the safety of human being.

Connecting rod failed due to insufficient strength to hold the load. Increasing the strength, automatically it will longer the life cycles of the connecting rod. In this study, the design of the connecting rod will be modeled and at the same time increase the strength. And different materials are applied for gaining more stability. The study will be focus on the finite element modeling and analysis. From the analysis results, the decision whether connecting rod needs to change in material, load, design etc factors which induces stress in the component.

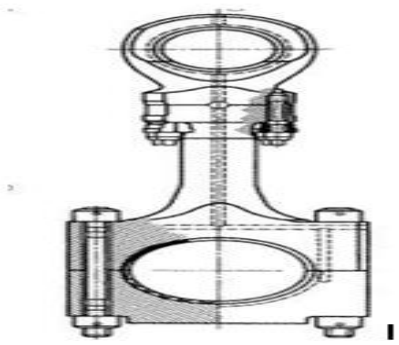


Fig: man-b&w l58/64 con rod
bottom end bolts

Because of the stress reversal mentioned higher than, bottom end bolts have a limited life. This varies from engine to engine, however is usually around 12-15000 hours. If a bottom end bolt was to fail in operation, then the results would be disastrous.

Bottom end bolts ought to be treated with care once removed from the engine throughout overhauls. They must be inspected for any damage to the surface from that a crack might begin. This damage may be due to corrosion (water in lo) or because of incorrect handling.

Types of connecting rods

- Marine type: the large end bearing is seperate from rod the rod which has a palm end (t- shaped end).

According to machinig process

Most commonly utilized in automobile engines, connecting rods are typically employed in an internal combustion engine. The connecting rods link the pistons to the crankshaft and supply fluid movement between them. Farm equipment, cars and truck, construction equipment and the other kind of vehicle with an internal combustion engines uses some variety of connecting rod.

•Forged

Connecting rods are typed by the process used to manufacture the rods. The method of creating forged connecting rods constitutes forcing the grain of the chosen material, like a steel alloy, within the specific shape of the rod. Manufacturers use differing types of steel alloys including 4340 steel or a chrome and nickel alloy. The nickel/chrome alloy will increase the strength of the connecting rod while not creating the finished product brittle.

•Cast rods

Cast rods are typically the selection of original equipment manufacturers as a result of they handle the load of a stock engine and are more cost-effective to create. Cast connecting rods possess a seam down the middle that's noticeable and differentiates it from the forged type. Don't use cast rods in high hp applications over 450 and going 6,000 rpm.

Steel connecting rod

Steel connecting rod

VI. RESOURCES

Solid works

Solid works is mechanical design automation software that takes advantage of the familiar microsoft windows graphical user interface. It is an easy-to-learn tool which makes it possible.
for mechanical designers to quickly sketch ideas, experiment with features and dimensions, and produce models and detailed drawings.
A solid works model consists of parts, assemblies, and drawings.

history of solid works

Solid works corporation was founded in december 1993 by massachusetts institute of technology graduate jon hirschtick; hirschtick used $1 million he had made while a member of the mit blackjack teamto set up the company. Initially based in waltham, massachusetts, usa, hirschtick recruited a team of engineers with the goal of building 3d cad software that was easy-to-use, affordable, and available on the windows desktop. Operating later from concord, massachusetts, solid works released its first product solid works 95, in 1995. In 1997 dassault, best known for its catia cad software, acquired solid works for $310 million in stock.
Solid works currently markets several versions of the solid works cad software in addition to edrawings, a collaboration tool, and draft sight, a 2d cad product.Solid works was headed by john mceleney from 2001 to july 2007 and jeff ray from 2007 to january 2011. The current ceo is bertrand sicot.

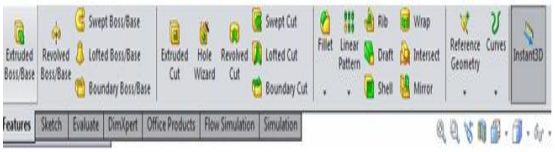


Fig shows feature bar

CHAPTER -5
DESIGNING OF A CONNECTING ROD BY USING ADVANCED MODELING SOFTWARE SOLID WORKS

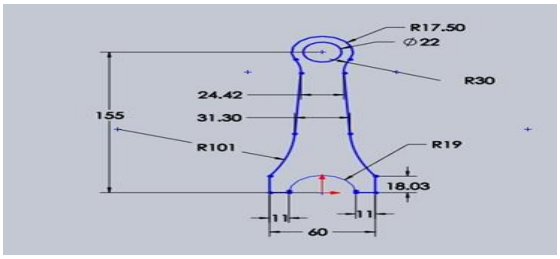
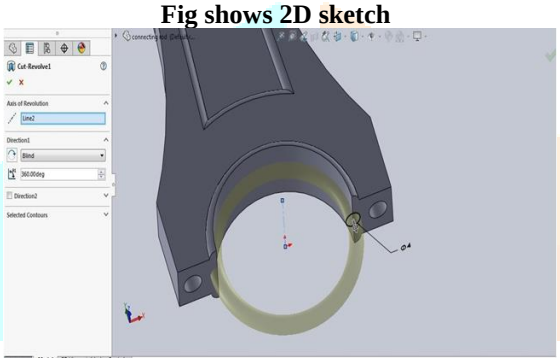
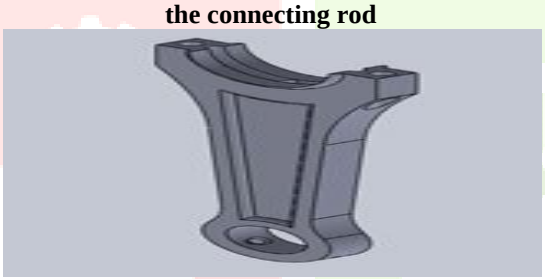


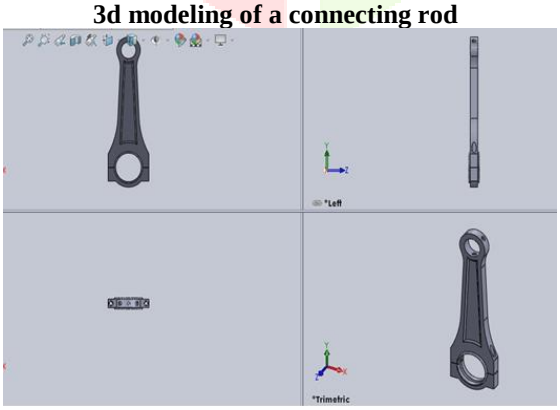
Fig shows 2D sketch



Revolve boss is used to make oil circulation in the connecting rod



3d modeling of a connecting rod

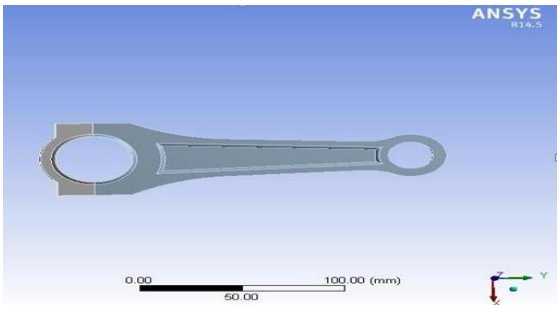


Different views of a connecting rod

CHAPTER-6

ANALYSIS IN ANSYS (FEM Model)

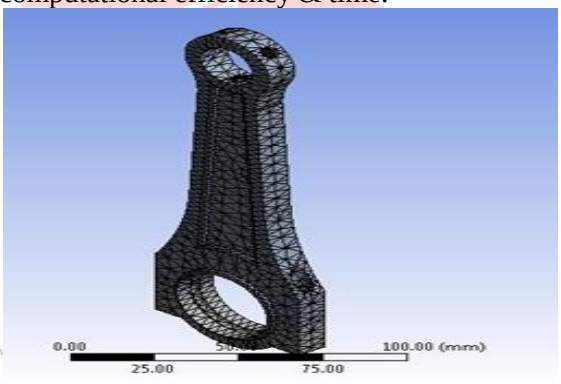
Analysis on connecting rod by using Ansys 14.5 software



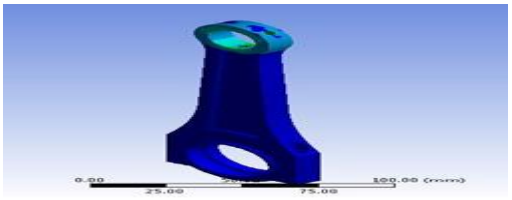
Structural analysis

MESHING

Meshing is probably the most important part in any of the computer simulations, because it can show drastic changes in results you get. Meshing means you create a mesh of some grid-points called 'nodes'. It's done with a variety of tools & options available in the software. The results are calculated by solving the relevant governing equations numerically at each of the nodes of the mesh. The governing equations are almost always partial differential equations, and Finite element method is used to find solutions to such equations. The pattern and relative positioning of the nodes also affect the solution, the computational efficiency & time.



Mesh Type: Tetrahedral
Material: Al6061+B4C



Total Deformation

CHAPTER:7
RESULTS AND DISCUSSION:

Modeling of the connecting rod has done by using solid works 2016 premium software package. And therefore the model is saved in initial graphics exchange specification (iges) and is imported into

the ansys work bench to perform static structural analysis, thermal and modal analysis. The results of the analysis have shown below

Structural analysis:

Materials	Max Stress (N/mm^2)	Total Deformation (mm)	Max strain	Maximum shear stress (N/mm^2)
Al – Alloy	27.241	0.0020414	0.00039726	14.231
42 CrMo4	27.399	0.0068567	0.00135	14.285
Al6061+B4C	27.295	0.00074167	0.0001449	14.25

Table 7.1: load 3mpa

CHAPTER8
CONCLUSION

- Modeling and analysis of connecting rod is done
- Modeling of connecting rod is done in solid works 2016 design software
- The file is saved as igs to import in ansys workbench
- The analysis in ansys is extremely important prior to the fabrication of connecting rod.
- The static structural analysis has carried out in the ansys 14.5 software package for connecting rod by different materials like aluminum alloy, 42crmo4 and Al6061+B4C.
- The material properties and brief explanation about composites has given.
- The utmost stress, strain and deformation values of static analysis are tabulated.
- From load applied 3mpa on the connecting rod by assigning materials, in general aluminum alloy is used for the connecting rods but 42CrMo4 and Al6061+B4C are new composite materials. From results we can conclude that Al6061+B4C is showing less stress and low deformation values compared to the 42CrMo4.
- Hence the materials with low stress values are also preferable for the fabrication of connecting rod

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