A REVIEW ON "DESIGN OF CONNECTING ROD FOR WEIGHT REDUCTION USING ALTERNATIVE COMPOSITE MATERIAL"

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***Abstract*— Connecting rods are the integral parts of an internal combustion engine. The efficiency of any engine can be defined as less the weight of any engine lesser the energy required hence it is important to reduce the weight. There is a demand for high speed and efficient vehicle. For a high-speed vehicle, the manufacturer has to design lighter, faster, and more efficient engines. In this context, it has become important to optimize the design of Crankshaft assembly which is amongst larger volume production components in the internal combustion engine. Weight reduction of a connecting rod will increase the fuel efficiency of the engine. It is found from the literature that to satisfy the objective of weight reduction, the use of composite materials plays a vital role. Aluminum SiC fly ash composite can be used as an alternate material. It gives the required strength and lightweight. In the view, the project is undertaken to use the Aluminium SiC fly ash composite material for the design of connecting rod for weight reduction.**

Keywords—Connecting Rod, Crankshaft, Weight Reduction, Composite Material, Aluminium Sic, Fly ash.

I. INTRODUCTION

In the automobile sector, there is a demand for high performance and more efficient engines. Keeping it in mind, the manufacturer has to design lighter, faster, and more efficient engines. Automobile engines consist of the piston, cylinder, crankshaft, connecting rod assembly. So the engine performance collectively depends on the geometry and weight of these components. To get the high efficiency of the engine it is necessary to optimize these components of an engine. For this study connecting rod is selected for the weight optimization. If a connecting rod is optimized, then the weight of the crankshaft required for balancing the crank assembly will reduce. Thus we can achieve weight reduction in engine assembly which can improve engine performance.

Fig 1. Connecting rod

II. LITERATURE REVIEW

F. Yin et al. [1] studied connecting rod of an air compressor and die forging for the aluminum alloy. The connecting rod of air compressor was manufactured by using liquid die forging replacing existing die casting and hot die forging of aluminum alloy. The outputs of study show defects of gas holes, porosity and non-metal inclusions in the die casting eliminated. Also, there is a reduction in the investment of forging equipment. There is an increment in material utilization and the rate of production. But the price of this type of manufacturing is higher compared to another process. Quality of connecting rod is better.

David Raja Selvam et al. [2] Manufactured the Al6061-Fly Ash-SiC composites by using stir casting methods. Reinforcement weight percentage was varied to generate a different combination of composites. To improve the wettability of SiC and Fly ash particles, magnesium was added in the matrix. Microstructure and mechanical properties for prepared combinations are observed. Microstructure shows a homogeneous mixture of fly ash and SiC particles in the aluminum matrix. Fly Ash addition helped to prevent SiC dissolution and the formation of Al_4C_3. Mechanical properties studied by keeping fly ash percentage constant and increment in SiC percentage and result shows an increase in hardness and tensile strength. Tensile strength of aluminum composites increased from 173 MPa to 213 MPa with the increase in the percentage of SiC.

Md. Habibur Rahman et al. [3] investigated silicon carbide reinforced aluminum matrix composites for mechanical properties and wear characteristics. A stir casting process prepared aluminum composites of varying SiC content from 0 to 20 percent with an increment of 5 percent. The results showed that SiC reinforcements in aluminum matrix increased hardness and tensile strength. Maximum hardness is observed at 20 percent SiC. The microstructural study shows the nonhomogeneous distribution of SiC particles in the Al matrix and porosities increased with increasing percentage of SiC. Wear test is performed on Pin-on-disc equipment and test shows wear resistance increases with increment in the percentage of SiC in Aluminium matrix.

Mr. Vamsi Krishna et al. [4] investigated the mechanical properties of hybrid metal matrix composites. In this study, the mechanical properties of Al6061-SiC/Graphite and Al6061-SiC hybrid composites were compared. To prepare composite by using stir casting method reinforcement was increased from 5-15% in steps increment of 5 percent by weight. There was an increment in tensile strength of composite due to graphite and SiC. Microstructure shows a homogeneous mixture of SiC particles in the aluminum matrix without any void. It has been noticed that the Tensile strength of aluminum composites increased with increase in the percentage of SiC.

P.B. Pawar et al. [5] developed Aluminium SiC Composite for Spur Gear. Stir casting was used to prepare aluminum composite with SiC which varies from particle 2.5 to 10 percent of weight fraction. Al-SiC shows better hardness than aluminum metal. 10% of SiC content shows the highest values of hardness and toughness. Uniform distribution of SiC particles can be achieved by powder metallurgy but stir casting is more economical. FEA analysis was used to found stress distribution and it shows the highest stress value at the tip of the teeth. This study concludes that aluminum composites can be used for making power transmitting elements which are in continuous loading.

Dora Siva Prasad et al. [6] investigated the mechanical properties of aluminum hybrid composites. Aluminum composites were prepared with a variation of 2, 4, 6, and 8 wt% SiC particulates by a stir casting process. A scanning electron microscope was used to studied microstructure. It was observed that with increasing reinforcement the hardness and porosity increased. Yield strength and ultimate tensile strength increase with an increase in weight fraction of SiC particles due to the increase in dislocation density. Elongation decreases with an increase in reinforcement. It reduced the time for obtaining the maximum hardness by the aging heat treatment.

H.C. Anilkumar et al. [7] investigated the mechanical properties of fly ash reinforced aluminum alloy (al6061) composites. Three sets of composites with fly ash particle sizes of 4-25, 45-50 and 75-100 μm and each set with reinforcement weight fractions of 10, 15 and 20% were used. These samples were tested and compared with unreinforced Al6061. It was observed that with the increase in particle size of reinforced fly ash the tensile strength, compressive strength and hardness of the composites decreased. UTS, compressive strength, hardness increases with the percentage of fly ash. Ductility decreases with an increasing percentage of fly ash.

R. Harikrishnan et al. [8] Evaluated mechanical properties of aluminum metal matrix composites (al+sic+mg+flash) Composite materials especially aluminum and silicon, fly ash Magnesium composites having good mechanical properties compared with the conventional materials. It is used in various industrial application these materials having light weight along with high hardness. It withstands high load compares with the existing materials are most applicable in the engineering products instead of existing materials. Finally, it was concluded that the percentage of silicon increases automatically the hardness, double shear strength, and increases at the same time the tensile value.

J.P. Fuertes et al. [9] performed mechanical properties analysis of an Al-Mg alloy connecting rod with sub-micrometric structure. This research work compares the forge ability of an AA5754 connecting rod manufactured from two different states: after an annealing heat treatment (N0) and after having been previously ECAP deformed with two passages (N2) and using route C. N2 shows an increase in the HV micro hardness values of 21 %, in relation to the connecting rod forged from the N0 state. Highest micro hardness values obtained experimentally coincide with the zones with the highest accumulated plastic strain values attained from the finite volume simulations.

Naveen Lohan et al. [10] performed optimization and cost reduction by finite element analysis of connecting rod using aluminum composite. The connecting rod is investigated with a composite material that comprises aluminum as a matrix and with variously suitable reinforcements to reduce its weight and increasing its strength. Analysis results of steel material connecting rod and Aluminum material connecting rod were compared. That cost calculation shows that Composite material connecting rod has good strength to weight ratio as compared steel material connecting rod with a reduction in cost. It gives a weight reduction of 43%. Due to the low weight of connecting rod less power will be wasted in overcoming inertia forces also overall weight of the vehicle will reduce will increase efficiency engine. Due to the decrease in weight of the connecting rod, the overall weight of the engine will reduce hence less heavy mounting is required will add to an overall weight saving of vehicle leading to cost saving in fuel. Due to the reduction in weight there is about 20 % reduction in the cost of material being used for the manufacturing of connecting rod.

Ajit Kumar Senapati et al. [11] used waste fly ash in the fabrication of aluminum alloy matrix composite. Waste fly ash from two different industries was employed as reinforcement in aluminum alloy based matrix composites. The Al composite was made-up by a stir-casting method. Fly ash addition effect was observed by mechanical testing by preparing standard specimens. Microstructure examination was conducted on image analyzer and scanning electron micrographs to check the fly ash distributions. Fly ash percentage is an important criterion for fabricating AMC's.

Dr. B.K. Roy [12] carried out design and analysis of the connecting rod. This paper describes the design and analysis process of the connecting rod. A new design of connecting rod proposed and stress results are compared with the existing stress result. CAE analysis performed with a slight variation in the design parameters which gives the optimum solution. Fatigue analysis and Static analysis are important which shows different factors on which design should finalize. Various parameters like Stress, Deformation, Strain, and Life have been studied and inspected to finalize design parameters in consideration with safe permissible stresses.

III. FINDINGS OF LITERATURE REVIEW

- Aluminum composites are lightweight material compared to existing material and can be used as an alternative.
- About 43% weight reduction is possible by using Aluminium composites.
- Composite materials especially aluminum and silicon, fly ash Magnesium composites are having good mechanical properties compared with the conventional materials.
- Weight optimization of the connecting rod will help in improving the performance of the engine.

IV. CONCLUSION

From studying the literature, it is found that the weight reduction of a connecting rod is possible by using Aluminium composite materials. These are light materials as compared to other existing material. By using Aluminium composite material higher weight reduction of connecting rod can be achieved. This will further help in improving the engine performance & fuel economy.

REFERENCES

[1] F. Yin, G.X. Wang, S.Z. Hong and Z.P. Zeng, Technological study of liquid die forging for the aluminum alloy connecting rod of an air compressor, Journal of Materials Processing Technology 139, 2003, pp. 462-464.
[2] David Raja Selvam. J, Robinson Smart. D.S. and Dinaharan. I, Synthesis and characterization of Al6061-Fly Ashp-SiCp composites by stir casting and composting methods, Energy Procedia 34, 2013, pp. 637 – 646.
[3] Md. Habibur Rahman and H. M. Mamun Al-Rashed, Characterization of silicon carbide reinforced aluminum matrix Composites, Procedia Engineering 90, 2014, pp. 103-109.
[4] M. Vamsi Krishna and Anthony.M., An investigation on the mechanical properties of hybrid metal matrix composites, Procedia Engineering 97, 2014, pp. 918 – 924.
[5] P.B. Pawar and Abhay A. Utpat, Development of aluminum-based silicon carbide particulate metal matrix composite for spur gear, Procedia Materials Science 6, 2014, pp.1150-1156.
[6] Dora Siva Prasad, Chintada Shoba and Nallu Ramanaiah, Investigations on mechanical properties of aluminum hybrid composites, Journal of Material Research and technology, 2 0 1 4, pp79-85
[7] H.C. Anilkumar, H.S. Hebbar and K.S. Ravishankar, Mechanical properties of fly ash reinforced aluminum alloy

(al6061) composites, International Journal of Mechanical and Materials Engineering, Vol.6, 2011, pp.41-45

[8] R. Harikrishnan, TTM.Kannan, P. Vijaya Kumar, and S. Giridharan, Evaluation of mechanical properties of aluminum metal matrix composites, International Journal of Innovations in Scientific Engineering, Vol. 1, 2015.

[9] J.P. Fuertes, O. Murillo, J. Leon, C. Luis, D. Salcedo, I. Puertas and R. Luri, Mechanical properties analysis of an Al-Mg alloy connecting rod with sub-micrometric structure, Procedia Engineering 132, 2015, pp. 313–318.

[10] Naveen Lohan and Sandeep Nadal, Optimization and cost reduction by finite element analysis of connecting rod using aluminum composite, International Journal of Engineering Sciences & Research Technology, 3(10), 2014.

[11] Ajit Kumar Senapati, Purna Chandra Mishra and Bharat Chandra Routara, use of waste fly ash in the fabrication of aluminum alloy matrix composite, International Journal of Engineering and Technology (IJET), Vol 6, 2014, pp. 905-912.

[12] DR. B. K. Roy, Design analysis and optimization of various parameters of connecting rod using CAE software, International Journal of New Innovations in Engineering and Technology, Vol. 1, 2012.