

A Review Paper on MMC Connecting Rod

Aadesh Shaha¹ Sagar Parsewar² Aakash Salunke³ Dnyaneshwar Suryawanshi⁴ Prof. Aadil Shaikh⁵

^{1,2,3,4,5}Trinity Academy of Engineering, India

Abstract— Composite materials are widely used in engineering field. Connecting rod is an important part which is a connecting link between piston and rotary crankshaft. In I.C. Engine a connecting rod is subjected to tensile, compressive and fatigue stresses. A vast research is going on in the field of metallurgy for selection of material for particular application. In this we are going to manufacture a connecting rod using Metal Matrix Composite (MMC) Technique. The main objective of using MMC connecting rod is that it is light in weight, more durability, high strength and stiffness. By using this weight of pedal box assembly is reduced and forces acting on connecting rod are also minimized. In this the analysis is done on Ansys software. Accordingly, we manufactured the component on the basis of result we obtained.

Keywords: Metal Matrix Composite (MMC), Connecting rod weight reduction, Connecting rod analysis, Composite materials, Reduction in weight of pedal box

I. INTRODUCTION

In modern automotive IC engine, the connecting rod is designed of steel. It's made of titanium or aluminum for enhance performance of engines. It's not rigidly fixed at either end, so angle at each end continuously varies. The bigger end is attached to connecting rod and shaft experiences tremendous stress from reciprocating load takes place by piston. Various forces acting on connecting rod are.

- 1) Force on piston due to gas pressure and inertia force due to reciprocating parts.
- 2) Force due to inertia of connecting rod or bending forces.
- 3) Force due to friction of piston rings and of the piston.
- 4) Force due to friction of piston pin bearing and crank pin bearing.

Generally connecting rod is manufactured by using forging from powder metal.

In this we are going to manufacture using Metal Matrix Composite (MMC) technique technique is an advanced method of manufacturing in which one is metal and other may be organic compound or ceramics. So here metal is Al and composite or organic compound is SiC. Aluminium Matrix Composite (AMC) are used for fabrication of aeronautical and aerospace components, automotive parts (pistons, cylinders, head and block, chasis, connecting rods, brake components, clutches). They are also used in military applications like defence weapons, bulletproof jacket and many more things.

II. MATERIALS

Recently connecting rods are made of steel alloy, brass and aluminum alloys. But in this we are going to manufacture a connecting rod using MMC technique aluminum as main metal matrix and composite is silicon carbide (SiC). Aluminum is used as compared to steel because of following properties:

Properties	Steel	Aluminum
Weight	More	Less
Density	More (approx. 2.5 times)	Less
Malleability and Elasticity	Less	More
Corrosion Resistance	Less	More
Strength	More	Less

Table 1: Comparison between steel and aluminum

As shown in the table aluminum is more efficient that means it has various required properties than steel. But main point arise in the strength criteria as aluminum has less strength than steel. So, to increase strength Titanium is used to increase strength of connecting rod. Parameters of connecting rod and mechanical properties of connecting rod are shown in table below.

Description of Parameters	Quantity
Length of connecting rod	124mm
Outer diameter of big end	40mm
Inner diameter of big end	30mm
Outer diameter of small end	18 mm
Inner diameter of small end	12 mm

Table 2: Parameters of connecting rod

Composition (Vol.%)	Al75/SiC25	Al70/SiC30	Al60/SiC40
Density (g/cm ³)	2.8	2.8	2.9
Young's Modulus (GPa)	115	125	150
Young's Modulus per density (GPa-cm ³ g)	41	45	52
Coefficient of thermal expansion	15	14	13
Thermal Conductivity	145	150	155

Table 3: Mechanical Properties of Al/SiC MMC's

III. METHODOLOGY

There is various process for manufacturing of composite materials but one of the most effective is stir casting. The process of stir casting was developed in 1968 by S.Ray. In this when we stirred the molten aluminum alloy by incorporating alumina silica powder particles into aluminium melt and in this process various phases occurred when matrix is in molten form by mechanical stirrer. In this process aluminium is base element. Stir casting is the simplest and cost-effective method.

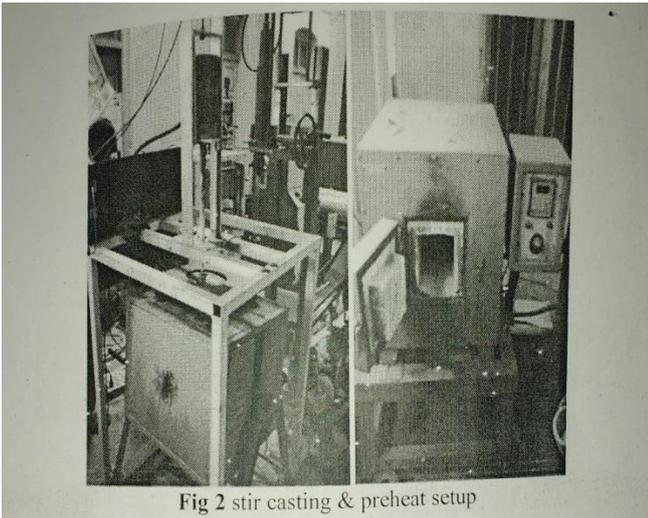


Fig 2 stir casting & preheat setup

In this process the liquid composite material is then cast by conventional casting methods and may also be processed by conventional metal forming technologies. In this material is heated above its melting point so material is completely melted and stirrer starts rotating. Due to stirring speed properties get reduced, so research is going on to have specific speed for particular time. Hence metal matrix composite involves incorporation of dispersed phase into a molten matrix metal followed by its solidification. Other methods are compo casting and squeeze casting.

IV. RESULT AND DISCUSSION

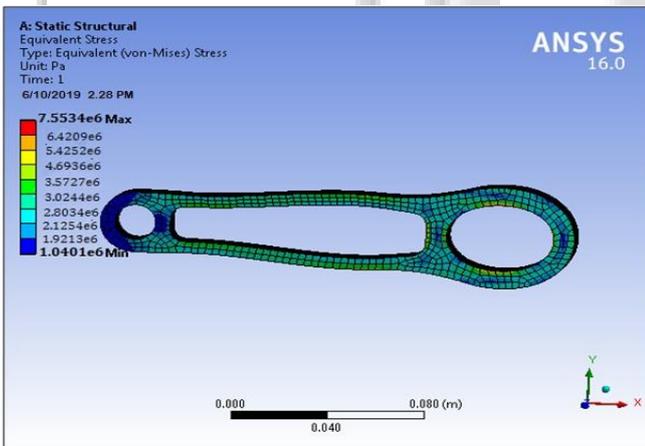


Fig. Metal Matrix Composite (MMC) Connecting Rod After analysis of Conventional and MMC

Connecting rod it was found that:

Stress	Conventional Connecting Rod	MMC Connecting Rod
Tensile Stress (MPa)	0.624	0.423
Life (Days)	76	302
Strength to weight ratio	Lesser	Comparatively Greater
Mass (grams)	115.48	72.17

– Fatigue life of the conventional connecting rod is 50,000 cycles at maximum stress value of 1.175 MPa whereas in MMC connecting rod the component fails after 65,000 cycles at maximum stress of 0.650 MPa.

- Hence in composite rod it has more life as compared to conventional connecting rod.
- Tensile stress is also reduced by 32% approximately in composite rod.
- The most important is mass is reduced by 37.5% that of conventional connecting rod.

V. CONCLUSION

In this composite as we know Aluminium (Al) is base metal and Silicon Carbide (SiC) is composite material. But by using silicon carbide strength reduces i.e. ductility reduces and hardness increases. So, to increase strength titanium is used and there is a wide scope of using Mg and Cu which is used for particular application.

Aluminium Metal Matrix Composite (AMMC's) can be broadly of two types solid state processing and liquid state processing. Stir Casting is one of the most effective and provides uniform distribution of particles. It is one type of liquid casting. Similarly, solid in casting powder metallurgy is most effective but cost is more as compared to stir casting. Other methods are compo-casting, squeeze casting, spray casting but are not widely used.

REFERENCES

- [1] Design and Fatigue Analysis on Metal Matrix Composite Connecting Rod Using FEA Dharun Lingam, Run Lingam (2013)
- [2] Dynamic Analysis of Bajaj Pulsar 150cc Connecting Rod Using Ansys14.0, Amit Kumar, Bhingale P.P, etal (2014)
- [3] Fabrication methods of particulate reinforced Aluminum metal matrix composite-A review Narendra Panwar, Amit Chauhan (2017)
- [4] Design and Analysis of Composite Connecting Rod T.R.Sydanna, B.Sunil Kumar 2017.
- [5] Experimental Behavior and Analysis Connecting Rod Metal Matrix(8090-B4c) Composite, Kalaiyarasan A Sakthivel k, Santosh M, Subaash Rajkumar S.2017
- [6] Characteristic Behaviour of Aluminium Metal Matrix Composite A review Manish Shukla S.K. Dhakad, Pankaj Agarwal.2017
- [7] Fatigue Analysis of Sundry I.C. Engine Connecting Rod S.V.Uma Maheswara Rao ,et.al(2017)