



Fabrication and Test Performance of Two Wheeler Connecting Rod using Aluminium Metal Matrix Composites Reinforcement with 6% of TiO₂

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Abstract

The most commonly used automobile engine materials are ferrous metals, these materials increase the weight of the vehicle. An alternate approach of constructing the engine components by the application of nonferrous metals provides the solution to handle this situation. For example, medium carbon steels are commonly used in connecting rod manufacturing that has more weight, alternative approaches are aluminium and titanium. Aluminium metal matrix composite reinforced with titanium dioxide (AlTiO₂) is the better choice of aluminium and titanium. For testing the mechanical properties of AlTiO₂, the preparation of the varying weight percentages (0%, 3%, 6% and 9%) of TiO₂ with aluminium in the casting process had done. 6% of TiO₂ had shown better mechanical properties among the remaining other combinations. A clear idea was formed to fabricate the connecting rod by the application of aluminium metal matrix composite reinforced with 6% of TiO₂ and perform a test drive on a two-wheeler. Based upon our expectations favourable results were obtained.

Keywords: Aluminium (Al), Titanium dioxide (TiO₂), Connecting rod, Casting, Forging, CNC machine, Two wheeler bike engine.

1. Introduction

In present-day technology, automobiles play an important role in carrying the purpose of goods and passengers. The function of the automobile engine is to develop the power to mobilise the automobile from one place to another place. All the engine components are made of ferrous metals leads to an increase in the weight of the vehicle.

Connecting rod is an important part of an automobile engine that transmits the power from the engine piston to the crankshaft by converting the reciprocation motion of the piston to the rotary motion of the crankshaft. The most commonly used material for manufacturing a connecting rod is medium carbon steel because it has a good ability of easily forged but there is a drawback due to its heavy weight. An alternative solution to deal with this problem is aluminium and Titanium for the manufacturing of connecting rods. Aluminium metal matrix

composite reinforced with titanium dioxide is the better material for the preparation of connecting rod.

Mechanical testing on varying weight percentages of TiO₂ with aluminium metal matrix composite material for better material selection had performed. Tensile, compression, impact, hardness and wear tests on aluminium metal matrix composites with varying weight percentages such as 0%, 3%, 6% and 9% of titanium dioxide (TiO₂) were performed. ASTM and other standards were followed for the preparation of material specimens to conduct these above-mentioned mechanical tests. 6% of TiO₂ had shown better mechanical properties among all remaining combinations of materials.

2. Fabrication:

Fabrication of connecting rod is carried out by three processes, they are casting, forging and CNC machine cutting.

A stir casting furnace is used for the casting process of aluminium metal matrix composite as shown in Figure 1. In the casting process 1880grams of pure aluminium powder and then heated in the

crucible stir casting furnace as it reaches its molten state is around 700°C as shown in Figure 2(a), continuing the process until the molten metal reaches 850°C and then adding the 6% (120 grams) weight of titanium dioxide as shown in Figure 2(b). At the temperature of 1843°C melting of titanium dioxide was observed, stirring at a speed of 300 rpm for up to 10 minutes as shown in Figure 2(c). Pouring the molten Al-TiO₂ into the 200 × 200 × 50 mm³ die cavity for the preparation of connecting rods. Solidified AlTiO₂ after the casting process is shown in Figure 3. There are more possibilities of forming internal cracks, larger gas bubbles such as blowholes or blisters and less strength due to poor bonding of atoms in solidified AlTiO₂. To improve the strength of the atoms, get rid of blowholes in the AlTiO₂ workpiece and also remove the internal cracks, a forging process is applied to the AlTiO₂ work piece under the action of compressive force by applying hammering and pressing operation with the application of closed die forging machine. AlTiO₂ workpiece after the forging process is shown in Figure 4. Three connecting rods are prepared based on the dimensions of connecting rod of the 100CC Hero Honda Splendor bike by the application of a Computer Numerical Control (CNC) machine as shown in Figure 5. The dimensions of the AlTiO₂ connecting rod are shown in Table 1. CNC machine cutting operation is shown in Figure 6. The fabricated connecting rod is shown in Figure 7.



Figure1. Stir casting setup

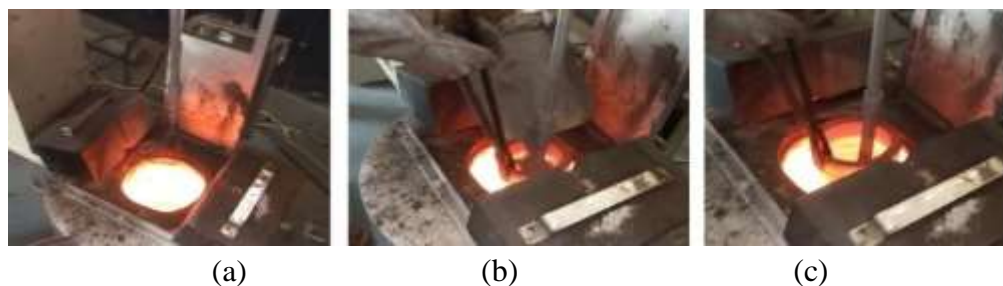


Figure 2. Stir casting process (a) Molten metal of pure aluminum, (b) Mixing Titanium dioxide, (c) Stirring the molten metal of AlTiO₂,



Figure 3. Solidified AlTiO₂ after casting **Figure 4.** AlTiO₂ work piece after forging process

Table 1. Dimensions of AlTiO₂ connecting rod

Overall length	124.25mm
Maximum width	30 mm
Maximum thickness	14 mm
Shank thickness	12 mm
Big end inner diameter	30 mm
Small end inner diameter	12.7 mm
Big end outer diameter	40 mm
Small end outer diameter	18.5 mm
Length from centre of the both the ends	95 mm
Piston pin hole diameter	2.3 mm

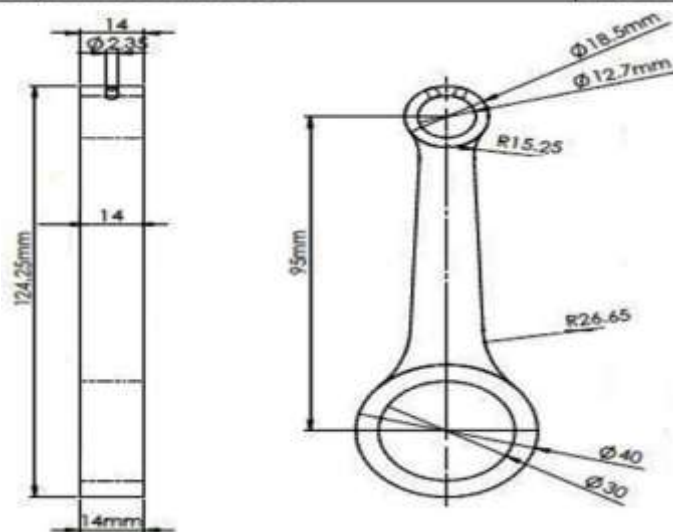


Figure 5. Dimensions of connecting rod



Figure 6. AlTiO₂ Connecting rod cutting operation in CNC machine



Figure 7. Fabricated Connecting rod

3. Assemble of AlTiO₂ Connecting Rod:

For assembling the AlTiO₂ connecting rod, it is necessary to dismantle the engine including the piston, connecting rod and crankcase assembly as shown in Figure 8.



Figure 8. Dismantle of Engine

Join the connecting rod big end to the crankshaft of the crankcase assembly, and test whether the connecting rod is properly assembled or not by rotating it. Fix the connecting rod small end to the piston with the help of the piston pin. Rotate the crankshaft and observe the reciprocating motion of the piston in a smooth way or not. If there is any obstruction raised then dismantle the piston from connecting rod small end and again fix it in a proper position to eliminate the obstruction then properly place the piston in a cylinder, and fix the cylinder head to the cylinder. The assembling of connecting rod is based on the explanation is shown in Figure 9.

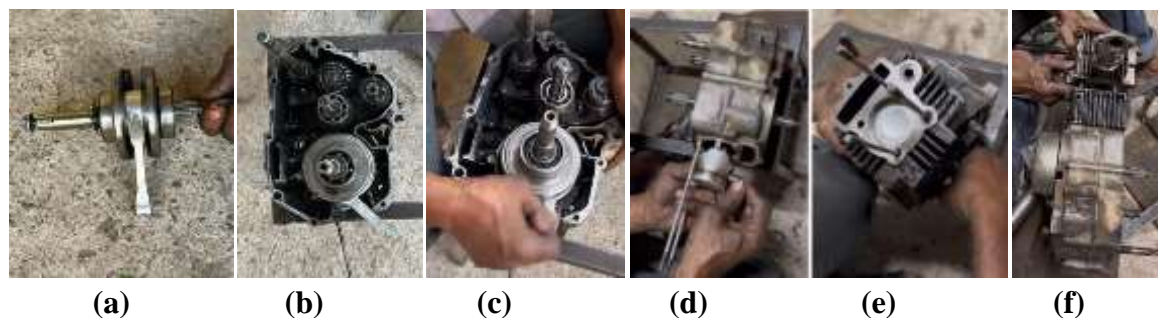


Figure 9. Assembling of AlTiO₂ connecting rod

4. Test Performance Result of AlTiO₂ Connecting Rod:

To perform the test drive, it is necessary to fix the engine in the proper position of the two-wheeler as shown in Figure 10. Start the engine with the help of a kick rod. It has observed engine was running smoothly. Continuing the engine in running condition up to half an hour before conducting the test drive.



Figure 10. Engine assembled to the two wheeler bike

Start the test drive of the two-wheeler bike. It has been observed up to two hours of riding, no problem is encountered. The test Performance of a two-wheeler connecting rod using Aluminium MMC reinforcement with 6% of TiO₂ showed satisfactory results.

For checking the condition of connecting rod, dismantle the engine and remove the connecting rod from the engine. It has observed a slight bent in the AlTiO₂ connecting rod as shown in Figure 11.



Figure 11. Condition of AlTiO₂ connecting rod after test performance

5. Conclusion:

Aluminium MMC reinforced titanium dioxide of varying weight percentages of AlTiO₂ was used to fabricate and test the performance of connecting rod. After conducting mechanical tests such as tensile, compression, impact, hardness, and wear tests on aluminium metal matrix composites with varying weight percentages of (0%, 3%, 6%, 9%) of titanium

dioxide, 6% of TiO₂ had shown better mechanical properties among the remaining combinations. AlTiO₂ connecting rod fabricated based on the dimensions of 100CC Hero Honda Splendor bike engine connecting rod. Two hours of continuous test drives were conducted successfully. The test drive performance has given satisfactory results. After dismantling the connecting rod a slight bent on connecting rod was observed, this is due to the more load of the ferrous metal engine components on it. If all other components are replaced with less weighted non-ferrous engine components then aluminium MMC with 6% of TiO₂ will give up to the performance results of medium carbon steel connecting rods.

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