Mechanical Properties Comparison of Al – SiC MMC Disc Brake

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Abstract— Aluminium have low density, high ductility, high strength and more wear resistance. These are excellent mechanical properties of aluminium while compare with other materials. They are used highly in aerospace and automobile industries. From the above information, we developed an Al – SiC MMC brake disc for four wheelers by Stir Casting method in the ration of 95%:5% and 90%:10%. We have conducted various mechanical tests on brake disc and compared its mechanical properties. Designing and analysis of brake disc is done by CATIA V6 and ANSYS 16.0.

Key words: Aluminium, SiC, MMC, Brake Disc

I. INTRODUCTION

A disc brake is a one type of mechanical brake that uses callipers to squeeze pairs of pads against a disc or rotor to create a friction to stop vehicle. While applying brake, brake pads are made contact with the rotating element of a wheel. Generally these brake pads are made up of grey iron a form of a cast iron. Due to the contact, brake pads got wear on its surface and its life span reduced. Also there will be a heat generation while applying brake. The brake material should have the capability to dissipate the heat.

Aluminium 6601is precipitation aluminium alloy containing magnesium and Silicon as its major elements. It has good mechanical properties. It is one of the general purpose usage alloy.

Silicon Carbide (SiC) is a rare mineral moissanite which is produced in nature due to chemical reaction between Silicon and Carbide. Sic are used to produce very hard and strong materials. They have high thermal conductivity with low thermal expansion. Due to this they can withstand against thermal shocks.

I. METHODOLOGY

First step is the selection of proper material for a disc brake. Here Aluminium with Silicon carbide composite was used. The metal matrix composite composition in the ratio of 95 % Al with 5% of SiC and 90% Al with 10%SiC. The brake disc was manufactured by stir casting method. In this method first solid Al was melted in the furnace by heating it upto 600^0C. Then SiC powder is added into the molten Al metal and heated upto 1200^0C. This molten metal is poured into sand mould and allowed to cool for 4 – 5 hours. After cooling, required shape of a disc is obtained by lathe turning process.

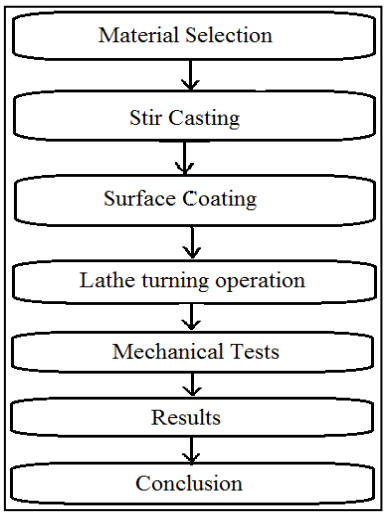

Fig. 2.1: Flow Chart of Methodology

Fig. 2.2: Stir Casting Chamber

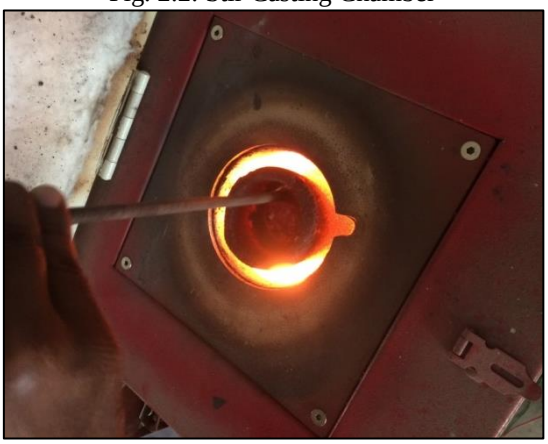

Fig. 2.3: Melting Of Aluminium in Stir Casting Chamber

II. MECHANICAL TESTS

A. Wear Test

Wear test was conducted using pin on disc method at room temperature. One specimen of each composition is prepared

with the dimensions 30mm length and 6mm diameter by machining in lathe. Wear test was performed by using following parameters,

– Load (N) – 19.62N
– Disk rotation speed – 2m/s
– Wear track diameter – 50mm

B. Rockwell Hardness Test

Rockwell hardness number of the disc was determined by using Rockwell hardness machine. Few numbers of readings are taken and average RHN was found out. Before starting the test, the disc surface was polished by using grinding machine.

III. RESULTS & DISCUSSION

A. Wear Test

Wear test on both specimens (One is 95%Al – 5%SiC and another one is 90%Al - 10%Sic) are conducted by pin on disc technique. The metal removal rate of 90%Al - 10%SiC specimen is slightly higher than the 95%Al – 5%SiC specimen. From results, it is clear that while introducing more SiC in Al, the metal removal rate is reduced (i.e) wear rate decreased.

Sl No.	Al – SiC MMCs Composition	Initial Weight (gram)	Final Weight (gram)	Metal Removal (gram)
1	95%Al – 5%SiC	6.18	6.052	0.128
2	90%Al - 10%SiC	5.96	5.878	0.082

Table 4.1: Metal Removal Rate of Al – SiC MMCs.

B. Rockwell Hardness Test

Following table shows the Rockwell hardness number of different Al-SiC MMCs.

Sl. No.	Al – SiC MMCs Composition	Rockwell Hardness Number
1	Grey Cast iron Disc	142
2	95%Al – 5%SiC MMC Disc	178
3	90%Al - 10%SiC MMC Disc	205

Table 4.2: Rockwell Hardness Number of Al – SiC MMCs.

From the above table, Al-SiC MMC disc has higher surface hardness value than traditional gray cast iron disc. In Al – SiC MMC, 90%Al - 10%SiC disc has higher hardness value.

IV. ANALYSIS

Modelling of disc brake is done by CATIA v6 and analysis of disc is carried out by ANSYS 16.0.

A. Structural Analysis

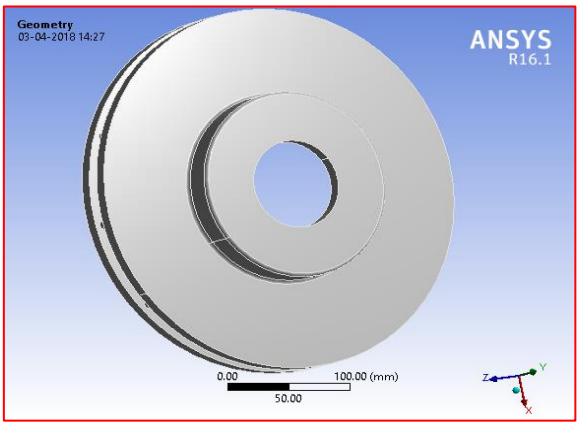

Fig. 5.1: Al – SiC MMC Reinforced Brake Disc

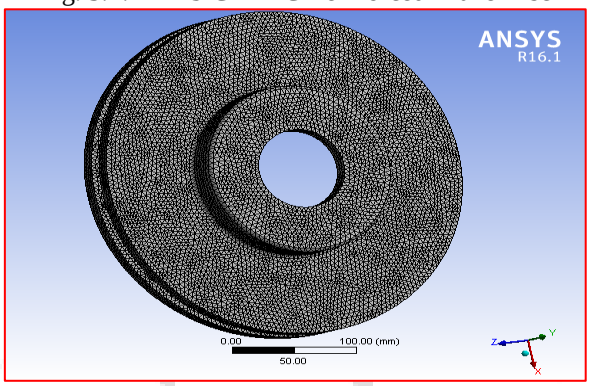

Fig. 5.2: Meshing Model of Brake Disc

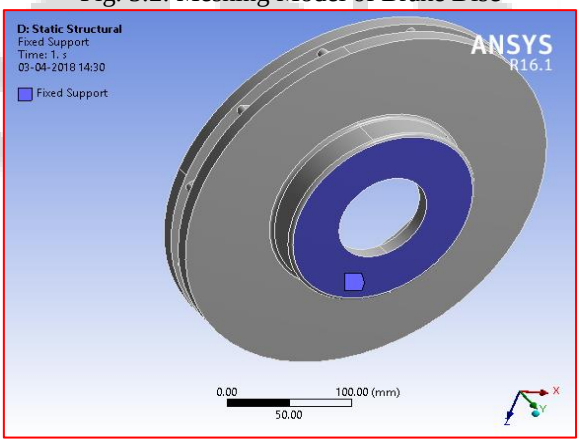

Fig. 5.3: Static Structural Analysis of Brake Disc - Fixing Support

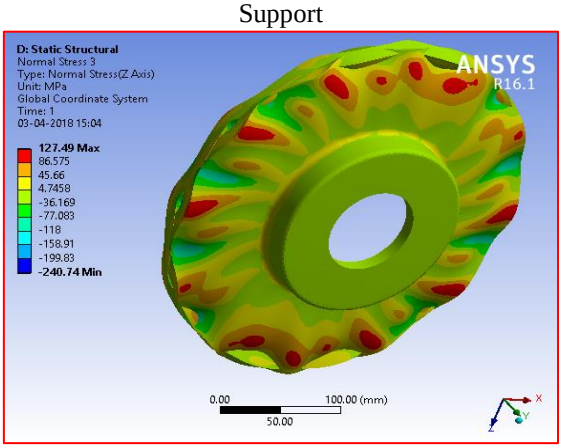

Fig. 5.4: Normal Stress Distribution on Brake Disc in z Direction

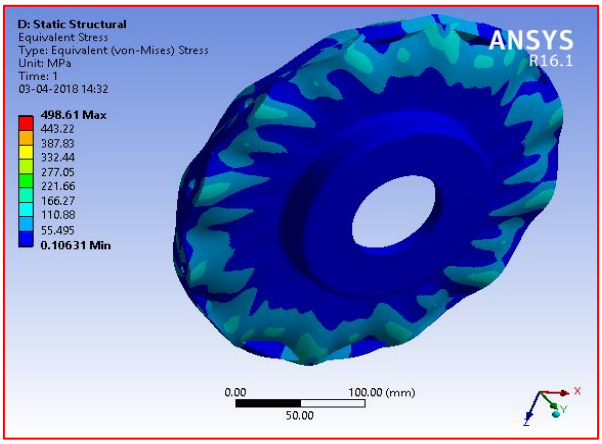

Fig. 5.5: Equivalent Stress Distribution on Brake Disc

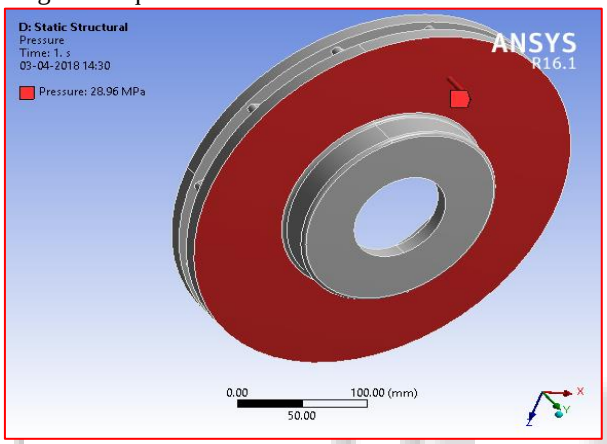

Fig. 5.6: Static Structural Analysis of Brake Disc by Applying Pressure

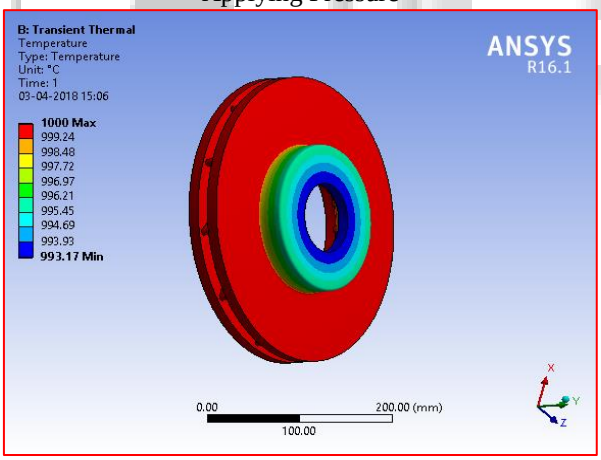

Fig. 5.7: Transient Thermal Analysis of Brake Disc

B. *Thermal Analysis:*

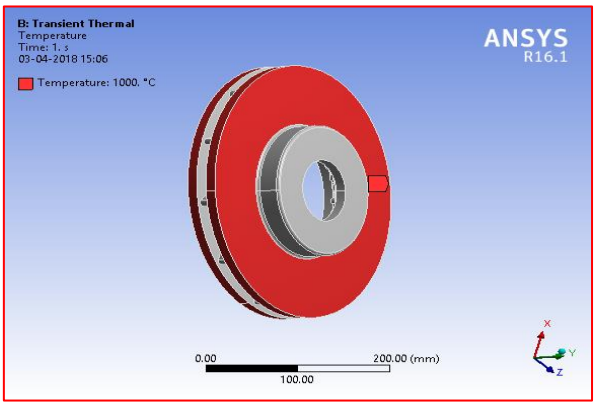

Fig. 5.8: Transient Thermal Analysis of Brake Disc – Applying Temperature

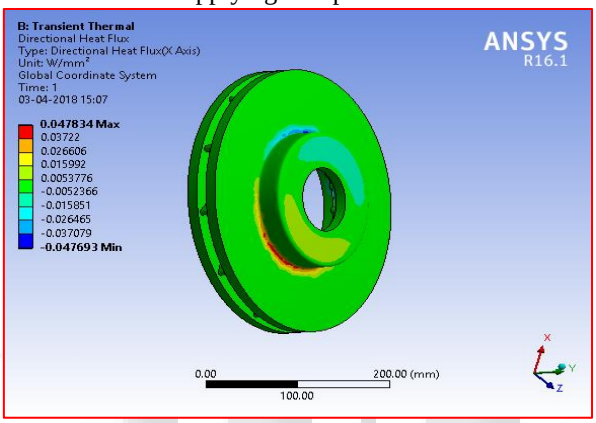

Fig. 5.9: Heat Flux Distribution of Brake Disc in X Axis

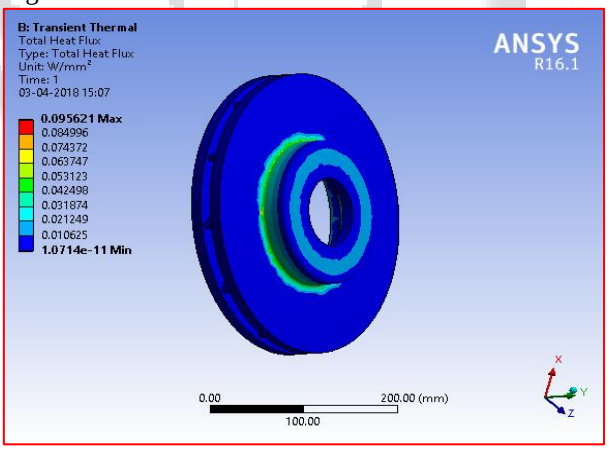

Fig. 5.10: Total Heat Flux of Brake Disc

V. CONCLUSION

Al – SiC MMC disc brake was manufactured successfully by stir casting technique. By comparing different mechanical properties of 95%Al – 5%SiC and 90%Al – 10% Sic MMCs, we may concluded that introducing SiC in Al will increase surface hardness, provide high resistance against wear by reducing metal removal rate from disc. Finally 95%Al – 5%SiC MMC disc brake can be replacing traditional grey cast iron disc brake in automobile.

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