# Tribological Behaviour of Aluminium based Silicon Carbide with Additional Fillers of LM25 Alloy

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**Abstract:** ***A Disc brake is sliding friction couple made of rotor (disc) connected to the wheel and a stator on which the friction material (say brake pad) is mounted. The friction causes wear of Brake pads. The brake pad is characterized by the frictional behaviour brake pads are always subjected to wear. The behaviour of brake pad material related to wear under the influence of parameters like velocity of sliding, sliding distance. Brake pads should ensure continuous coefficient of friction, safety and durability. The use of asbestos material is being avoided to manufacture the brake pads as it is harmful and toxic in nature. Further it leads to various health issues like asbestosis, mesothelioma and lung cancers. Hence, in this study, the tribological behaviour of Aluminium Based Silicon Carbide is been tested under the wear study. In this concept, an attempt is made to try out Aluminum Matrix material for brake pads. Composite are of polymer, ceramic and metal matrix type. The use of composites is motivated because of good friction co efficient and wear resistant properties. The aim of this project is to design a heat resistant material for optimum friction coefficient (μ) and to design a perfect composite material which has low wear rate at different temperature, load and velocity conditions. The Specimen is prepared using two different compositions of fillers. . The Experimental investigation of sample specimen is done by Pin on Disc Apparatus for validation of wear rate and Friction Co - efficient.***

**Keywords:** Brake Pads, Composite Material. Tribological Study

## 1. Introduction

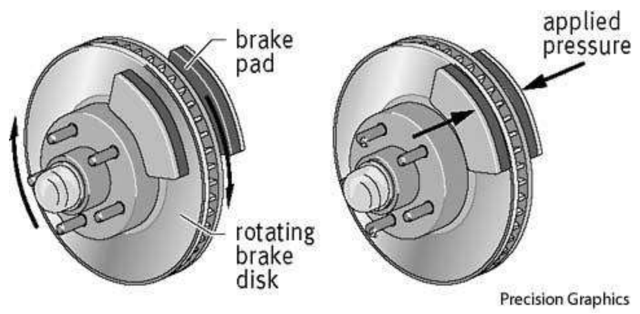


**Figure 1:** Disc Brake and Pads Assembly [3]

The disk brake is one type which uses brake callipers to initiate the braking action by pressing the brake pads against the brake disc which in turn creates friction which directly slows down the motion of the vehicle either by reducing the rotational speed of the wheel or by holding it in one place. The heat formed due to friction should be dissipated to the surroundings through proper design of the brake disc. Due to this rapid dissipation of heat, the disc brake offers a good performance in the braking of a vehicle unlike drum brakes.

Aluminium matrix composites with Al2O3 reinforcements give predominant mechanical and physical properties. Al - Al2O3 Ceramics has wider applications in a various fields such as vehicle, aviation, military equipment and other applications. Kevlar is a thermo - safe and solid manufactured fiber, identified with different Aramids, Kevlar - 119 has higher elongation capacity, adaptable weariness resistant, yarn types found in mechanical elastic products such as tires, hoses and other wide and larger productivity of applications are utilized, it achieves an excellence of thermal and other properties. A carbon - Ceramic is a subgroup of Ceramics which offers excellent braking performance, which withstand high temperature and very light weight material.

- Brake pads convert the kinetic energy of the vehicle to thermal energy through friction.
- Two brake pads are contained in the brake calliper, with their friction surfaces facing the rotor.
- When the brakes are hydraulically applied, the calliper clamps or squeezes the two pads together onto the spinning rotor to slow and stop the vehicle.
- When a brake pad heats up due to contact with the rotor, it transfers small amounts of its friction material onto the disc, leaving a dull grey coating on it.
- The brake pad and disc (both now having the friction material), then "stick" to each other, providing the friction.

**Figure 2:** Behaviour of Brake pads under Wear

The Brake pad material should have good thermal conductivity, thermal resistance and withstand high contact pressures. Friction composites mainly consist of about ten classes of ingredients such as, binder, fibres, friction modifiers and fillers. Binder known as resin or matrix provides the mechanical integrity to the composite apart from contributing to the friction and wear. Fibres being multi - functional play a critical role in absorbing stresses


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generated at the mating interfaces, while simultaneously retaining the integrity of the composite at elevated temperatures and influencing wear also.

## 2. Problem Definition

"*To analyse and compare the wear analysis and Tribological behaviour of AlSiC material under laboratory Simulated Conditions*"

The value of coefficient of friction and wear of existing material has been noted by the literature view and hence to improve the coefficient of friction and wear experimental analysis on Pin on Disk Test rig has made also the analysis of composite material for selecting the clutch plate material was important. In this work attempt has been made to improve the mechanical wear properties of the selected composites. In this work the brake pads is generally made from Matrix composites of Ceramics and Metal. This is because MMC has a good wear resistance with high thermal conductivity and the production cost is low compare to other materials.

The Present Work is undertaken to accomplish the following Objectives:

- To understand Tribological Properties of pads Material using laboratory scale experiment.
- To fabricate a perfect composite material having low wear rate at different temperature, load and velocity conditions.
- Wear Analysis is to be carried out.
- The Taguchi Analysis is formulated to determine smaller the better criteria for wear of Material is to be carried out.

Based on the Literature review, the following scope of work has been identified:

- To Study Tribological Properties of Brake Pads Material.
- To Study Behaviour of composite material of Pads.
- To Study the wear and mechanical properties of composite material of Brake Pads.

## 3. Material Selection

### 3.1 Material Requirements

- The material's ability to resist brake fade, caused by an increase in temperature the material will experience from the conversion of kinetic energy into thermal energy.
- The ability to recover quickly from increased temperature or moisture, and exhibit approximately the same friction levels at any point in the drying or cooling process.
- The friction coefficient of modern brake pads should be low enough prevent locking of the wheels but high enough to provide sufficient stopping power. Friction coefficients are typically between 0.3 and 0.5 for brake pad materials.
- The ability to resist wear due to friction, but not to the extent that rotor wear occurs more quickly than brake material is sacrificed.
- The ability of the material to provide smooth and even contact with the rotor or drum, instead of a material that breaks off in chunks or causes pits, dents, or other damage to the surface in contact).

### 3.2 AlSiC

AlSiC alloys are semi - finished products, and can be formed in different shapes. They are a pre - alloyed mixture of alloying elements. They are also known as modifiers, hardeners, or grain refiners based on their applications. They are added to a melt to achieve the desired result. They are used instead of a pure metal because they are very economical and save energy and production time. The material is used because of its following properties –

- Light weight
- High stiffness
- Low thermal expansion
- High thermal conductivity
- Excellent mechanical damping
- Facture toughness
- Near net shape process allowance

**Table 1:** Properties of Aluminum Silicon Carbide

| Parameter | Value |
|---|---|
| Ultimate Tensile Strength | 95 MPa |
| Yield Strength | 75 MPa |
| Young's Modulus | 115 GPa |
| Shear Modulus | 58 GPa |
| Poisson Ratio | 0.29 |
| Density | 2800 $Kg/m^3$ |

### 3.3. Preparation of Sample Specimen


**Figure 3:** Sample Specimen for AlSiC


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The Experimental methodology is done on three samples,
1) AlSiC
2) AlSiC with 5% LM25 Fillers
3) AlSiC with 10% LM25 Fillers

## 4. Experimental Investigation

Pin on disk wear testing is a method of characterizing the coefficient of friction, frictional force and rate of wear between two materials. As a particularly versatile method for testing wear resistance, pin on disk can be configured in multiple scenarios depending on the goals of your project. Pin on disk testing can simulate multiple wear modes, including unidirectional, bidirectional, omnidirectional and quasi - rotational wear. Our equipment allows us to test virtually any combination of materials.

In this experiment, the test was conducted with the following parameters:
1) Load
2) Speed
3) Distance

The Loading condition to be set is 1, 2 and 3 kg. The material will be subjected to wear test for 20N in three different formats. There will be three trails testing on pin. The Pin will be subjected to loading condition from one side, then the other side and again from the first side. Before each test the weight of material and the height of material will be measured.

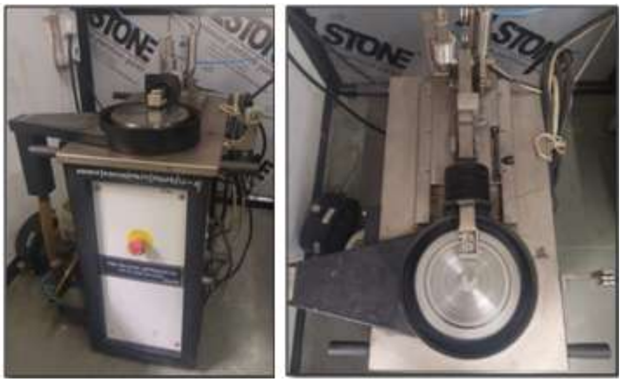

**Figure 4:** Work piece setting on Pin on Disc

**Table 2:** Sliding Velocities and Distances for Different Loading

| Load (N) | Speed (Rpm) | Sliding Velocity (m/s) | Sliding Distance (mm) |
|---|---|---|---|
| 10 | 250 | 1.43 | 863500 |
| 20 | 500 | 2.87 | 2590500 |
| 30 | 750 | 4.31 | 5181000 |

**Table 3:** Specifications of Pin on Disc Test Setup

| Parameters | Values |
|---|---|
| Specimen pinsize | 10 dia. & 32 mm long |
| Wear Disc Size | Dia.165 mm, 8 mm thick |
| Wear Track Diameter | Min 50 mm – Max 100 mm. |
| Disc rotation | 2000 rpm |
| Sliding speed | 0.5 to 10 m/s |
| Normal load | 2 Kg, 19.62 N |
| Frictional Force | 0N – 200N |
| Overall Dimensions | 670 x 580 x 880 mm |
| Total Weight of Setup | 220 Kg. |
| Motor | Eltek 0.1 HP. |

**Table 4:** Initial Parameter of Experimental Testing

| Material | Load (N) | Speed (RPM) | Time (Minutes) |
|---|---|---|---|
| Sample 1 AlSiC | 10 | 250 | 10 |
| | 20 | 500 | 15 |
| | 30 | 750 | 20 |
| Sample 2 AlSiC + 5% LM | 10 | 250 | 10 |
| | 20 | 500 | 15 |
| | 30 | 750 | 20 |
| Sample 3 AlSiC + 10% LM | 10 | 250 | 10 |
| | 20 | 500 | 15 |
| | 30 | 750 | 20 |

The Readings of Wear testing will be done in following parameters
1) Load Varying from 10 to 30 N
2) Speed Varying from 250, 500 and 750 RPM.
3) Time difference of test for 10 min, 15 and 20 mins respectively.

## 5. Result and Discussion

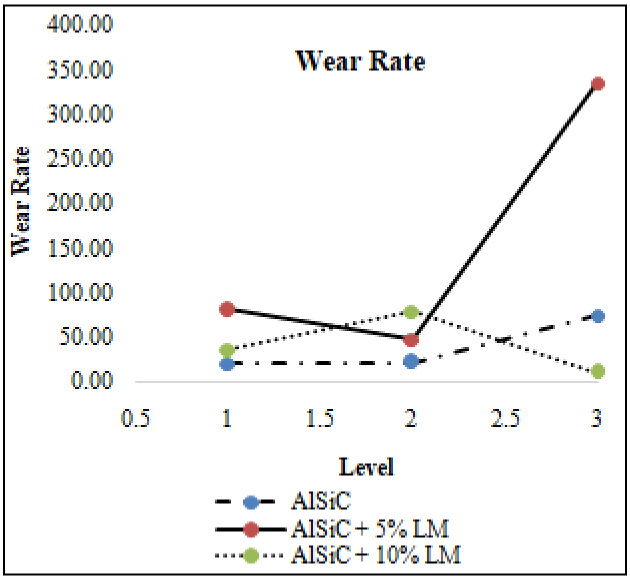


**Figure 5:** Response Analysis for Wear Rate

In the current case study dry lubrication is been for three different sample using three different level parameter. The figure 5. explains the behaviour of material under different level of input. The wear rate for AlSiC with 5% fillers gradually increases initially but as the level goes on increasing the wear rate for same increase rapidly. Hence in terms of wear rate for AlSiC with 10% LM gives best result for the extreme level of loading conditions. The material initially shows the response of moderate wear rate but goes on decreasing for maximum loading, speed and time duration.


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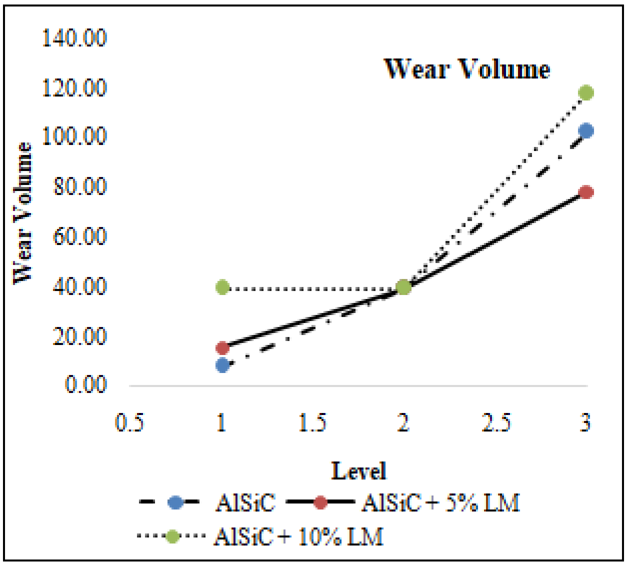


**Figure 6:** Response analysis for Wear Volume

The wear volume increases non - linearly with increasing head penetration, i. e., at higher head penetrations, the wear is generated from a larger area. The current case study is performed using Speed, load and time. After each reading the length of the specimen is measured and the difference between both the lengths are calculated. All the materials are performed under the same condition. The value of forces describes the co - efficient of friction. The value of friction is somewhat similar for all the material under loading of 20 N with speed as 500 RPM. As the speed increase the variations in the values of the material starts differentiating. The material with 5% Alloy shows better result as that of 10% Alloy. As the speed and load increase, the parameter difference can be easily obtained.

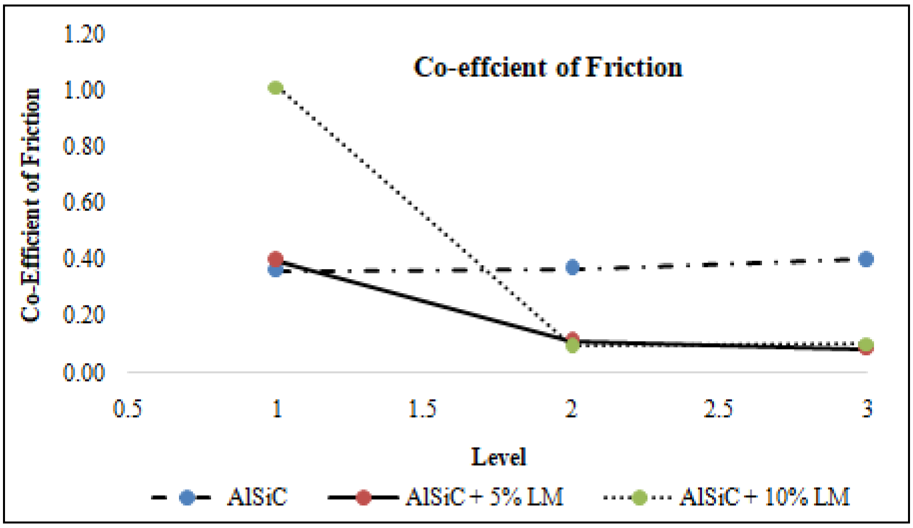


**Figure 7:** Response analysis for Co - Efficient of Friction

A coefficient of friction that is more than one just means that the frictional force is stronger than the normal force. The coefficient of friction is depend on velocity of the moving object. The coefficient of friction can also be changed by the mass and speed of the moving object. The lower the co - efficient of friction is obtained, the more gripping force is determined between the sliding and rotating material. The values of co - efficient are calculated as ration of applied force to frictional force generated using the Tribometer. The value of AlSiC remains constant for all the loading conditions which is generally the standard material for brake pad. The variation in values of LM makes the material varying in the respective co - efficient. Amongst all material with respective loading, AlSiC with 5% LM can be better material for Co - Efficient of Friction.

## 6. Conclusions

- The Specimen of AlSiC is been selected for Pin is been manufactured. The materials used here as mention in the chapter 3, of experimental reviews andinvestigation.
- AlSiC has been added filler with 5% and 10% LM Alloy.
- The Experimental Investigation is been done for determine the wear behavior for all the three specimens under the conditions of variation in load, speed and Time of test.
- All the materials shows their respective behavior under varying loading conditions. The material of AlSiC with 5% LM, shows the least wear rate and wear volume under varying loading conditions. The magnitude for material shows better result when the load increases and is in extreme condition as the experimental parameters.

## References

[1] Balaji R. “Modelling and analysis of Disk Brake under Tribological behaviour of Al - Al2O3 Ceramic Matrix Composites/Kevlar® 119 composite/C/Sic - Carbon Matrix Composite/Cr - Ni - Mo - V steel. ”, Materials Today: Proceedings, Else Vier Publication, Volume 18, 2019.

[2] Salako Ismaila, Jacob S. Jatau, Mohammed A. Bawa, “Particulate Reinforced Aluminium Alloy Matrix Composite Brake Rotor – A Review of the Mechanical and Wear Behaviours”, Journal of Scientific and Engineering Research, 2019.


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[3] S. Sri karthikeyan, "elemental analysis of brake pad using natural fibres", Materials Today: Proceedings, Proceedings, Else Vier Publication, Volume 16, 2019.
[4] C. Brainard Abraham, "Basalt fibre reinforced aluminium matrix composites – A review", Materials Today: Proceedings. Materials Today: Proceedings, Proceedings, Else Vier Publication, 2019.
[5] V. Purkar, "Experimentation and Analysis of Aluminum Metal Matrix Composite with Silicon Carbide Used for Brake Pad Applications under Wet Friction Condition", International Journal for Research in Applied Science & Engineering Technology (IJRASET) Volume 5 Issue 9, September 2017.
[6] Dr. Satish Pujari, "Experimental Investigations on Wear Properties of Palm kernel Reinforced Composites for Brake Pad Applications", Journal for Defence Technology, 2018.
[7] Bushra Rashid, "Eco - Friendly Composites for Brake Pads From Agro Waste: A Review", Reference Module in Materials Science and Materials Engineering, Else Vier Publication, 2017.
[8] V. Purkar, "Wear behavior of Aluminium Metal Matrix Composite with Silicon Carbide used for Brake Pads under Dry Friction Condition", International Advanced Research Journal in Science, Engineering and Technology Vol.3, Issue 6, June 2016.
[9] Harshal P. Deshmukh, "Experimentation and Analysis of Three Different Compositions of Semi - Metallic Brake Pads for Wear Rate under Dry Friction Condition", International Journal of Engineering Research & Technology (IJERT), Vol.4 Issue 10, October - 2015.
[10] Rathod Abhik, "Evaluation of Properties for Al - SiC Reinforced Metal Matrix Composite for Brake Pads", Procedia Engineering, Else Vier Publication, 2017.
[11] Faiz Ahmad, "Tribology Behaviour of Alumina Particles Reinforced Aluminium Matrix Composites and Brake Disc Materials", The Malaysian International Tribology Conference, Else Vier Publication, 2013
[12] R. Vijay, "Optimization of Tribological Properties of Nonasbestos Brake Pad Material by Using Steel Wool", Hindawi Publishing Corporation Advances in Tribology, 2013
[13] D. Gultekin, "The effects of applied load on the coefficient of friction in Cu - MMC brake pad/Al - SiCp MMC brake disc system", Journal of Wear, Else Vier Publication, 2010.


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