

Analysis of Composite Drum Brake Using FEA Approach

Simon George^{#1}, Arun LR^{*2}, Guru Prasad BS^{#3}

[#]Department of Mechanical engineering the oxford college of engineering, Bangalore, India

Abstract— The modern development in the field of material technology gave rise to hybrid materials such as composites that paved the way for engineers to explore the possibility of substitute material which can perform efficiently and effectively than conventional materials. For the Engineering applications such as Automotive and Aerospace are the *prima-feci* in such applications. The present work is concentrated on the development of a particulate reinforced composite material for an automobile brakedrum in place of conventional material such as cast iron and aluminum alloys are heavier and can be replaced by light weight aluminium hybrid composites. Al6061 with 9% SiC and 15 % fly ash is used to develop the composite by vortex casting. It is observed that this composition has enhanced mechanical and physical properties and FEA analysis shows the projected improvement which enables it to be used in practical application such as drum brakes.

Keywords— Drum Brake, Brakedrum, Aluminium hybrid composites, SiC, Flyash, Ansys.

I. INTRODUCTION

This Drum brakes are the first types of brakes used on automobiles. Even after 100 years of first usage, drum brakes are still used on the rear wheels of most vehicles. The drum brakes are used extensively as the rear brake in automobiles, Light Motor Vehicles (LMV's) in particular. The leading-trailing shoe design or Internally Expanding Drum Brake is used extensively as rear brake on passenger cars and light weight pickup trucks, automobiles in general. Most of the front-wheel-driven vehicles use rear leading-trailing shoe brakes. Such design provided low sensitivity to lining friction changes and has stable torque production.

The brake drum of a motorcycle is usually made from cast aluminum or cast iron and essentially a cylinder sandwiched between the wheel rim and the wheel hub. Within the drum are brake shoes lined with friction material. The brake shoes are pressed against the inside of the drum surface by a cam or actuators inside the wheel cylinders. The inside surface of the drum is acted upon by the linings of the brake shoes. When the brakes are applied, the brake shoes are forced to come into contact with the inside surface of the brake drum to stop or slow the rotation of the wheel due to friction. The drum may appear to be perfectly round to the naked eye and it appears that they have a constant diameter when measured with a micrometer or a vernier caliper, but it

is not perfectly circular. The Brakedrum may have lobes and bores which may make it not really round and can affect the function due to the manufacturing defects and errors. The component would function well for a short period of time but wear at some point may result in noise and vibration. In this study atypical automobile drum brake Figure (a) with an inner diameter of 274mm outer diameter of 295mm and pad thickness of 4mm is selected for analysis. A flat cam mechanism is used to provide force on one end of the shoes while the other end of the shoes is pivoted.

K. Radhakrishna [1] et al, he had used aluminium with copper and fly ash as reinforcements and concluded that up to 15% the reinforcements are successfully dispersed in the matrix and hardness, wear resistance increases up to 15 wt% addition of reinforcements.

Beinias [2] et al, used aluminium with flyash as reinforcements and stated with the addition of fly ash brittleness increases and corrosion increases as it forms porosity.

Sudarshan, M.K. Surappa [3] et al, have synthesized A356 Al-fly ash particle composites. They studied mechanical properties and dry sliding wear and come into brief idea that The damping capacity of composite increases with the increase in volume fraction of fly ash. The 6% of fly ash particles into A356 Al alloy shows low wear rates at low loads (10 and 20 N) while 12% of fly ash reinforced composites show lower wear rates compared to the unreinforced alloy in the load range 20–80 N. At higher load, subsurface delamination and thermal softening is the main mechanism in both the alloy as well in composites.

S. C. Mishra [4] et al, and co workers has studied on Aluminium – fly ash composite produced by impeller mixing and came into a brief idea that Up to 17wt% fly ash reinforcement can be reinforced by liquid metallurgy route. The addition of magnesium into the aluminium melt increase the wettability and thus increase in the mechanical properties such as hardness, tensile strength and the wear resistance is observed.

GanesanPandi [4] et al experimentally investigated the machining and tribological behaviour of hybrid aluminum composites. In this study, Silicon carbide,

Alumina oxide, Fly ash and graphite used as reinforcements and found that Aluminum metal matrix composites with multiple reinforcements showing good mechanical and tribological properties and stated that addition of graphite content into aluminum composites improves tensile strength, machinability and elastic modulus due to solid lubricating properties of the graphite particles. Also addition of Alumina and fly ash particles into aluminum composites improves mechanical properties. Hence authors stated that addition of two or more reinforcements gives the better mechanical and tribological properties to the aluminum matrix.

G Rajesh Babu et al [5] carried out the static and dynamic analysis of banjo type rear axle housing by using FE method for two different materials like cast iron and mild steel. The induced deformation in cast iron housing is greater than mild steel housing and also the natural frequencies of the cast iron are lower than the mild steel. Also observed that the stress induced in the cast iron is lower than the mild steel and concluded that the cast iron is preferred for production of rear axle housing.

Muhammad najib bin abdul hamid[6] conducted the experimental analysis on drum brake and FEA analysis and concluded that improved material performs better.

Nam Ho Kim [7] et al conducted FE analysis and experimentation on metal/metal wear in oscillatory contact and concluded that These results from the block on ring experiments and the finite element simulation are close, supporting the possibility of using finite element analysis coupled with specimen-level test data to estimate wear. A systematic approach to numerical modeling, simulation, and validation for metal-on-metal wear is developed using both experimental and computational tools. Maximum wear depth predictions produced by finite element simulation of the block-on-ring test agree to within 88% of the experimental measurements without using curve fitting. Computer simulation of the wear process requires an extrapolation scheme and more research is needed in order to systematically identify appropriate extrapolation size as a function of test conditions

Fig (a) A design of simplex or leading-trailing drum brake



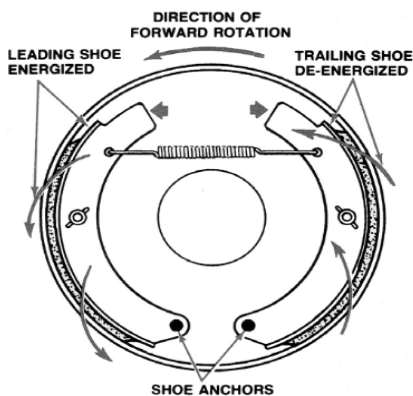
Fig (b): Drum Brake used for Two wheeler



Fig (c): Brake used for Two wheeler

II. EXPERIMENTATION

In present work AL6061 is taken as matrix metal and SiC



Content	Al	Cu	Mg	Si	Fe
%	97.99	0.206	0.729	0.533	0.191
Mn	Ni	Pb	Sn	Ti	Zn
0.076	<0.050	0.024	0.011	0.094	0.064

(a1)

Content	SiO2	Al2O3	Fe2O3	CaO	MgO
%	65.56	19.90	3.79	7.56	1.24
TiO2	LOI				
1.20	0.70				

(a2)

Table (a1): Chemical composition of Al6061, (a2): Chemical composition of Fly Ash

and Fly ash is taken as reinforced particulate.

Tensile strength-Tensile test is conducted with Universal testing machine and the specimen is prepared as per ASTM standard dimensions.

Hardness -Hardness is the resistance to surface indentation (e.g., a local dent or scratch). Thus, it is a measure of plastic deformation. The Hardness of the composites samples were measured using a Leitz, Brinnel hardness measuring machine with a load of 100 N. The specimen prepared as per ASTM standard and the dimension of the specimen is 19X19 mm

Wear--Wear test is carried out with pin-on disc setup with ASTM standard dimension. To check the wear rate on different loading conditions.

III. COMPARISON OF MECHANICAL PROPERTIES
It is observed from the comparison of results that the mechanical properties of hybrid aluminium composite is superior to the monolithic Aluminium metal.

FA % +Sic %	UTS in N
0	320
9% Sic+15% FA	412

(c)

Weight loss due to wear		
Load	Base Metal	Sic 9 % + Fa 15 %
50	0.003	0.002
100	0.009	0.0039
150	0.019	0.0071

(d)

FA % +Sic %	Hardness in Kgf
0	50
9% Sic+15% FA	71

(e)

Table (c): Ultimate Tensile Strength, (d): Wear rate, (e): Hardness

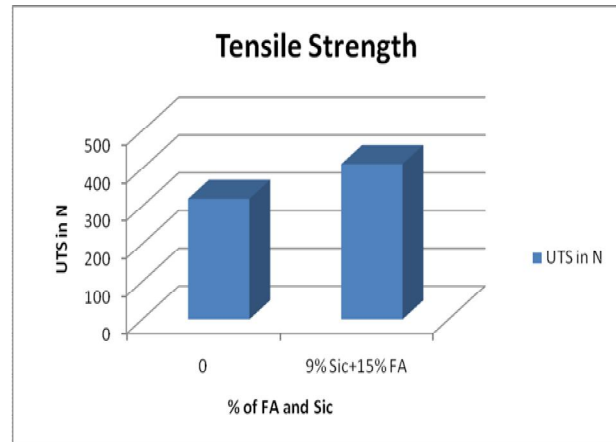


Fig (d): Ultimate tensile strength

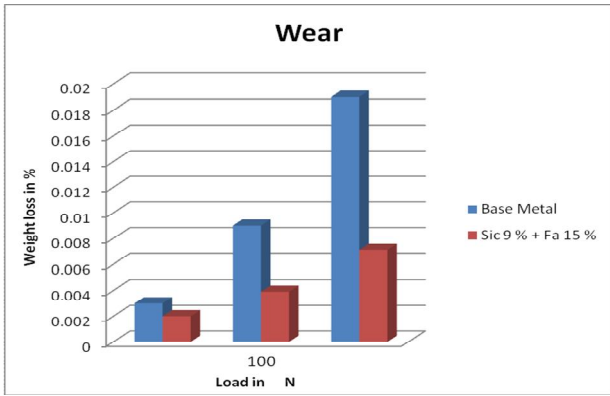


Fig (f): Weight Loss Due To Wear

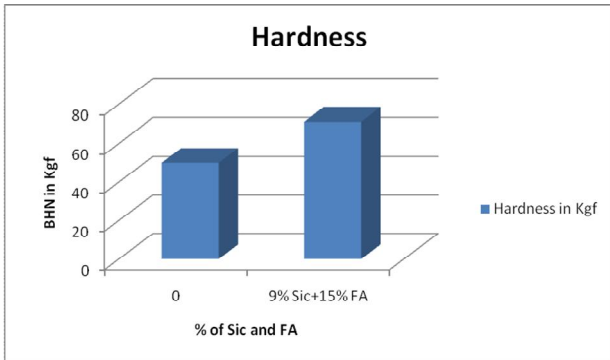


Fig (g): Hardness

IV .FE ANALYSIS RESULTS AND DISCUSSION

The finite element model for the static analysis is modeled by using Hypermesh. The geometry from the

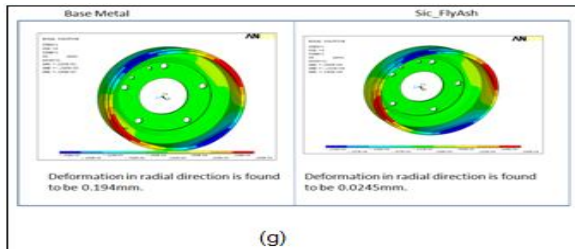


Figure (g): Comparison of deformation in radial direction b/w base metal and Aluminium composite

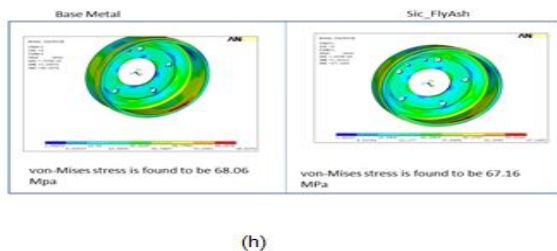


Figure (h): Comparison of Von-Mises stresses b/w base metal and Aluminium composite

Catia software is exported into IGES/STEP format. This has been imported into Hypermesh, the de-featuring operation is carried out to remove small diameter bolt holes, fillets etc. Meshing is generated using tetrahedral solid 187 element with various elements length based on the geometry. The FE model is imported in ANSYS window and verified for elemental quality, material assignment and element type. The boundary conditions and loading details are applied in ansys. Then the analysis type is selected and solved for the given loading and BCs. After solving the model, output results such as von-Mises stress, major principle stress, and deformation plots are extracted.

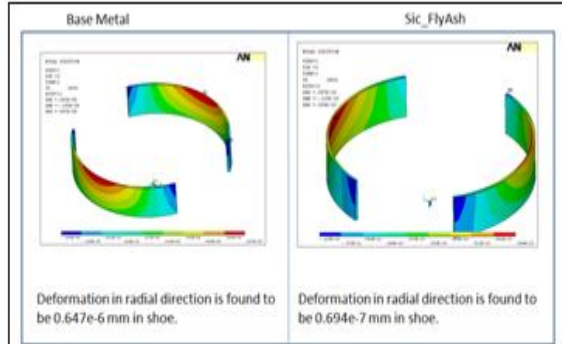


Fig: (i) Comparison of deformation in shoe in radial direction b/w base metal and Aluminium composite

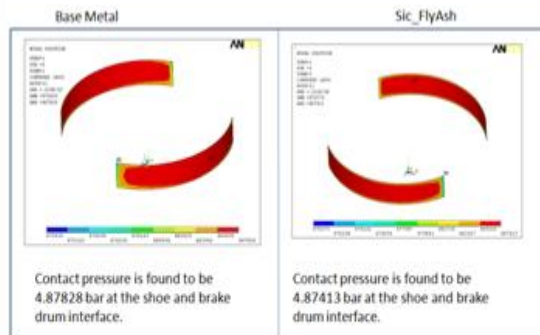


Fig: (j) Comparison of contact pressure at shoe and brake drum interface b/w base metal and Aluminium composite

V .CONCLUSION

The radial deformation induced in brake drum is found to be less for sic-flyash composite material by 0.1695mm, hence it exhibits sic fly ash composites have better wear resistance compare to base metal. the von-mises stress is found to 68MPa for both materials because of same loading and boundary conditions .the von-mises stress is found to 68MPa for both materials because of same loading and boundary conditions .the radial deformation induced in brake shoe is found to be almost same.

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