Design & Analysis of Full Face Liner of Ftl-098 Material on Band in Terms of Performance of Brakes as Load & Speed Fade

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Abstract— Fade is the term used to indicate a loss of braking effectiveness at elevated temperatures because of a reduction in the kinetic friction coefficient (μ). The fade phenomenon in friction materials represents a deviation from law of friction and its occurrence reduces braking efficiency and reliability. Three primary attributes governing brake fade have been identified as load fade, speed fade and temperature fade. High interfacial temperatures can lead to a decrease in shear strength of the pad and consequently a decrease in frictional force which induces fade. This paper deals with application of full face liner for effective braking on band brake system. This is expected to improve brake torque; brake power absorbed and reduced brake wear. Material of brake liner for full face liner is FTL098.

Key words: Brake Fade, Full Faced Liner

I. Introduction

Different non-asbestos friction materials have to be replaced with asbestos fibers as it can lodge in the lungs and induce adverse respiratory conditions. So the Environmental Protection Agency announced a proposed ban on asbestos. The ban would have required all new vehicles to have non-asbestos brakes. From this we can see that there are different frictions materials available which can be replace by asbestos material. The different test conducted brake liner as per the specification & working condition as per the Europe regulation 90. After the test the characteristic, frictional coefficient, wear behavior is observed and according to that we will prepared the result. It gives lower emissions and fuel efficiency as environmental regulations become more stringent this shifts towards environment. The wear behavior of the brake liner is less so the life of liner is more. It maintains the temperature of the drum & liner so it will not realize the hazardous material in the atmosphere. The band for the band brake is prepared in a full face form that allows overall cost reduction, ease liner replacement and lowered maintenance cost of brake. As an important part of friction brake, the friction materials (namely, brake shoe, brake lining, etc.) should have high and stable friction coefficient; great thermal conductivity; excellent heat and wear resistances; and weak absorbability of water, oil, or brake fluid.

II. Literature review

Sayali S. Adhav, D.V. Kushare (2016) this researcher shows Design Analysis and Performance evaluation of discrete moulded liner buttons on band in terms of performance of brake as load fade and speed fade. This paper deals with application of molded liner buttons to induce temperature reduction at the brake liner interface by increased air circulation. This is expected to improve brake torque; brake power absorbed and reduced brake wear [1].

Xingming Xiao[1], et. al. [2016] this researchers study on Review on the Friction and Wear Behavior of Brake Materials. Friction and wear behaviors of brake's friction materials are considered as an important subject. In this article, friction materials were classified by matrix categories, and their major components were introduced first [2].

Bouchetara Mostefa, Belhocine Ali (2014) this research work shows the analysis of thermo-mechanical behavior of dry contact between brake disc and pads during the braking phase. Modeling of transient temperature in disk was done to install ventilation system in vehicles. This analysis further coupled to determine the Von-Misses stress, deformation and contact pressure distribution in pads. The results obtained were satisfactory when comparison was done with specialized literature survey [3].

Dr. S.B.Chikalthankar, Dr. V.M. Nandedkar this research work represents the study of frictional and wear characteristics of non-asbestos brake pad using Link chase machine. Parameters like coefficient of friction and wear were considered foe the work study. This study outlined a proposed work to develop a non-asbestos material which is expected to show a stable friction coefficient and wear rate [4].

K. Sowjanya and S. Suresh (2013) this work explains the structural analysis of disk brake rotor and its effect on the brake disk design. Study was carried on the basis of strength and rigidity criteria. Materials like aluminum metal matrix composites were examined for thermal solution to structural analysis. Maximum Von-Misses stress was observed to be 50.334 MP a for CI and211.98MPa for AIMMCI and 566.7 MP for AMMCII [5]. The design is found to be safe.

M.A. Maleque, A. Atiqah (2012) objective of this work was to develop a new natural fiber reinforced Aluminum composite for automotive brake pad application. Properties like density, porosity, microstructures analyses, hardness and mechanical properties were examined using dens meter, UTM, hardness tester. Four new formulations were prepared by varying coconut fiber content from 0, 5, 10, 15% volume fractions. Results obtained were concluded that 5 & 10% volume fraction showed better physic-mechanical properties compared to other fractions [6]. And it verified that coconut fiber can be used as potential filler material.

A.M. Zaharudina, R.J. Talib (2012) studied Taguchi method for optimizing the manufacturing parameters of frictional materials like semi-metallic materials produced using powder metallurgy. Factors like physical properties like hardness, specific gravity and tribological properties like wear, fade were considered as processing parameters. Results concluded that molding pressure has the strongest effect and impact on physical as well as tribological properties [7].

Zaid (2009) conducted study on ventilated disc brake rotor of normal passenger vehicle with full load capacity. Study concerns with heat and temperature distribution on rotor. FEM approach was used and modeling was done in CATIA. For study purpose 10 cycles of braking and 10 idle cycle were taken into consideration. Material used was gray cast iron at a temperature of 530°.This study provide a better understanding on thermal behavior of gray cast iron and also helped to find and develop an optimum rotor system for automotive industry [8].

Ji-Hoon, Choi & Lee (2004) carried work on transient analysis for thermo elastic contact problem of disk brake. For this work material used was carbon, carbon composite and wear was assumed to be negligible. Two disks were considered one isotropic and other orthotropic. Pressure and temperature distributions were numerically computed at the disk surfaces at different braking conditions. The final results computed showed that orthotropic disc brakes provides mild pressure distribution and are therefore more better and optimum, performance level wise over the isotropic brake disc [9].

Masahiro Kubota (2000) this paper represents the research work carried for achieving an optimum thermal, vibration and weight balance of brake disc rotor . Analysis was done on the airflow through ventilation holes, thermal stress analysis and vibration analysis during braking. Computational fluid dynamics was used to analyze the actual performance. Substantial weight reduction was achieved without deteriorating cooling performance by obtaining relationship between rotor weight, shape and other performance parameters [10].

Malcolm K. Stanford (2001) this paper presented works on friction and wear behavior of four hard coatings using pin-on disk machine. The four coatings were of Ni, Cr, Fe, Si, and Metco. Cylindrical pins machined from non-asbestos organic compounds and coated and uncoated disks were slide over each other. Properties like hardness, porosity and corrosion resistance were processed. Lowest wear was observed when lining material slide against stellate coated disc. High friction coefficient was observed for Metco coated disc [11].

III. EXPERIMENTATION

Design and analysis of the band brake liner:

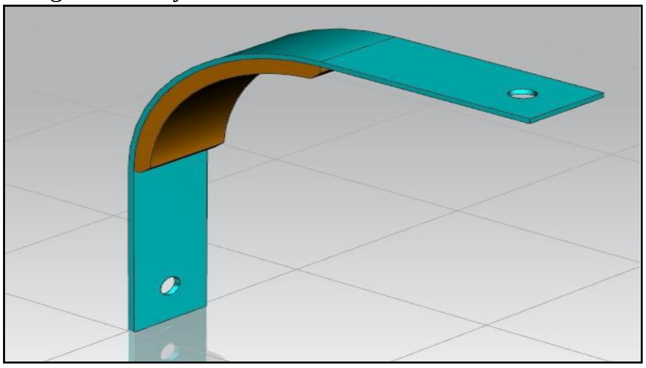


Fig. 1: Full Faced FTL-098 Band Liner

Base band is a nylon fibre based strip for holding purpose on which the full face liner is mounted. Liner is made of brake liner material FTL-098 in the moulded form, and it is mounted on the base band. FTL-098 is asbestos free material developed as a premium material specifically for car and CV disc brake pad applications. It has nominal co-efficient of friction 0.42, with excellent resisting fading. Being organic it is kinder to disc and cleaner in operations than equivalent metallic based material. Material properties of the full face liner button:

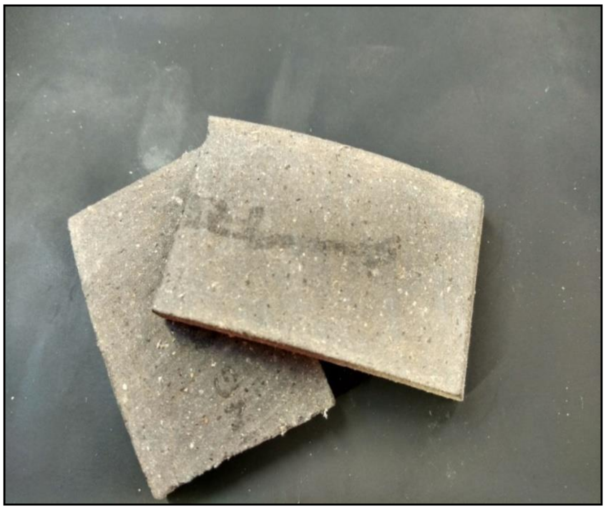


Fig. 2: FTL-098 Liner

Applications: Specifically for car and CV disc brake pad applications.

Design & analysis of Full face band liner under given system of forces, the input parameters for the same as shown below:

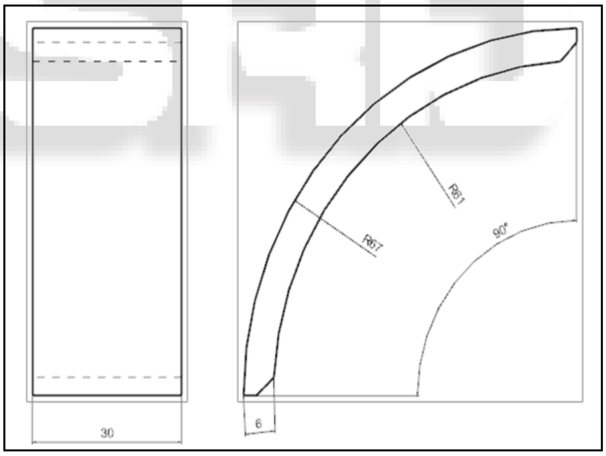


Fig. 3: 2D Diagram of FTL-097 Band Full Faced

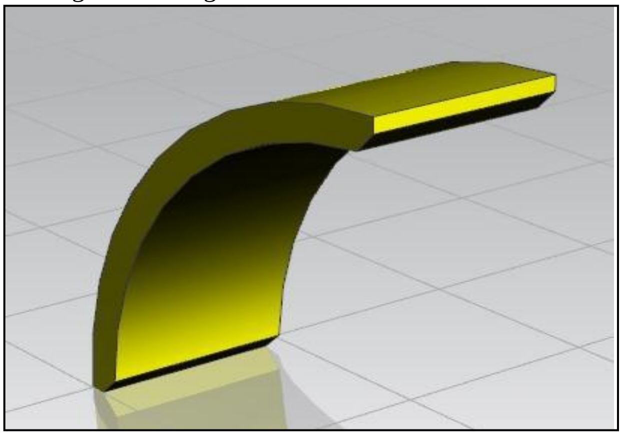


Fig. 4: FTL-098 Full Face Liner

Structural	
Density	2.45g/cm
Hardness	92-94
Friction Coefficient	0.42
Min. assembly shear Strength	418N/cm^2
Wear rate	5.98m/s (90min)
Thermal	
Thermal Conductivity	400°C
Specific Heat	600°C

Table 1: Material Properties FTL-098

The geometry of full face liner was developed using UG-NX 10. The analysis of above part is done using ANSYS Workbench 16.0. Geometry exported from UG-NX as a step file.

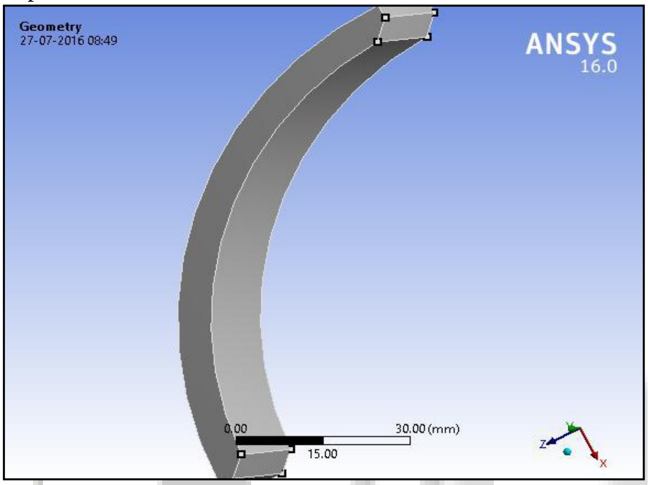


Figure 5: Geometry of Full Faced FTL-098 Band Liner

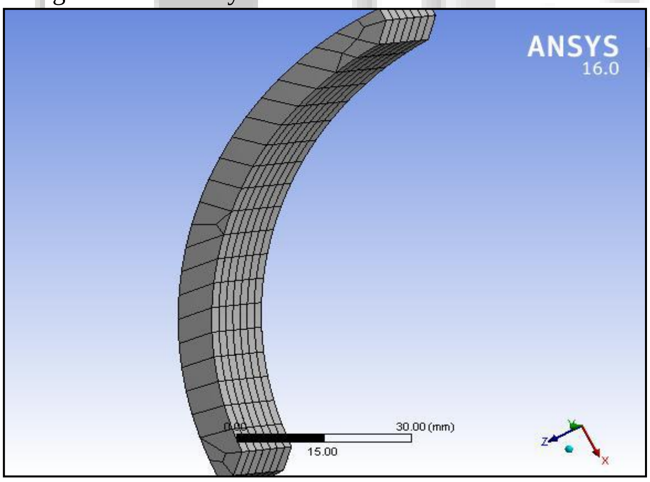


Fig. 6: Meshing

Statistics	
Nodes	1420
Elements	203
Mesh Metric	None

Table 2: Meshing Parameter

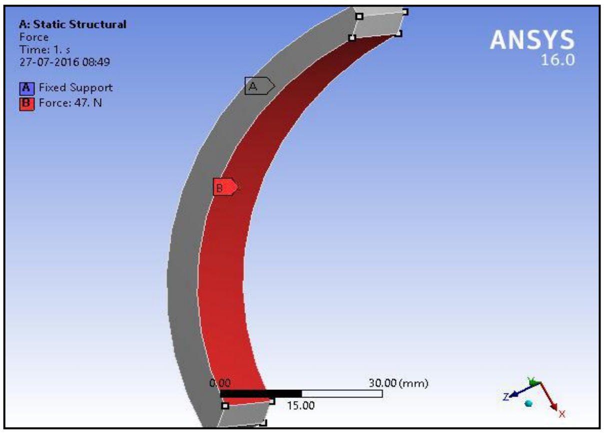


Fig. 7: Boundary Conditions on Full Faced FTL-098 Band Liner

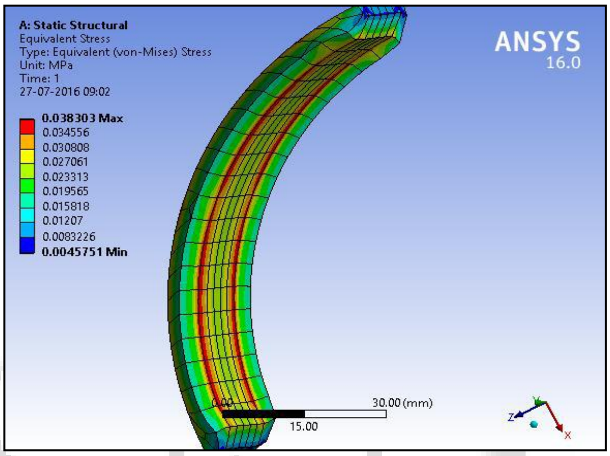


Fig. 8: Equivalent Von-Mises Stress for Full Faced FTL-098 Band Liner

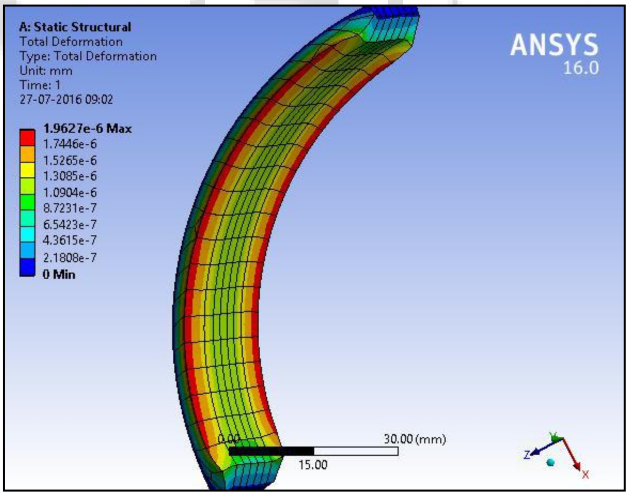


Fig. 9: Total Deformation for Full Faced FTL-098 Band Liner

As the Equivalent Von-Mises stress 0.0389 N/mm^2 < Allowable stress of 4 N/mm^2 the brake liner is safe.

A. Test & Trial on the Band Brake Liner:

1) Procedure:

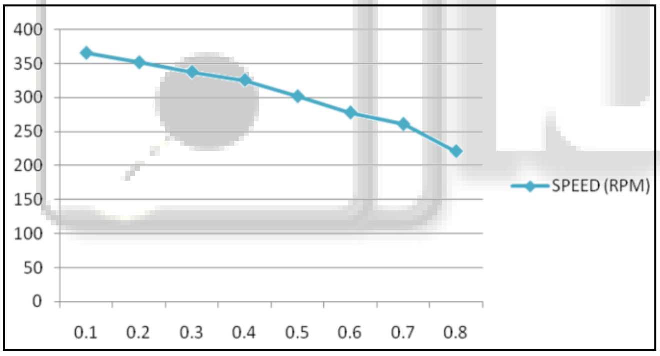
1) The band is loaded on the test mechanism.
2) The motor is started and the no-load speed is measured and noted using a digital contact less tachometer.
3) The load pan is added with a load of 100 grams; speed of the load drum is measured again and noted.

4) The procedure is repeated with increment of 100 grams up to 800 gm. Load

IV. RESULT TABLE

Sr. No.	Load (Kg)	Speed Rpm	Brake Torque N-m	% Deceleration	Fade Dimension mm/10000 Cycles	Fade Volume mm^3/10000 Cycles
1.	0.1	366	0.056898	6.153846	0.01	3.103333
2.	0.2	352	0.113796	9.74359	0.01	3.103333
3.	0.3	338	0.170694	13.33333	0.012	3.724
4.	0.4	326	0.227592	16.41026	0.013	4.034333
5.	0.5	302	0.28449	22.5641	0.015	4.655
6.	0.6	278	0.341388	28.71795	0.018	5.586
7.	0.7	261	0.398286	33.07692	0.018	5.586
8.	0.8	221	0.455184	43.33333	0.019	5.896333

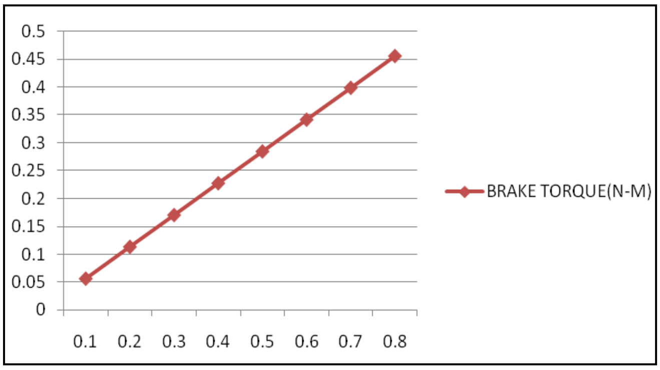
A. *Speed (rpm)*



Load (kg)
Fig. 10: Graph of Speed vs. Brake Load

Drum speed drops with increase in brake load.

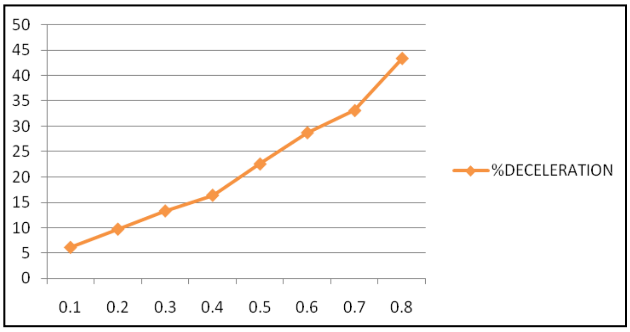
B. *Brake Torque (n-m)*



Load (kg)
Fig. 11: Graph of Brake Torque vs. Brake Load

The brake torque increases with increase in brake load.

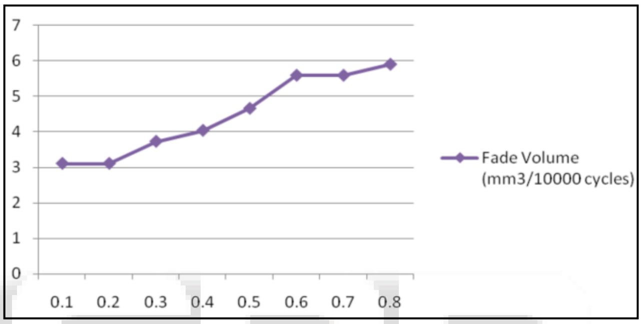
C. *% Deceleration*



Load (kg)
Fig. 12: Graph of Percentage Deceleration vs. Brake Load

The retardation / deceleration of drum increases with increase in brake load, indicating the effectiveness of brake.

D. *Fade Volume / 10000 Cycles*



Load (kg)
Fig. 13: Graph of Fade Volume / 10000 Cycles vs. Brake Load

The fade volume / 10000 cycles is limited to 5.89 mm^3 which is far less than the Allowable value of 40 mm^3 for the FTL-098 material indicating excellent brake performance against fade by virtue of application of discrete brake liner button geometry.

E. *Final Result & Discussion*

1) As the equivalent Von-Mises stress < Allowable stress for all full face liners in material FTL-098 designed parts, the full face liners are equally safe to use, only that the cost is slightly high.
2) Drum speed drops with increase in brake load.
3) The brake torque is increases with increase in brake load.
4) The retardation / deceleration of drum increases with increase in brake load indicating the effectiveness brake.
5) The fade volume / 10000 cycles is limited to 5.89 mm^3 which is far less than the Allowable value of 40 mm^3 for the FTL-098 material, indicating excellent brake performance against fade y virtue of application of discrete brake liner button geometry as discussed in previous researches.. The fade volume / 10000 cycles is limited to 6.813 mm^3 which is far less than the Allowable value of 40 mm^3 for the FTL-097 material indicating excellent brake performance against fade by virtue of application of discrete brake liner button geometry as discussed in previous researches. But comparing both materials the fade volume of FTL-098

is less than that of FTL-097 hence band will wear less; hence FTL-098 band will be recommended over the FTL-097 band.

V. FUTURE SCOPE

The full face liner in the present model can be reinforced with copper wire for better heat dissipation and further reduce the fade rate to test the performance and comparative analysis of both the arrangements will be done as future work in project and recommendation for various applications can be done the basis of data derived from test and comparison.

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