Comparative Performance Evaluation of Serrated Friction Liner Band in Band Brakes

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Abstract— This paper is mainly consist the performance evaluation of serrated brake liner. Heat generated during repetitive braking in applications like hoist, conveyors, lifting cranes, and crabs etc., problem of brake band glazing is really massive and because of which coefficient of friction is not uniform nor stable. This results into miss behaving of brakes and to overcome this problem different geometries of band liner with gaps on its surface that helps in dissipation of heat were developed and tested on test rig. Two different geometries of same material were tested and their comparative performance evaluation is presented here in this paper.

Key words: Band Brake, Braking Performance Evaluation, Serrated Friction Liner, Cross-Serrated Liners

I. INTRODUCTION

Friction material in band brakes plays an important role in braking system. During braking process, friction liners convert the kinetic energy of a moving machine to thermal energy by friction. The ideal band brake friction material should have properties like constant coefficient of friction under various operating conditions such as applied loads, temperature, speeds, mode of braking and in dry or wet conditions. These properties helps to maintain the braking characteristics of a machine.

In various field of application such a material handling equipment, lifts and hoist, band brakes find application in braking. Material transport equipment like conveyors, trolleys etc. Many machines use a continuous feed arrangement with intermittent brake for product forming. Band brakes are common in these examples. But here in these applications the braking effort is not important but the frequency of braking is. And this repetitive and frequent braking leads to excessive heating and the problem of band glazing is frequent. Glazing reduces the coefficient of friction between the brake drum and the liners leading to slip and thereby inaccurate positioning of the said load.

In the plain geometry of conventional geometry liners, due to this plain geometry the heat get produced and no ventilation leads to a partial vacuum created between brake liner and the drum which will lead to brake liner sticking on to drum leading to brake jam or brake lock, which further leads to inaccuracy of machine.

It is the friction pads or facings that really absorb the power from the drum to stop the machine. There are gaps between the pads brake facings in serrated and cross serrated brake liner. These gaps prevent the pads from sticking to the brake lining onto the drum. The gaps break any vacuum that might form and cause the facing to stick to drum.

The specific geometry pattern under discussion are as shown below.

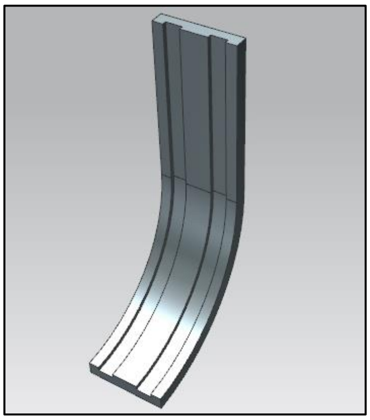

Fig. 1: Serrated Friction Liner

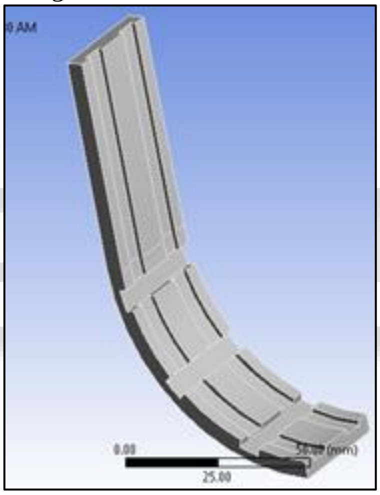

Fig. 2: Cross-Serrated Friction Liner

II. NEED OF NON-ASBESTOS MATERIAL & SHAPE DEVELOPMENT OF BAND LINER

There are number of applications of high friction materials in automotive, aerospace and industrial brake systems. Compositions of high friction material mainly consist of a matrix of polymeric blends, reinforcing material, friction and anti-wear material. It is been observed that there is serious health problems caused by the use of asbestos which commonly used as reinforcement material in friction linings. Asbestos fibres causes lung cancer. Thus, there has been a long felt need to find alternative reinforcing materials with non-asbestos material for the production of brake linings.

The main objective of friction materials are to provide a stable coefficient of friction and a low wear rate at various operating pressures, Speed, environmental conditions and temperatures. Also, these materials must also be compatible with the drum material in order to reduce its extensive wear, noise, and vibration during braking. These properties can be achieved with NAO fibrous material.

Also previous study on friction material band clear that not only selection of ingredients for making brake friction composites is important but also their shapes help to have desired friction and wear attributes.

So, non-asbestos organic fibre friction lining is selected in this work for different shapes or geometries to achieve good heat dissipation and low fade or less glazing of band. This improves the braking capacity of band.

III. DESCRIPTION OF TEST RIG & EQUIPMENTS FOR PERFORMANCE EVALUATION OF BAND LINER

The following Fig. 3 shows the setup required for performance evaluation of band brake liners.

Fig. 3: Test Rig Set Up

The developed test rig is mainly consist of a single phase AC motor with variable speed. This motor drives the spur gear train through an open belt drive. Spur gear train further finally drives a drum on which the friction band is mounted for performance evaluation of band liner. The band here used is of moulded condition. The application of the braking force is done using either an electrical solenoid or simply by lever mechanism.

The dimensions of both geometries of band liner:

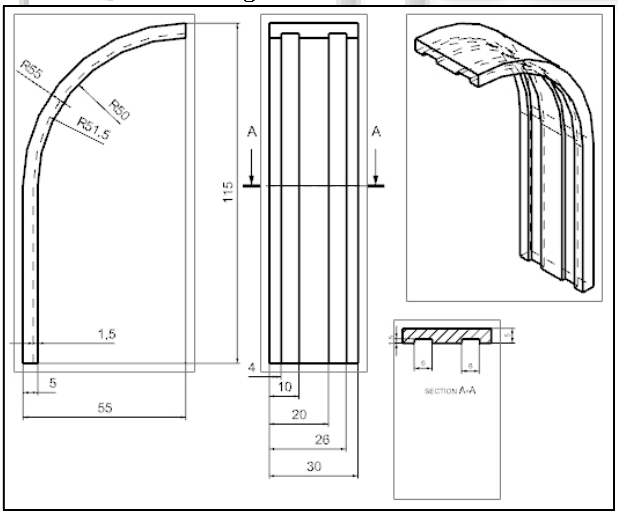

Fig. 4: Specifications of Serrated Band Liner

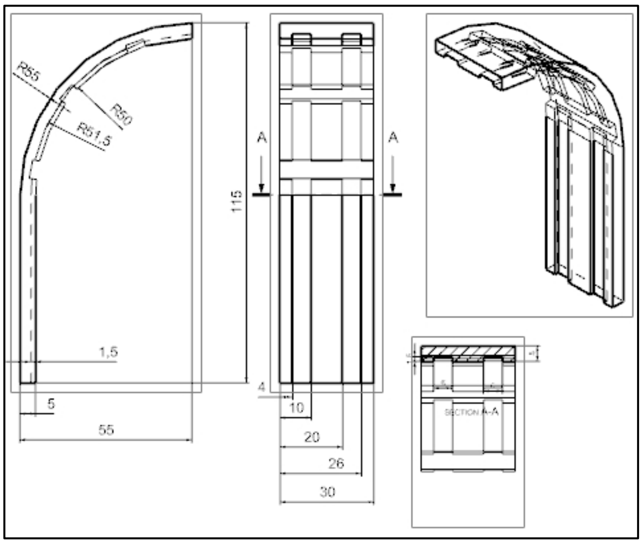

Fig. 5: Specifications of Cross-Serrated Band Liner

Dimensions of brake pads are as per the design and thickness of liner is 5 mm. Grooves of 6 mm and 1.5 mm in depth are provided for better heat dissipation that helps in preventing the band liner to stick to the drum surface. In second liner cross grooves of same dimensions are provided to check for better geometry for better performance.

Material used for liner is HC-AF 393, which is moulded non-asbestos friction material, contains short filaments of synthetic man made mineral fibers and organic fibers with highly thermally stable "Novalak" phenolic powder resin as a binder and fused in a matrix which contributes to the strength and performance regarding friction/wear properties.

IV. PERFORMANCE EVALUATION OF FRICTION LINER FOR BRAKING APPLICATION

As already discussed the details of test rig set up. Both geometries with serrated spacing and cross serrated were tested on test rig and there performance is evaluated in this section. The test procedure is very simple and is given below.

A. *Procedure:*

1) Start motor
2) Load the loading pan on to the effort lever
3) Add 1.0 kg weight to the load pan
4) Note speed of drum
5) Add 0.5 kg load
6) Note speed of drum
7) Repeat step 5 and 6 several times
8) Plot graph of brake effort Vs speed
9) Plot graph of brake effort Vs torque
10) Plot graph of brake effort Vs brake effort

B. *Observations*

Diameter of load drum = 100 mm

– For Serrated Friction Liner Band

LOAD kg	SPEED rpm	TORQUE N-m	BRAKE POWER watt
1	518	0.4905	26.6105406
1.5	480	0.73575	36.987624
2	440	0.981	45.207096
2.5	401	1.22625	51.50012925

3	347	1.4715	53.4779397
3.5	321	1.71675	57.71610495
4	265	1.962	54.454002
4.5	226	2.20725	52.2450189

Table 1: Serrated liner readings

C. *Calculations*

Brake Power = (2×π×N×T) / 60
Where,
T: Torque = Load × 9.8067 × Drum Radius
N: Speed of Drum in rpm

– For Cross Serrated Friction Liner Band

LOAD kg	SPEED rpm	TORQUE N-m	BRAKE POWER watt
1	510	0.4905	26.199567
1.5	468	0.73575	36.0629334
2	432	0.981	44.3851488
2.5	389	1.22625	49.95897825
3	320	1.4715	49.316832
3.5	303	1.71675	54.47968785
4	256	1.962	52.6046208
4.5	205	2.20725	47.39039325

Table 2: Cross Serrated Liner Readings

V. RESULT & DISCUSSION

From the observation Table 1 and Table 2, for serrated and cross serrated friction liner, different graphs are plot for brake effort vs speed, brake effort vs torque and braking effort vs braking power available etc. These graphs are shown below.

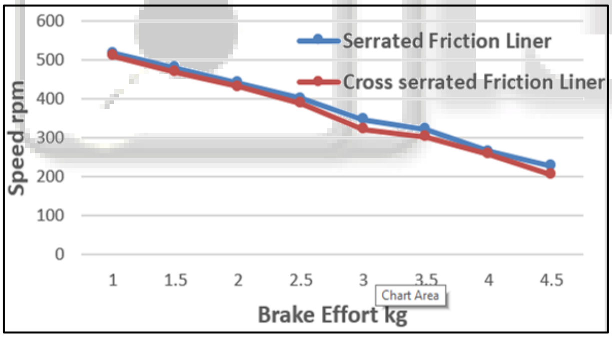

Fig. 6: Braking Effort Vs Speed of Drum

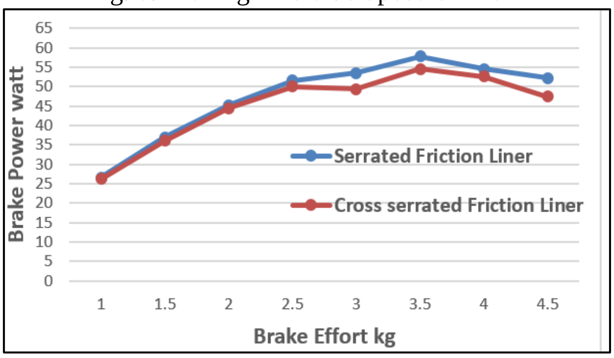

Fig. 7: Braking Effort Vs Brake Power

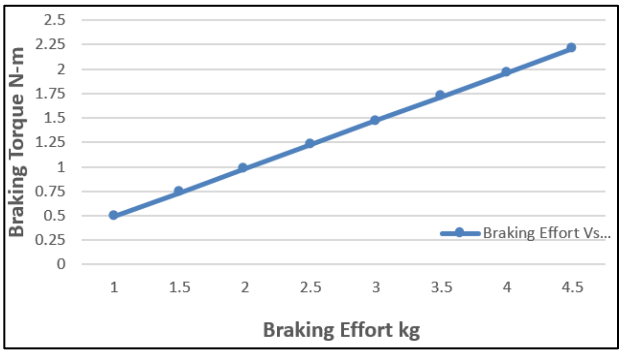

Fig. 8: Braking Effort Vs Brake Torque

A. *Results*

1) With increase in brake effort the speed of drum drops indicated good conversion of braking effort into retardation of drum.
2) With increase in brake effort the brake torque applied also increases resulting into effective braking.
3) Brake power absorbed is maximum up to 3.5 kg effort but slightly reduces thereafter indicating that 3.5 kg load is optimal effort for maximum braking effect.
4) Both liner shows effective strength and braking properties for given applications.

VI. CONCLUSION

Cross serrated band shows better performance as compared to serrated band the drum shows better retardation as compared to serrated band case more brake power is available with the cross serrated structure.

Power absorbed by cross serrated band brake is more as compared to serrated band brake, this shows cross serrated band brake provides more braking action than serrated liner.

Space available in cross serrated brake band helps heat generated due to continuous braking action to get dissipated and hence, performance of cross serrated band is better than serrated and conventional brake liner band.

VII. FUTURE WORK

It is found that following things can be added as extension to this work,

1) Performance of different friction liner with different materials, composites with different composition can be evaluated and rank to material can be assigned.
2) Different shape for friction band can be tested for better heat dissipation and better performance of band.

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