Microstructure and Roughness Analysis of Drum Brakes of Maruti 800

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Abstract The purpose of this paper was to focus on the basics of drum brake systems, so as to provide an in-depth microstructure analysis of the drum brake and the roughness value of the drum surface. As the roughness affects the braking capacity of linings on drum surface, it also allows the duration of service for the drum. This study has helped to know the amount of wear on drum and to minimum roughness value of drum surface that is required for safe braking.

Keywords Drum brakes · Maruti 800 · Microstructure analysis · Roughness analysis · Tribological analysis

1 Introduction

A drum brake is a brake that presses the set of shoes or pads against a rotating drum called as brake drum; this action causes friction which stops the vehicle. Drum brake consists of wheel cylinder, brake drum, shoe, backing plate and various springs and pins. In normal braking, when the brakes are applied, the brake fluid is pushed from master cylinder and moves to the wheel cylinders, the piston pushes outwards force over the brake linings on the brake drum surface, which creates friction and reduces the speed of the vehicle, and heat is generated that is dissipated through natural convection. Emergency brakes are also drum brakes which are bypass for fluid action; they are connected to hand brakes by means of steel cables. It is fully mechanical brakes, and when regular brakes fail, the cable stretches the lever which directly connected to shoes to stop in emergency.

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Grey cast iron is used for the drum brakes as they have good tribological properties and good at heat dissipation. Brake lining is made up of asbestos material such as reinforcements, binder, abrasives, friction modifiers and filler materials [1]. The microstructure reveals the quality of the surface, and the insight the microstructure helps us to check the current state of material at microscopic level. Any changes observed can be noted, accordingly change the etchant, which are used for etching the surface to get a neat microstructure. There are various types of etchants [2]: nital—96–98 mL ethanol, 2–4 mL nitric acid (HNO_3), picral—4 g picric acid ($(NO_2)3C_2H_2OH$), 100 mL ethanol, glyceregia—three-part glycerine, two-part hydrochloric acid (HCl), one-part nitric acid (HNO_3), alkaline sodium, picrate—2 g picric acid ($(NO_2)3C_6H_2OH$), 25 g sodium hydroxide (NaOH), 100 mL distilled water and Klemm I 50 mL sat. Aq. sodium thiosulfate ($Na_2S_2O_3{\cdot}5H_2O$).

Surface roughness is the parameter of the smoothness of the surface; it measures the peaks and valleys of the surfaces, and they are measured in grit which is the number of scratches per inch. For the smooth surface, the number of Ra value is less, and it is the average value of the height of peaks and valleys; higher the value rougher is the surface. Coefficient of friction slightly depends on the roughness of the drum [3].

2 Experimental Work and Discussions

The vehicle selected was Maruti 800 DX and has two different set of brakes. Front brakes are disc brakes, and rear are drum brakes, while drum brakes are selected as they are more important in normal and emergency braking.

Standard dimension of new drum brake was 180 mm (diameter of drum).

The selected vehicle has run 62,900 km, and the wear was checked in the drum brakes of rear wheels as well as thickness of used brake drum. As the brake drums are more costlier, they should be replaced very rarely so our main focus was on brake drum rather than brake linings which are easier to replace Figs. 1 and 2.

Comparison of thickness of brake drum and lining of new and used brake to find the amount of wear is mentioned in Table 1.

Thickness of brake lining was reduced by 1 mm, and brake drum was reduced by 0.4 mm. Wear on brake linings and decrease in thickness of brake lining were observed. There were two ways abrasive wear on lining and drum was observed, as the liner materials was removed or cut by the brake drum and straight lining was seen on drum and material was removed from surface of the drum by liner, so it is expected that to replace the liner after every 5000 km s (Fig. 3).

The sample of $1 \times 1''$ drum brake was used to perform the microstructure analysis and to find out Ra value of the drum brake [4].

Fig. 1 New drum brake for Ra value

Fig. 2 Used drum for microstructure and Ra value

Table 1 Thickness comparison

	Thickness (mm)	
	Drum	Lining
New	3	5
Used	2.96	4

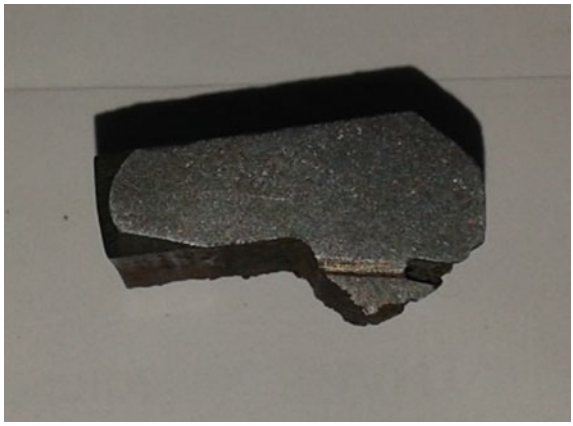

Fig. 3 Etched sample of 1 × 1″ sample of drum brake

2.1 Microstructure Analysis of Drum Brake

The drum under investigation was removed, and new drum was replaced on its behalf. The sample of 1 × 1″ in was submitted to the metallurgical laboratory for microstructure analysis and roughness analysis. Also other sample pieces of old and new brakes were submitted for Ra (roughness) factor analysis. The above-mentioned tests were carried out at ELCA laboratories at Thane. The microstructure analysis was carried as per ASM Handbook. The longitudinal orientation of the sample was considered for the analysis and central location of sample was selected for ease of eaching and 2% nital was used as etchant [nital—96–98 mL ethanol, 2–4 mL nitric acid (HNO_3)].

The microstructure analysis revealed that there was uniform distribution of type A graphite flakes in pearlite matrix, and the whole microstructure was grey cast iron. The image below shows 200× magnified image of the drum brake (Fig. 4).

The graphite flakes in the pearlite matrix lead to unmachinable surface due to presence of graphite, the brake may break during machining, and the microstructure does not change.

2.2 Surface Roughness Test of Drum Brake

Surface roughness test was performed on the drum brake by using instrument Handysurf E-35B [5].

Three readings were taken for the given sample, and values of roughness as below Ra (μm) is 1.866 and 2.033. The maximum and minimum values are from 1.2 to 3.5.

From Table 2, it can be observed that the Ra value was near to lower limit, but was not below lower limit of 1.2, and it does not exceed the limit of 3.5. It was also seen

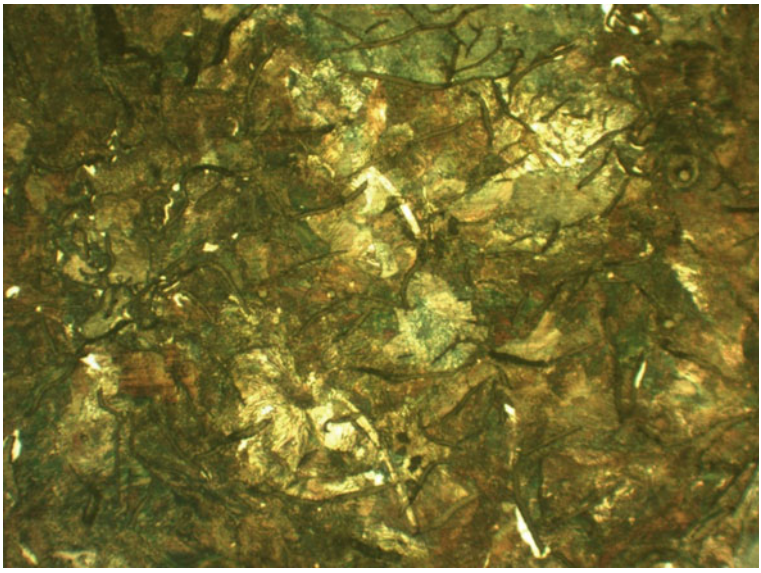

Fig. 4 Microstructure of brake drum

Table 2 Table of new and old Ra values

Range	Ra value of new drum (μm)	Ra value of used drum (μm) (reading1)	Ra value of used drum (reading 2)	Ra value of used drum (reading 3)
Minimum	1.2	1.9	1.8	1.9
Maximum	3.5	3.0	3.1	3.0

that the drum needs to be replaced when the value decreases below 1.2 or exceeds the limit 3.5.

The roughness of the drum has a slight effect on the coefficient of friction, which for practical purposes may be neglected. The effect of the roughness of brake drums on the wear of linings was probably less in service than on the test machine.

3 Conclusion

The microstructure analysis revealed that the graphite flakes in the pearlite matrix lead to unmachinable surface due to the presence of graphite. The brake may break during machining as the microstructure does not change. Average values of roughness Ra (μm) were 1.866 and 3.033, wherein the increase in Ra value could lead to irregular surface of drum, which leads to replacement of the drum. It can also be concluded that no hot spots are seen on the drum brakes. Excessive braking and rapid cooling

will lead to hot spots, damaging of drum and required replacement of drum. It can further be concluded that the above drum brakes are safe for further use.

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