

PAPER • OPEN ACCESS

## Performance analysis of a brake magnet

To cite this article: Facai Ren *et al* 2019 *J. Phys.: Conf. Ser.* **1325** 012195

View the [article online](#) for updates and enhancements.

You may also like

- [When will an elevator arrive?](#)  
Zhijie Feng and S Redner
- [Research On The Performance Test Method Of Elevator Brake](#)  
Zhaolin Ren
- [Computer vision for system protection of elevators](#)  
Shengnan Lan, Yipeng Gao and Saihua Jiang



**ECS**  
The  
Electrochemical  
Society  
Advancing solid state &  
electrochemical science & technology

**DISCOVER**  
how sustainability  
intersects with  
electrochemistry & solid  
state science research

# Performance analysis of a brake magnet

Facai Ren<sup>1</sup>, Xinghua Wu<sup>1</sup> and Xiaoying Tang<sup>1</sup>

<sup>1</sup>Shanghai Institute of Special Equipment Inspection and Technical Research,  
Shanghai 200062, PR China

Corresponding author e-mail: caifaren@163.com

**Abstract.** The performance of elevator brake is very important for the safe operation of elevator. In this study, the performance of a brake magnet used in a elevator was analyzed. The outer wall of engine base and the plunger were analyzed by the optical microscope, scanning electron microscope, energy dispersive spectrometer and microhardness analysis.

## 1. Introduction

Elevator brake can ensure that the elevator starts and stops accurately. In case of emergency, the brake can stop the elevator immediately and minimize casualties and property losses. The structure of elevator brake mainly includes electromagnet, brake shoe, brake arm and spring. Among them, the performance of brake magnets plays an important role in the safe operation of elevators. Therefore, the research on the performance of brake magnet can effectively reduce the occurrence of elevator accidents.

Some researchers have studied the performance of various brakes. Kalikate et al. [1] estimated the braking performance of the magnetorheological brake system for a two-wheeler application according to the braking distance. The results showed that the magnetorheological brake could not meet the requirements of the automobile brake system under the current technical conditions. Attia et al. [2] introduced a complete test rig for an Magneto-Rheological fluid disc brake and developed theoretical analysis for both Magneto-Rheological brake and the mechanical system. Shiao et al. [3] proposed a new type of magnetorheological fluid brake to improve braking torque by increasing magnetic field intensity. Dhir et al. [4] investigated the temperature rise of disc brake and its effect on the durability of brake disc by finite element method. The results showed that the magnetorheological brake could not meet the requirements of the automobile brake system under the current technical conditions. Yan et al. [5] introduced the comparison of thermal fluid characteristics of three kinds of curved blade brake discs and the influence of blade outlet angle on the thermal fluid characteristics. The results showed that the increase of the outlet angle would increase the circumferential pressure difference, thus significantly enhancing the local heat transfer on the inner disk surface. Liu et al. [6] analyzed the braking performance of urban rail train by analyzing the utilization ratio of braking force and the initial braking speed of urban rail train.

In this paper, the performance analysis of a brake magnet was carried out. The chemical composition, microhardness and microstructure of the brake magnet were analyzed.

## 2. Macroscopic morphology

The macroscopic morphology of the brake magnet used in elevator is shown in Fig. 1. The brake magnet has a complete appearance and no obvious damage except slight peeling off of the paint on the outer layer of the seat and a certain degree of rust on the side of the seat.



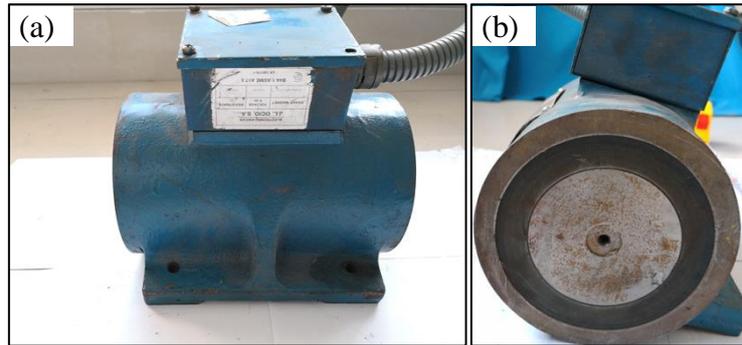


Figure 1. Macroscopic morphology of the brake magnet.

The main structure of the brake magnet is obtained by cutting along the middle of the brake magnet, as shown in Fig. 2. The main structures from the outside to the core are: the outer wall of engine base, the plastic protective layer, the electromagnetic coil and the plunger. Sampling the outer wall of the frame and the plunger respectively, and analyzing and testing their material and performance through sample preparation.

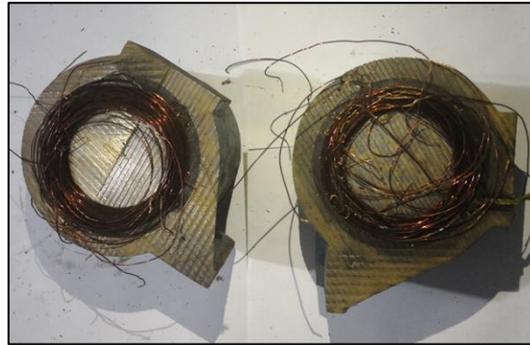


Figure 2. Internal morphology of the brake magnet.

### 3. Results and Discussions

#### 3.1. Analysis of the outer wall of engine base

The metallographic microstructure of the outer wall of engine base is shown in Fig. 3. It can be seen that the microstructures are mainly ferrite and pearlite, and contain vermicular graphite. The grain size of ferrite is about 20~50 $\mu\text{m}$ . The length of vermicular graphite is uneven. The shorter is about 20 $\mu\text{m}$  and the longer is more than 100 $\mu\text{m}$ .

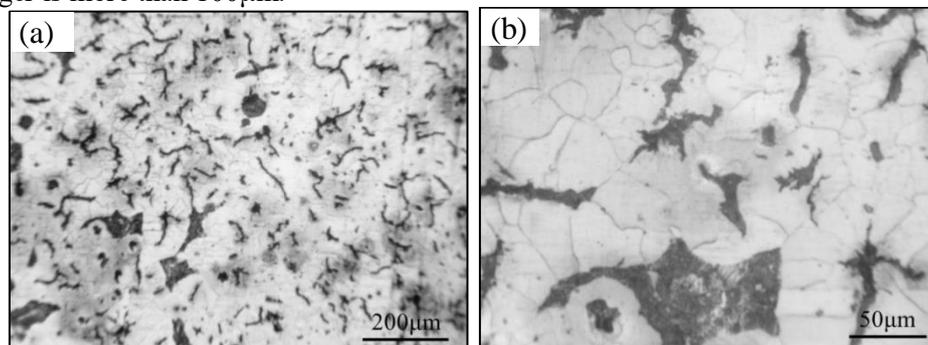


Figure 3. Metallographic microstructure of the outer wall of engine base.

The SEM morphology and chemical composition of the outer wall of engine base are shown in Fig. 4. As shown in Fig. 4(a) and (b), it can be further confirmed that the main microstructures are ferrite and pearlite, and contains vermicular graphite. Fig. 4(c) shows the high magnification pearlite. The

chemical composition result analyzed by EDS is shown in Fig. 4(d). It is inferred that the material is vermicular cast iron.

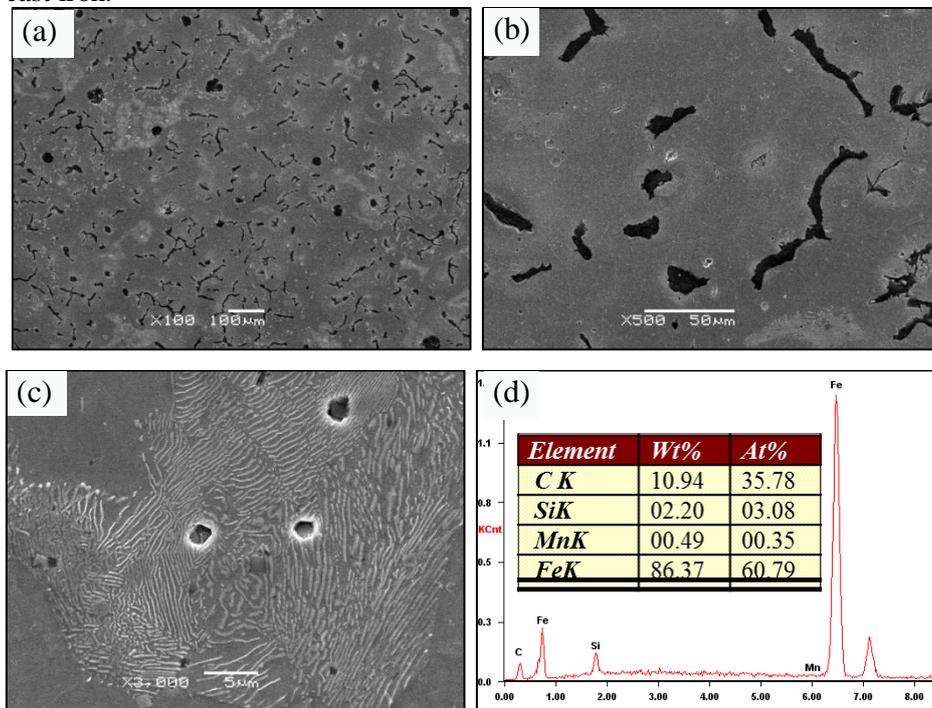


Figure 4. SEM morphology and chemical composition of the outer wall of engine base.

The Vickers hardness ( $HV_{0.1}$ ) values of the outer wall of engine base are shown in Table 1. The Vickers hardness ( $HV_{0.1}$ ) average value of this material is about 208.3.

Table 1 Vickers hardness values of the outer wall of engine base.

Points	1	2	3	4	5	Average value
Vickers hardness ( $HV_{0.1}$ )	188.9	221.4	216.7	208.6	206	208.3

### 3.2. Analysis of the plunger

The metallographic microstructure of the plunger is shown in Fig. 5. It can be seen that the microstructures are mainly ferrite and pearlite. The grain size of ferrite is about 20~40 $\mu\text{m}$ . Pearlite is lamellar and evenly distributed.

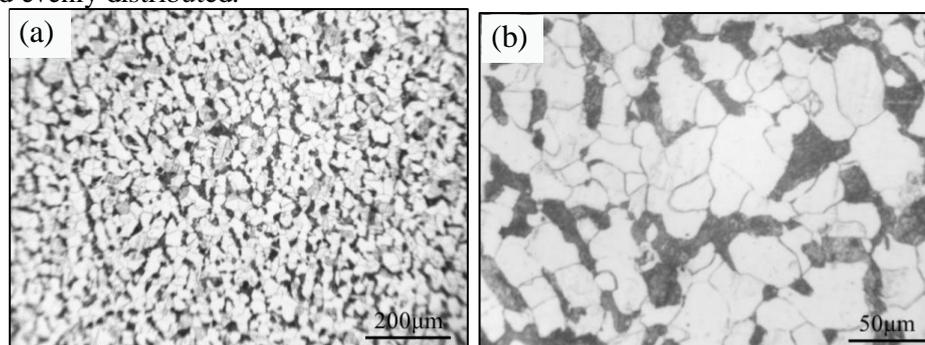


Figure 5. Metallographic microstructure of the plunger.

The SEM morphology and chemical composition of the plunger is shown in Fig. 6. As shown in Fig. 6(a) and (b), the microstructures are mainly ferrite and dispersed lamellar pearlite with relatively low carbon content. Fig. 6(c) shows the high magnification pearlite. The chemical composition result

analyzed by EDS of the plunger is shown in Fig. 6(d). It is inferred that the material is Q235 steel and the heat treatment process is annealing.

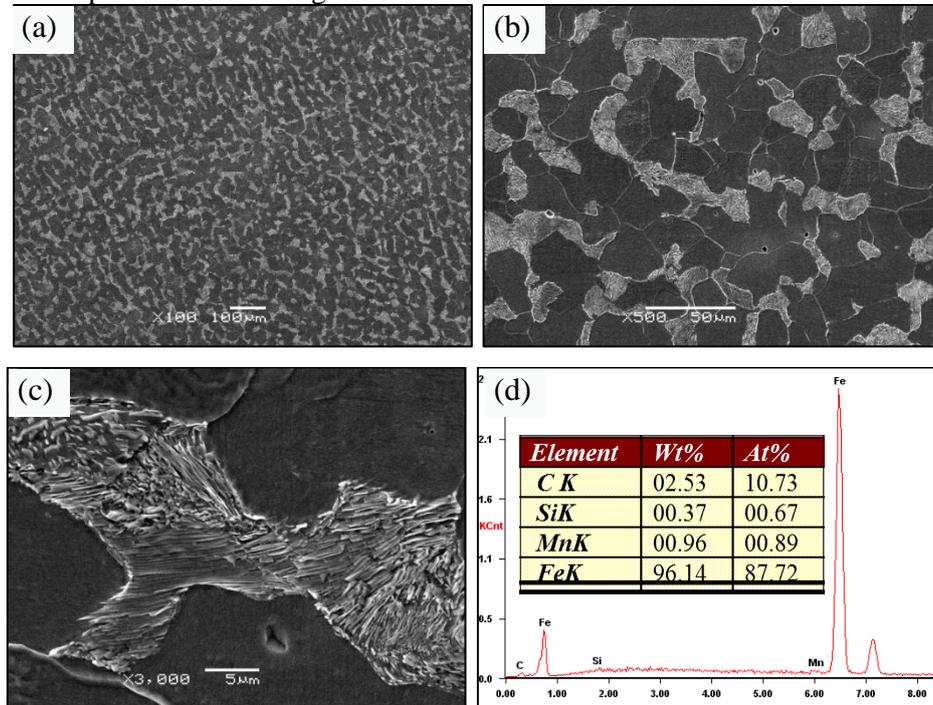


Figure 6. SEM morphology and chemical composition of the plunger.

The Vickers hardness ( $HV_{0.1}$ ) values of the plunger are shown in Table 2. The Vickers hardness ( $HV_{0.1}$ ) average value of this material is about 166.6.

Table 2 Vickers hardness values of the plunger.

Points	1	2	3	4	5	Average value
Vickers hardness ( $HV_{0.1}$ )	156.3	161	177.7	152.4	185.4	166.6

#### 4. Conclusion

Based on the analysis of metallographic microstructure, chemical composition and microhardness, it can be inferred that the outer wall of engine base is made of vermicular cast iron and the plunger is made of Q235 steel.

#### References

- [1] S.M. Kalikate, S.R. Patil, S.M.Sawant, Simulation-based estimation of an automotive magnetorheological brake system performance, *J. Adv. Res.* 14 (2018) 43-51.
- [2] E.M. Attia, N.M. Elsodany, H.A. El-Gamal, M.A. Elgohary, Theoretical and experimental study of magneto-rheological fluid disc brake, *Alex. Eng. J.* 56 (2017) 189-200.
- [3] Y.J. Shiao, Q.A. Nguyen, Torque enhancement for a new magnetorheological brake, *Procedia Eng.* 76 (2014) 12-23.
- [4] D.K. Dhir, Thermo-mechanical performance of automotive disc brakes, *Mater. Today. Proc.* 5 (2018) 1864-1871.
- [5] H.H. Yan, W.T. Wu, S.S. Feng, G.N. Xie, Role of vane configuration on the heat dissipation performance of ventilated brake discs, *Appl. Therm. Eng.* 136 (2018) 118-130.
- [6] H.D. Liu, M.Su, H.Q. Peng, Z.Y. Zhang, H.L. Xing, Braking performances of urban rail trains, *J. Transport. Syst. Eng. Inf. Technol.* 11 (2011) 93-97.