Microstructure analysis of elevator brake base

Facai Ren¹, Bo Li², Xiao Liang¹ and Xinghua Wu¹

¹Shanghai Institute of Special Equipment Inspection and Technical Research, Shanghai 200062, PR China
²School of Mechanical and Power Engineering, East China University of Science and Technology, Shanghai 200237, PR China

Corresponding author e-mail: caifaren@163.com

Abstract. The friction tests of the outside and inside walls of elevator brake base were conducted. The friction curves and coefficients were obtained. The friction coefficient was about 0.26~0.29. The microstructure of the elevator brake base before and after friction test was investigated based on the optical microscope and scanning electron microscope analysis.

1. Introduction

Elevator brake plays a very important role to the elevator safe operation. In an emergency, it can enable the elevator cabin to slow down and stop. Thus, every part of the elevator brake should have excellent strength, wearability and heat-resistance.

Pan et al. [1] conducted sliding wear experiments of CL65 wheel steel. The changes of the microstructure at the outermost layer of the wear surface and wear property at different wear stages were analyzed. The results show that when the microstructure is sub-micrometer ferrite subgrain, the abrasiveness is the best. Karakulak et al. [2] investigated the effect of Si addition on microstructure, hardness and wear resistance of as cast Mg-5Sn and Mg-10Sn alloys. The results show that both decreased grain size and increased amount of intermetallics caused a hardness increase. Zheng et al. [3] investigated the influences of microstructure of 7075 aluminum alloys on the mechanical properties and wear mechanism of cermets tools. The results show that the existence of Co3W3(C, N) phase can improve abrasion resistance at proper cutting speed. Zheng et al. [4] investigated the influences of microstructure of 7075 aluminum alloys on the mechanical properties and wear mechanism of cermets tools. The results show that the existence of Co3W3(C, N) phase can improve abrasion resistance at proper cutting speed. Li et al. [5] conducted the comparative study on wear scars of Inconel 690 and 600 materials in the atmosphere. The results show that the Inconel 690 presents more excellent wear resistance than Inconel 600 for its thicker and harder tribological transformed structure. Wang et al. [6] investigated the microstructure and tribological property of the nitrided layer and as-cast high-entropy alloy. The results show that the wear mechanism of as-cast alloys in air was abrasive wear of oxide particles while the wear mechanism of high-entropy alloy in acid rain was abrasive, oxidative and corrosive wear.

In this paper, the microstructure of elevator brake base before and after friction test was investigated based on the optical microscope and scanning electron microscope analysis. The microstructure, chemical composition and micro-hardness of elevator brake bas were analyzed.
2. Macroscopic morphology

The macroscopic morphology of elevator brake base is shown in Fig. 1. The outside diameter and inside diameter of the elevator brake base are 160mm and 140mm, respectively. There is a certain degree of corrosion in the inside wall of the elevator brake base. The position contacted with the elevator brake plunger is somewhat weared. The specimens for the optical microscope, scanning electron microscope and energy spectrum analysis were machined from the outside and inside wall, respectively.

![Figure 1. Macroscopic morphology of elevator brake base.](image)

3. Results and Discussions

3.1. Metallographic microstructure analysis

The metallographic microstructure of elevator brake base is shown in Fig. 2. The microstructure of outside wall is shown in Fig. 2(a) and (c) while the microstructure of inside wall is shown in Fig. 2(b) and (d). It can be seen that the main microstructure is ferrite. The grain size is inhomogeneous. The smaller and larger grain size are 100 $\mu$m and 200 $\mu$m, respectively.

![Figure 2. Metallographic microstructure of elevator brake base.](image)
3.2. SEM analysis

The microstructure and chemical composition of the outside wall of elevator brake base are shown in Fig. 3. The microstructure is ferrite as shown in Fig. 3(a), which is the same to the optical microscope analysis. It can be seen from Fig. 3(b) that the carbon content is so little.

Figure 3. Microstructure and chemical composition of elevator brake base.

The microstructure and chemical composition of the inside wall of elevator brake base are shown in Fig. 4. The microstructure is also ferrite. The carbon content is also very low. It can be inferred that the material of elevator brake base is industrial pure iron.

Figure 4. Microstructure and chemical composition of elevator brake base.

3.3. Friction and wear properties analysis

The friction curve of the outside and inside wall of elevator brake base is shown in Fig. 5. The friction coefficients of outside and inside wall are about 0.26 and 0.29, respectively.

Figure 5. Friction curve of elevator brake base.
The wear scars micromorphology of elevator brake base is shown in Fig. 6. During the friction test, the adhesive wear phenomenon happened on both the outside and inside walls of the elevator brake base.

![Figure 6. Wear scars micromorphology of elevator brake base.](image)

3.4. Micro-hardness analysis
The Vickers hardness values of elevator brake base are shown in Table 1. The average Vickers hardness value of outside and inside wall are 95.5 and 98.8, respectively. It can be inferred that the hardness of the brake base is relatively low.

| Vickers hardness (HV0.1) | 1  | 2  | 3  | 4  | 5  | Average value |
|--------------------------|----|----|----|----|----|---------------|
| Outside wall             | 96.9 | 95.8 | 95.8 | 95.2 | 93.6 | 95.5          |
| Inside wall              | 96.9 | 98.2 | 102.1 | 97.6 | 99.1 | 98.8          |

4. Conclusion
The material of elevator brake base is industrial pure iron. The friction coefficient is about 0.26-0.29. The main wear mechanism is adhesive wear.

References
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