Investigation on wear mechanism of elevator brake sluice bar

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Abstract. The wear mechanism of elevator brake sluice bar was studied. The friction and wear tests of reciprocating ball-block were conducted and the friction curves of elevator brake sluice bar were obtained. The wear scars were investigated based on the optical microscope and scanning electron microscope analysis. The dominant wear mechanism of elevator brake sluice bar was adhesive wear.

1. Introduction
Elevator brake is one of the most important safety and security part. It can enable the elevator cabin to slow down and stop in an emergency manner. Thus, parts of the elevator brake should have excellent strength, wearability and heat-resistance.

Abbasi et al. [1] investigated the wear mechanisms under service conditions of used medium carbon NiCrVMo and CrB containing steel. The results show that the spalling wear was caused by delamination, white etching layers and crack propagation. Ziegler et al. [2] studied the wear and tribological behavior of selective laser sintering materials. A new wear mechanism in selective laser sintering materials is proposed. The results show that the differences between building orientations were small and inconclusive. Tan et al. [3] studied the tool life and wear mechanism of TiB2–20vol%B4C and TiB2–80vol%B4C ceramic cutting tool materials. The results show that the dominant wear mechanism was adhesive wear in all of the three tools tested, while chipping was also observed in TiB2–80vol%B4C and temperature deterioration in commercial grade tungsten carbide tool. Yang et al. [4] studied the tribological properties and wear mechanisms of Mo2FeB2 based cermets with Mn and Cr addition from room temperature to 800 °C. The results show that the wear mechanisms change from abrasive wear to mixed abrasive and oxidative wear, and finally to mild oxidative wear. Shen et al. [5] presented the formation and transition of wear patterns during the chopping process. The results show that the wear pattern on tool profile is a combination of cutting edge rounding and rake face wear. Naskar et al. [6] studied the wear mechanism of the top Al2O3, TiCN and TiAlN coatings and proposed a new flank wear model for ridge and groove formation on Al2O3 coating. The results show that the dissolution-diffusion wear was the dominant flank wear mechanism for TiCN coating.

In this paper, the friction and wear properties of elevator brake sluice bar were investigated. The microstructure, chemical composition and micro-hardness of elevator brake sluice bar were analyzed.
2. Macroscopic morphology
The macroscopic morphology of elevator brake sluice bar is shown in Fig. 1. It can be seen from Fig. 1(a) that there is no obvious signs of wear on the elevator brake sluice bar. There is plastic deformation phenomenon on the plank edge (Fig. 1(b)). The microstructure, chemical composition and micro-hardness of elevator brake sluice bar are tested and analyzed through sampling as shown in Fig. 1(c).

![Macroscopic morphology of elevator brake sluice bar](image)

3. Results and Discussions

3.1. Metallographic microstructure analysis
The metallographic microstructure of elevator brake sluice bar is shown in Fig. 2. It can be seen that the main microstructures are ferrite and small particles distributed along ferrite grain boundary.

![Metallographic microstructure of elevator brake sluice bar](image)

3.2. SEM analysis
The microstructure and chemical composition of elevator brake sluice bar are shown in Fig. 3. It can be seen from Fig. 3(a) and (b) that the main microstructures are ferrite and small particles distributed along ferrite grain boundary. The carbon content is few and chromium content is about 12.81 as shown in Fig. 3(c). Thus, it can be inferred that the material of elevator brake sluice bar is 0Cr13 of 1Cr13.
It can be inferred from the carbon and chromium enriched particles distributed along grain boundary that the particles might be \((\text{Cr, Fe})_2\text{C}_6\) carbide (Fig. 3(d)). It’s inferred that the material of elevator brake sluice bar experiences no quenching treatment, because no obvious martensite is found and a lot of carbide particles are found distributed along the grain boundary. It might be annealing microstructure, mainly includes chromium enriched ferrite and carbide particle distributed along the ferrite grain boundary.

3.3. Friction and wear properties analysis

The friction curve of elevator brake sluice bar is shown in Fig. 4. The friction coefficient is about 0.39, which is relatively high. The wear-resistant property is relatively poor.
The wear scars micromorphology and chemical composition of elevator brake sluice bar are shown in Fig. 5. The elevator brake sluice bar experienced relatively serious adhesive wear during the process of friction and wear test. Oxidation degree of wear scar surface is relatively lightly because of the presence of chromium.

![Wear scars micromorphology and chemical composition of elevator brake sluice bar.](image)

**Figure 5. Wear scars micromorphology and chemical composition of elevator brake sluice bar.**

### 3.4. Micro-hardness analysis

The Vickers hardness values of elevator brake sluice bar are shown in Table 1. The average value of Vickers hardness is about 184.9, which is equal to approximate 10 of Rockwell hardness (HRC). It’s much less than the hardness of quenched 1Cr13 steel (about 36–38HRC). Thus, it’s further inferred that the microstructure of elevator brake sluice bar is not quenching microstructure.

| Test points | 1     | 2     | 3     | 4     | 5     | Average value |
|-------------|-------|-------|-------|-------|-------|---------------|
| Vickers hardness (HV0.1) | 185.4 | 189.8 | 189.8 | 182.5 | 176.9 | 184.9         |

### 4. Conclusion

The material of elevator brake sluice bar is 0Cr13 or 1Cr13 steel. The supply state of this material is annealing. The hardness is relatively low and the wear-resistance property is relatively poor. The main wear mechanism is adhesive wear.
References
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