Failure Analysis on Loosing Bar of An Elevator Brake

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Abstract. A failure analysis was performed on loosing bar of an elevator brake. The macroscopic morphology and metallographic microstructure of the elevator brake loosing bar were investigated based on the optical microscope and scanning electron microscope analysis. The results showed that the material of elevator brake loosing bar meets the technical standard of 45 steel. The abnormal peel wear was caused by the abnormal rotation between the loosing bar and magnetic ring.

1. Introduction

Elevator brake plays a very important role in the safety and security of elevator operation. In an emergency case, elevator brake can reduce the severity of the accident. Thus, the failure analysis on loosing bar of an elevator brake is very important to prevent similar accidents from happening again.

Guo et al. [1] investigated an evaluation of a balance ball pin used in the car steering system to determine the cause of failure. The results show that unreasonable surface quenching resulted in inhomogeneous thickness of quench-hardened case. Liu et al. [2] investigated the fracture failure reasons of S13Cr-110 tubing. The results show that the failure cause of S13Cr-110 tubing is mainly attributed to the local stress corrosion after the formation of corrosion pits. Idapalapati et al. [3] analyzed the failure of an anchor chain link. The results show that the pre-existing edge crack significantly reduced the load capacity of the chain link. Yang et al. [4] investigated the oxidation and failure process of multilayer films of depleted uranium and gold during being exposed to atmosphere. The results show that the native defects in samples have a significant effect on the oxidation process and deterioration degree. Lanzutti et al. [5] investigated the causes of a safety system failure exposed to electric arc furnace dust. The results show that the components undergo a severe stress corrosion cracking stimulated by the presence of atmospheric condensates together with high chlorides containing electric arc furnace dusts. Yu et al. [6] analyzed the looseness failure between impeller and shaft. The results show that the decrease of torque capacity of interference connection is responsible for the failure. Karalis et al. [7] presented a failure analysis on a fractured mechanical fastener made of Cu-12Mn alloy. The results show that the fracture is attributed to the synergistic action of fatigue and selective leaching.

In this paper, the reasons for the loosing bar failure of an elevator brake were investigated. The microstructure, chemical composition and micro-hardness of elevator brake loosing bar were analyzed.
2. Macroscopic morphology
The macroscopic morphology of elevator brake loosing bar is shown in Fig. 1. The out diameter of elevator brake loosing bar is about 33.5mm. The length is about 191mm. The material is cold-drawn 45 steel. The surface uses galvanized treatment. The wear phenomenon is serious on the mating zone of loosing bar and magnetic ring. The circumferential furrow streaks are very obvious. The out diameter of this zone is in the range of 33.07mm-33.10mm while the out diameter of unweared zone is about 33.24mm. This indicates that the unilateral wear depth is about 0.07mm.

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

3. Results and Discussions
3.1. Metallographic microstructure analysis
The microstructure of wear surface observed from longitudinal section is shown in Fig. 2. The surface is undulant. The high multiple OM image of this zone is shown in Fig. 2(b) and (c). It can be seen that the surface microstructure of wear zone is pinched. Local microstructure shows fibrous distribution and has peeling phenomenon. The microstructures of this zone are ferrite and pearlite. The galvanizing coating is observed in the unwear zone. The depth is about 0.01mm, as shown in Fig. 2(d).
3.2. SEM analysis
The wear zone of elevator brake loosing bar was also analyzed by scanning electron microscope (SEM) as shown in Fig. 3. The low multiple SEM image of this zone is shown in Fig. 3(a). It can be seen that there are some circumferential wear marks. The depth differs from each other. Local morphology is notch. Rheological fracture morphology is observed in wear zone as shown in Fig. 3(b). It can be seen that there are rheological and strained phenomena along the motion direction. Adhesive strain and stripping morphology are also observed in this zone as shown in Fig. 3(c).

3.3. Chemical composition analysis
The chemical composition of escalator brake loosing bar is shown in Table 1. The chemical composition of escalator brake loosing bar is compared with 45 steel referring to GB/T 699-1999 < Quality carbon structural steels >. The results show that all element contents are within the standard.

| Element  | C      | S      | Si       | Mn   | P      |
|----------|--------|--------|----------|------|--------|
| Loosing bar | 0.46   | 0.020  | 0.19     | 0.57 | 0.020  |
| 45# steel | 0.42-0.50 | ≤0.035 | 0.17-0.37 | 0.50-0.80 | ≤0.035 |

Figure 2. Metallographic microstructure of elevator brake loosing bar.

Figure 3. SEM morphology of elevator brake loosing bar.
3.4. Micro-hardness analysis
The Vickers hardness values of the center for elevator brake loosing bar are shown in Table 2. The average value of Vickers hardness (HV₁) is about 242.6.

| Points | 1 | 2 | 3 | 4 | 5 | Average value |
|--------|---|---|---|---|---|---------------|
| Vickers hardness (HV₁) | 245 | 240 | 242 | 244 | 242 | 242.6          |

4. Conclusion
The material of elevator brake loosing bar meets the technical standard of 45 steel referring to GB/T 699-1999 < Quality carbon structural steels >. The abnormal peel wear is caused by the abnormal rotation in the mating zone of loosing bar and magnetic ring.

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