Material properties analysis on spring and screw of an elevator brake

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Abstract. The material properties of spring and screw of an elevator brake failed during use was analyzed. The macroscopic morphology and metallographic microstructure of the spring and screw of an elevator brake were investigated based on the optical microscope and scanning electron microscope analysis. The chemical composition was analyzed by X-ray energy spectrum analysis. The results showed that the material of spring and screw are 65Mn spring steel and 40 steel, respectively. The material of spring has porous holes inside.

1. Introduction
Elevator brake plays a very important role in passenger safety. Thus, the material properties analysis of spring and screw of an elevator brake plunger failed during use is very important to find out the cause of failure.

Shi et al. [1] conducted a statistical analysis of the material properties of low yield point steels using probabilistic theories and structural reliability theories. Zhang et al. [2] performed a failure analysis on a cracked handhole flange. The results show that handhole flange cracking was caused by the liquation crack and the liquation crack was caused by the low-melting point annular oxide inclusions and silicate eutectic. Su et al. [3] studied the mechanical properties and proposed a series of unified equations for calculating the reduction factors of normal and high strength aluminium alloy at elevated temperatures. The results show that the material properties of normal and high strength aluminium alloys were changed significantly during high temperatures. Verbelen et al. [4] studied the material properties that are involved in thermoplastic polyurethanes sintering through the analysis of four distinct thermoplastic polyurethanes grades. The results show that the smooth and dense powder layers can be deposited for the investigated powders. Molaei et al. [5] investigated the failure root causes of a 23” drill string stabilizer using optical and scanning electron microscopy and XRD techniques. The results show that a heterogeneous microstructure developed from the surface down to a depth of about 10 mm beside severe working condition was responsible for the damages. Gan et al. [6] performed the investigation on the leakage failure of the lead-free brass valve body. The results show that the failure was probably attributed to the combined action of brazing residual stresses and bismuth boundary segregation.

In this paper, the material properties of spring and screw of an elevator brake were investigated. The microstructure, chemical composition and micro-hardness of spring and screw of elevator brake plunger were analyzed.
2. Macroscopic morphology

The macroscopic morphology of spring and screw of an elevator brake are shown in Fig. 1. The paint on the spring surface of the elevator brake peeled off. The screw of elevator brake is corroded to a certain extent. The material and hardness of spring and screw of an elevator brake were analyzed and tested by sampling and sample preparation.

![Macroscopic morphology of spring and screw of the elevator brake.](image)

3. Results and Discussions

3.1. Metallographic microstructure analysis

The metallographic structure of spring for the elevator brake is shown in Fig. 2. The low multiple SEM image of this sample is shown in Fig. 2(a) and (b). The high multiple SEM image of this sample is shown in Fig. 2(c) and (d). It can be seen that the microstructure is mainly the tempered troostite and fine pearlite. The microstructure and heat treatment state of the material for the spring were further confirmed by SEM and EDS analysis.

![Metallographic microstructure of spring for the elevator brake.](image)

The metallographic structure of screw for the elevator brake is shown in Fig. 3. It can be seen that the microstructure is mainly the ferrite and dispersed large pearlite.

![Metallographic microstructure of screw for the elevator brake.](image)
3.2. SEM Micromorophology and Chemical composition analysis

The microstructure and chemical composition of spring for the elevator brake are shown in Fig. 4. It can be inferred that the spring material is 65Mn spring steel, which mainly contains tempered troostite and fine pearlite and a small amount of ferrite. The material contains void defects.

As shown in Fig. 5, the screw material mainly consists of ferrite and large pearlite. The carbon content of the material is low, and it is estimated to be 40 steel according to its structure and composition.
3.3. Micro-hardness analysis

The Vickers hardness values of spring and screw for the elevator brake are shown in Table 1. The Vickers hardness average value of the spring is about 393.3. Therefore, it is inferred that the heat treatment state should be tempered at medium temperature after quenching. The Vickers hardness of the screw is low, about 192.4. It is presumed that the heat treatment state of the screw is annealed.

| Element | Wt% | At% |
|---------|-----|-----|
| C       | 02.31 | 09.86 |
| Si      | 00.34 | 00.63 |
| Cr      | 01.23 | 01.22 |
| Mn      | 01.01 | 00.94 |
| Fe      | 95.10 | 87.35 |

Table 1 Vickers hardness of spring and screw for the elevator brake.

4. Conclusion

The spring material is 65Mn spring steel, and the heat treatment state is tempered at medium temperature after quenching. The material has porous holes inside. The screw material is 40 steel, and the heat treatment state is annealed.

References

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