Analysis on the performance of the drive machine braking systems for traction lifts

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Abstract. The drive machine and the braking system are quite important to the safety of lifts. The redundancy-type brake is given usually more than one brake responsibility. In order to know the safety situation of the braking performances of drive machines after China’s new regulations issued, the type test results of 57 drive machine samples are summarized and analysed, including the sets of mechanical parts, the braking performance when all groups work together and the braking performance when each group works separately. The result shows that most (about 93%) drive machines are equipped with 2 sets of mechanical braking parts. The average of the ratio of braking torque to output torque is 3.16. The average of the sum of braking torque that generated by every group works separately just equals to the whole braking torque.

1. Introduction

With the development of lift technology, traction lift has been most widely used. The traction lift relies on friction to provide power and also relies on friction to provide braking force. The drive machine is the core component of traction lift. The safety of the drive machines is directly related to the safety of passengers. The main technical and performance requirements are provided in China’s GB/T 24478 [1]. In different types of drive machines, the gearless permanent magnet synchronous traction machine has characteristics of low speed and large torque, while has advantages of energy saving, small size, stable operation at low speed, low noise and maintenance-free. The braking system is the most important component of the drive machine. Its safety and reliability are one of the important factors to ensure the safe operation of the lift. In the past several years, there were many lift accidents happened due to the weakness of braking force in China. Therefore, the unintended car movement protection means (UCMP) is added in the No. 1 modification of China’s GB 7588 [2] and “Regulation for type test of lifts” [3]. Most lift manufactures choose to use the drive machine braking system to provide the UCMP function. Therefore, the drive machine braking system is playing an increasingly important role.

After the new regulations are published and issued, the braking performance is valued much more by the lift drive machine manufacturers. However, what about the new performance of the lift drive machines following the new regulations? Depend on the accumulation of lift drive machine type tests,
a set of test results is summarized and analyzed, in order to obtain some safety situation and conclusions.

2. Mechanical types of brakes
As the regulation says [4], the lift shall be provided with a braking system, which operates automatically in the event of loss of the mains power supply or the supply to control circuits. This requirement is mostly achieved by an electro-mechanical braking system. The type of braking system is composed by electrical and mechanical parts. It is normally closed braking system. When the power is turned on, the two-way electromagnetic thrust is generated, the brake mechanism is separated from the rotating part of the motor. When the power is turned off, the electromagnetic force disappears, the brake force is formed under the action of the applied spring pressure.

Mechanical types of braking systems are mainly including drum type, block type, disk type and clamp-disk type, as shown in Figure 1. In this paper, 57 lift drive machine samples of distinctive types and models made by different manufacturers were type tested, with 4 (7%) drum type, 32 (56%) block type, 6 (11%) disk type and 15 (26%) clamp-disk type.

3. Braking performance analysis

3.1. Sets of mechanical parts
According to the type test results, most (about 93%) drive machines are equipped with 2 sets of mechanical braking parts. This is the minimum limit required by the standard. However, there are several samples equipped with 3 sets and 4 sets mechanical braking parts, as shown in Table 1. Obviously, the more sets of mechanical braking parts equipped, the stronger ability to resist failure. If one set of mechanical braking part did not work, the drive machine with 2 sets would loss 50% braking torque, while that with 3 sets would loss 33%, and that with 4 sets would loss 25%.

Table 1. Sets of mechanical parts in different types.

|           | Drum type | Block type | Disk type | Clamp-disk type | All   |
|-----------|-----------|------------|-----------|-----------------|-------|
| 2 sets    | 4         | 32         | 6         | 11              | 53    |
| 3 sets    | 0         | 0          | 0         | 2               | 2     |
| 4 sets    | 0         | 0          | 0         | 2               | 2     |

3.2. Braking performance when all groups work together
The safety of the drive machine is guaranteed by the braking torque far exceeding the output torque. This is called redundancy-type brake. The braking torque is at least 2.5 times of the output torque by the standards. According to the type test results, all drive machines can meet the requirement. Most drive machines have an output torque below 2500 N·m, as shown in Figure 2. The 2.5 times line shows the limit requirement of regulations.

The ratio of braking torque to output torque is a minimum of 2.53, a maximum of 5.47, an average of 3.16 and standard deviation of 0.59. The performances of different types of braking system are listed in Table 2. The block type braking system shows the worst braking performance. The maximum,
the minimum and the average data are all the smallest among all types. However, the smallest standard deviation means that the block type has the relatively stable performance, even if the performance is not the good performance.

The drum type data has the biggest maximum and the biggest standard deviation. It shows that the drum type does not have good characteristics of stable braking effect. Relatively, the disk type and the clamp-disk type data have better overall performances. They have the stable and good braking performance at the same time.

3.3. Braking performance when each group works separately

The requirement of at least 2 sets of mechanical parts is to improve the safety just in case some component fails. When one set of components fails, it is a must to have braking torque exceeding the output torque, in order to slow down or stop the traction wheel. For 3 sets or 4 sets type, it is better also that one set part can generate braking torque which exceeding the output torque. According to the type test results, only one 4 sets type sample can not meet the standard exceeding requirement.

Ratio of the sum of every grouped braking torque to whole braking torque is also considered in this paper. Overall, the average of the sum result equals to the whole braking torque, as shown in Figure 3, the 1.0 time line means the ideal relationship of the sum torque of grouped sets and the whole torque. The up and down float of a single sample is a normal fluctuation range. The maximum is up to 1.16 while the minimum is down to 0.71. Both of the maximum and the minimum are represented by the clamp-disk type, as shown in Table 3. Therefore, the data of clamp-disk type shows the biggest standard deviation. The smallest standard deviation is from the data of drum type. This indicates that the drum type braking system has the stable performance when only each group works separately.
4. Conclusion

The drive machine is main engine of the drive force for lifts. The braking system is the important guarantee for safe operation. The redundancy-type brake is given the brake responsibility of UCMP by many manufactures after the No. 1 modification of China’s GB 7588 and “Regulation for type test of lifts”. After 57 type tests of drive machine samples, the following conclusions are obtained.

1. Most (about 93%) drive machines are equipped with 2 sets of mechanical braking parts. However, some large torque drive machines are designed 3 sets or 4 sets mechanical braking parts.

2. The average of the ratio of braking torque to output torque is 3.16. The disk type and the clamp-disk type data have better overall performances, considering the stable and good braking performance at the same time.

3. Almost all samples can generate torque higher than output torque, including 3 sets and 4 sets samples. The average of the sum of braking torque that generated by every group works separately just equals to the whole braking torque.

References

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