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Study on the Performance Test Method of the Elevator Brake

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Abstract: The elevator brake is an important part to ensure the safe operation of the elevator, and its performance directly determines the safety of the whole machine. This paper describes a brake performance test scheme and test principle, and tests the elevator brake reliability through the test device, recording the suction and release voltage, the response time, the brake surface temperature, and the delay time of the mechanical parts on both sides. The analysis of the changing characteristics of the brake performance with time is helpful to further understand the safety condition of the elevator brake, and provides a reference for the related study of the brake performance.

Keywords. Elevator; Brake performance; Test.

1. Foreword

Elevator brake is the guarantee of safe operation of the elevator, at present, the brake test means and test equipment lack makes the elevator brake related safety risks failed to be found in time, therefore, the test method of the elevator brake and the development of elevator brake special performance test machine is the elevator industry to solve the problem as soon as possible [1].

2. Test the Device and the Principle

The brake performance test scheme is shown in figure 1. The whole system is composed of power supply, electrical control cabinet, transformer, sensor, force application device, data acquisition device, and test brake samples [2]. The electrical control cabinet realizes the switching action of the brake and its action frequency by controlling the power supply. The transformer converts alternating current to DC required for the brake coil. At the ends of the brake the design force device, to simulate the actual traction system, the brake piston force condition (if conditions permit, directly use the original supporting traction machine and the lock arm as force device, and on the original supporting traction machine direct test, in order to better simulate the field situation) [3]. At the same time, the laser displacement sensor can be installed at both ends of the brake to monitor and

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compare the action of the two plungers of the brake. In the test, the input voltage signal of the sensor signal and the brake coil can be collected through the data acquisition system and imported into the computer for analysis [4].

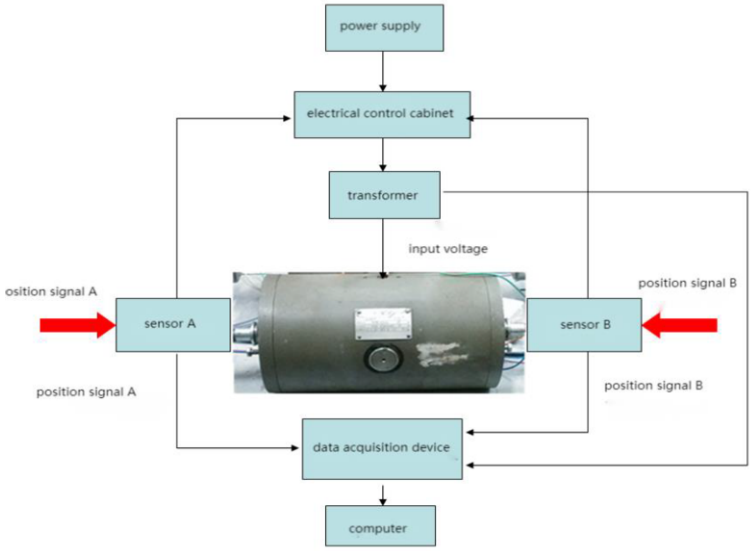

Figure 1. Schematic diagram of the brake performance test scheme

The physical photo of the test device is shown in figure 2.

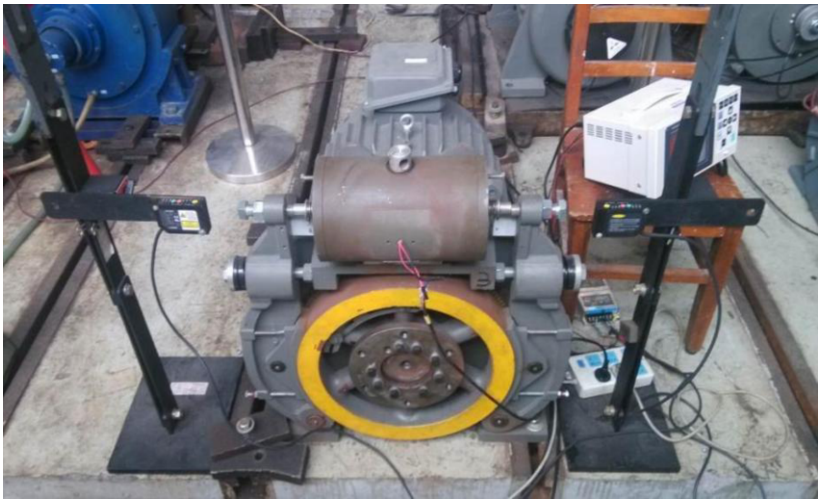

Figure 2. Photo of the brake performance test device

The test took a power on duration ED of 40% (i. e. 5 seconds for a cycle with 2 seconds power on and 3 seconds power off) with temperature monitoring. The action of a primary brake is a process of extending and retraction of a plunger.

3. Brake Action Performance Test Conditions

Test the typical brake samples on the test device as shown in figure 2. During the test, the brake condition in the performance test is observed and recorded using the data acquisition equipment, and the surface temperature of the brake housing is measured. Once the following conditions are found:

(1)Brake housing surface temperature exceeds 80℃. Reduce the action frequency of the brake, if the surface temperature of the shell is still too high, stop the test and check whether the brake fails;

(2) Insynchronization of the plunger of the same brake. Check the control system and input voltage and record the delay time of the two plungers. If the delay time reaches a certain degree, the test is stopped;

(3)The retraction action at both ends of the same brake is not synchronized. Check the spring compression and the fixation of the support seat and record the delay time of the two plunger movements. If the delay time reaches a certain degree, the trial is stopped.

4. Inspection Items, Inspection Basis Requirements, Inspection and Judgment Methods

The specific inspection items, requirements of inspection basis and inspection judgment methods are shown in table 1.

Table 1. Inspection items, basis requirements and test determination methods

Order number	Project	Inspection basis requirements	Test method	The result is determined
1	Arrester structure	1.1 The brake system shall have an electromechanical brake (friction type), and the brake shall be loosened [5] under continuous electrification;	Visual inspection, manual test;	The brake structure that meets the requirements of the inspection basis is considered compliant, otherwise not.
		1.2 All mechanical parts of the brake involved in braking the brake wheel (disc) (the core of the electromagnetic coil is regarded as a mechanical part while the coil is not) shall be installed in at least two groups: [6].	appearance inspection.	The brake structure that meets the requirements of the inspection basis is considered compliant, otherwise not.
2	Brake	2.1 The pressure of the brake brake or	appearance	The brake pressure

	pressure	liner shall be applied with a guided compression spring or weight;	inspection;	application mode that meets the requirements of the inspection basis is judged as conforming, otherwise it is regarded as non-conforming.
		2.2 The brakes that can be released by hand shall be kept open by the constant force of the hand.	Visual inspection, manual test.	The brake pressure that meets the requirements of the inspection basis is qualified, otherwise not.
3	Starting voltage	The minimum starting voltage of the brake electromagnet shall be less than 80% [7] of the rated voltage.	Use the displacement sensor, voltage sensor and oscilloscope for measurement and comparison.	The minimum starting voltage of the mechanical part of the brake during action is lower than 80% of the rated voltage, otherwise it is not conforming.
4	Release voltage	The maximum release voltage of the brake electromagnet shall be less than 55% of the rated voltage, and the minimum release voltage shall be no less than 10% of the rated voltage.	Use the displacement sensor, voltage sensor and oscilloscope for measurement and comparison.	The maximum release voltage of the brake mechanical component is less than 55% of the rated voltage, and the minimum release voltage is not lower than 10% of the rated voltage, otherwise.
5	Brake response time	The brake brake response time (the difference between the brake power outage time and the time when the	Use the displacement sensor, voltage	Response time less than or equal to 0.5s is consistent,

		brake reaches the full braking position) shall not be greater than 0.5s.	sensor and oscilloscope for measurement and comparison.	otherwise is non-conformity.
6	Brake coil pressure resistance	Apply a voltage of AC1000V between the conductive part of the brake coil and the ground for 1min without breakdown.	Load measurement was performed using a pressure manometer.	After testing, the coil is not broken down, otherwise it is not met.
7	Brake action test	The brake is installed on the drive host or the test tooling that can completely simulate the actual working state, and the continuous uninterrupted, 2 million action tests are (5 ± 1) s, when the power continuity rate is 40% and the large value of the power continuity rate of the elevator drive host. No maintenance shall be performed during the test and no brake shall be allowed during the test. After the test, the brake shall still meet the requirements of inspection items 3~6 in these Rules.	Test the brake installed on the drive main engine with special equipment. The test will be terminated if: 2 million times; Serious mechanical damage such as crack and breakage in any part of the brake; The action of the two groups of mechanical parts of the brake is obviously not synchronized, resulting in a response time exceeding 0.5s;	In the test, if the number of actions reaches 2 million times is terminated, and after the test, the brake still meets the requirements of inspection items 3~6 in these Rules, it is judged to meet, otherwise it is not.

For the brake sample, item 1~6 is tested first. If any item does not conform, the brake sample will be judged to be unqualified and the inspection will be stopped. If all the test results of item 1~6 meet, the action test of item 7 shall be conducted.

In the action test of item 7, if the brake is terminated for 2 million times, and there is no serious mechanical damage in any part of the brake, and the action of the two groups of mechanical parts is not significantly unsynchronized (resulting in the response time

exceeding 0.5s), the detection of item 3~6 is repeated. Otherwise, there is no need to test item 3~6, and it is directly judged as unqualified.

If all the test items of the above items 1~7 are consistent, the brake sample will be judged as qualified, otherwise, it will be judged as unqualified.

5. Test Results and Analysis

5.1. Suction and Release Voltage Test

According to clause 4.2.2.3 of GB / T24478-2009, the minimum suction voltage and the maximum release voltage of the brake electromagnet shall be below 80% and 55% [8] of the rated voltage, respectively.

Test a brand of drum brake as a sample. According to the nameplate information, the strong excitation voltage of the brake sample is DC200V. The test results of the lowest suction and highest release voltage are shown in table 2. It can be seen that the lowest suction voltage on the left side exceeds 200V and 80%=160V, which does not meet the requirements of the standard.

Table 2. Test results of the lowest suction and highest release voltage

Minimum suction and closing voltage (V)		**Maximum release voltage (V)**	
left side	165	left side	8
offside	125	offside	6

5.2. Brake Surface Temperature Test

Under specific test conditions, a 40% power-on duration is taken, and after a period of action, the brake enters a normal operating temperature. After testing, the surface temperature of the brake sample shell is maintained at about 60 degrees.

5.3. Plug Action Test

Using the laser sensor mounted on both sides of the brake sample, monitor the action of the two side plunger in real time and record its movement curve.

First, collect a set of synchronization and travel good plunger action curve as the benchmark curve, and as the curve, expand a certain range as the corresponding "acceptable area" of the plunger action curve, in the action test of the real ger action curve, respectively all fall into the area of the action synchronization and action travel is "acceptable", marked as "PASS". Otherwise, if the measured plunger action curve is completely or partially outside the "acceptable area", the bilateral plunger action will be considered "unacceptable" (based on the saved record curve) and marked "FAIL".

Figure 3 shows the "acceptable" brake plunger action curve. Among them, the blue and red thin solid lines are the measured action curves of the plunger on both sides, respectively, and the purple and orange wide lines are the "acceptable areas".

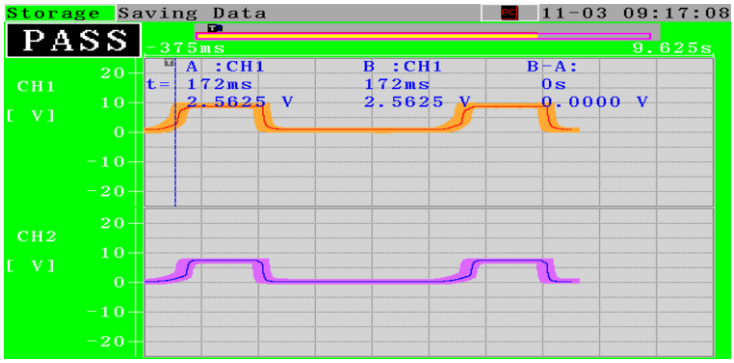

Figure 3. Brake plunger action curve (acceptable)

In the early stage of the movement test, the real-time measurement of the brake plunger action curve is all "acceptable". However, after a period of time (temperature reaches operating temperature), the action curve of one plunger (blue fine solid line) is beyond the "acceptable area" range, as shown in figure 4.

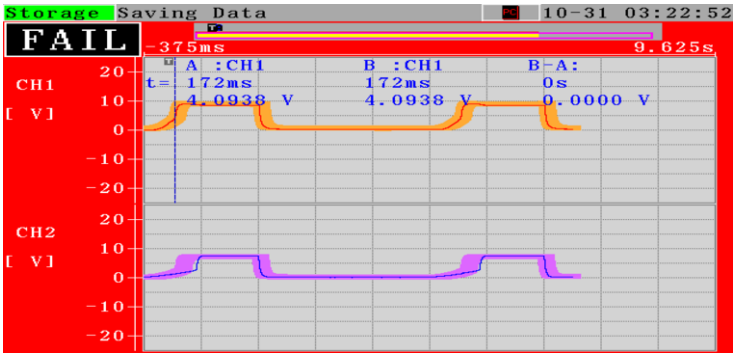

Figure 4. Brake plunger action curve (not acceptable)

During the test, the disynchronization of the two sides was not regular, with very serious disynchronization, as shown in figure 5.

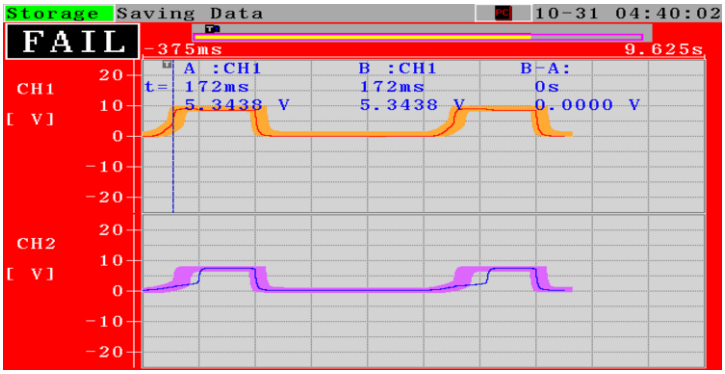

Figure 5. Brake plunger action curve (severely dissynchronized)

Occasionally, one side of the plunger cannot extend, as shown in figure 6.

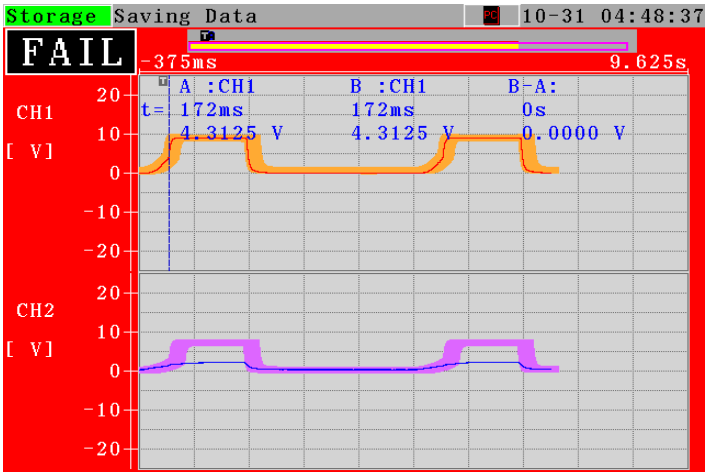

Figure 6. Action curve of brake plunger (no side)

5.4. Response Time Test

During the power-on action of the brake sample, the electrical signal and the action signal are simultaneously tested and compared to obtain the response time of the brake action. Figure 7 shows the test curve of the suction response time of the side plunger (the difference between the brake-on time and the time of the plunger to the fully open position).

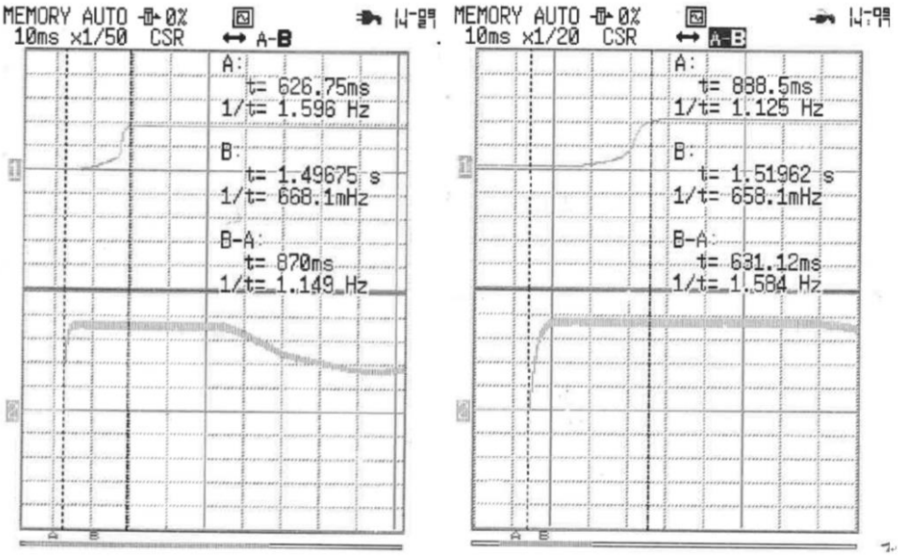

Figure 7. Brake suction response time (either side plunger)

Figure 8 shows the test curve of the release response time of the side plunger (the difference between the brake outage time and the plunger to the full braking position).

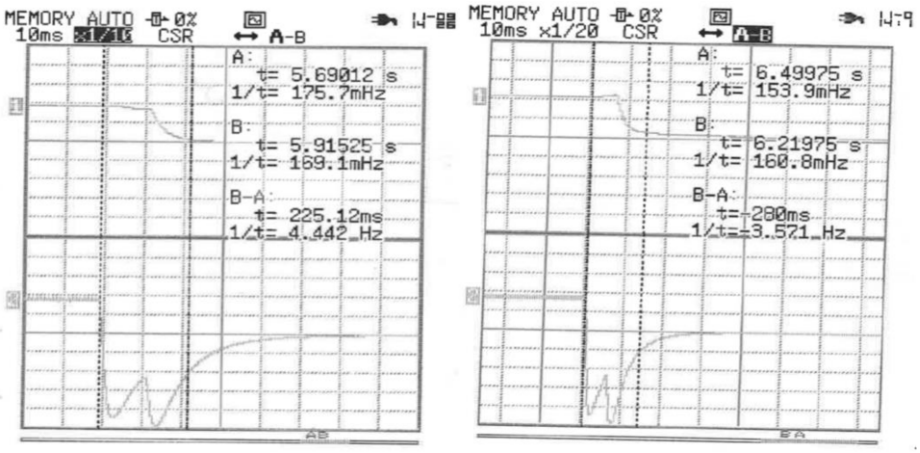

Figure 8. Brake release response time (either side plunger)

Specific measurement data are shown in table 3.

Table 3. Results

Suction process (s)		Release process (s)	
left side	0.870	left side	0.225
offside	0.631	offside	0.280

It can be seen that the suction response time of the two plungers is not synchronized and both exceed 0.5s, which may cause the brake suction closing, thus accelerating the excessive wear of the brake tile. However, the release response time of both sides meets the requirements and is basically consistent.

5.5. Test Results Analysis

The minimum suction voltage on one side of the brake sample is too high, the maximum release voltage and operating temperature are normal, and in the process of use (after the normal operating temperature), the two ends of the plunger action is not synchronized, that is, when the braking force of the drum on both sides, there will be an obvious time difference. And more seriously, there may be a side of the plunger can not extend, that is, the single side brake force can not be released, long-term operation with the brake will cause excessive wear of unilateral brake tile and loss of brake force.

6. Epilogue

Through the analysis of the elevator related accident cases, it is known that the brake failure will cause serious accidents, so it is necessary to test and analyze the brake performance to ensure the safe and reliable operation of the elevator. From the

perspective of research status, the current research on the safety performance of elevator brake is mainly based on standards and norms, while the quantitative research on safety performance test and evaluation is relatively few, and the related instruments and test process need to be further developed. Through this device, the brake performance test is helpful to understand the safety situation of the elevator brake, analyze the hidden dangers, do a good job in risk prevention and control, and reduce the occurrence of the elevator brake related accidents. The analysis of other aspects based on the test results, such as the brake performance degradation analysis related to the use time, requires further mining of the test data.

References

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