

Research on the device for measuring the engagement depth of bottom guide of landing door

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Abstract. A large number of elevator safety accidents occur at the landing door. The bottom guide of landing door has the function of fixing the landing door and guiding. The previous measurement of the engagement depth of the bottom guide of landing door has drawbacks and the measurement accuracy is low. The insufficient engagement depth of the bottom guide of landing door will affect the strength of the landing door. In order to improve the measurement accuracy of the engagement depth of the bottom guide of landing door, this paper proposes a device for measuring the engagement depth of the bottom guide of landing door, analyzes its structure and working principle, and measures the engagement depth of the bottom guide of landing door through direct measurement and indirect measurement. Through the measurement and numerical analysis of the engagement depth of the bottom guide of landing door by the steel tape, inclined feeler gauge and the device for measuring the engagement depth of bottom guide of landing door, it is concluded that the measurement accuracy of the device for measuring the engagement depth of bottom guide of landing door can be improved compared with the steel tape and inclined feeler gauge.

Keywords: Elevator, The bottom guide of landing door, Engagement depth, Measure Accuracy.

1. Introduction

In recent years, many elevator safety accidents occur at the elevator landing door, such as kicking the landing door, body or object hitting the landing door and causing people to fall down the shaft [1]. According to statistics, nearly 65% of elevator safety accidents occur in the door system. The reason is that the bottom guide of landing door is damaged or separated from the guide rail due to the external force on the landing door, which makes the landing door lose its protection function [2]. Therefore, the design structure and manufacturing quality of the landing door attract more and more attention from relevant departments. The bottom guide of landing door is fixed at the bottom of the horizontal sliding landing door, which can prevent the landing door from derailing or dislocation, and can withstand a certain external force impact. The bottom guide of landing door will be constantly worn during use, resulting in a reduction in the engagement depth. Insufficient engagement depth of the bottom guide of landing door will affect the strength of the landing door. The importance of the engagement depth of the bottom guide of landing door is self-evident. At present, the engagement depth of the bottom guide of landing door is mainly measured directly with a steel tape or indirectly with an inclined feeler gauge. The above measurement methods have many drawbacks [3-5].

Based on this, this paper proposes a device for measuring the engagement depth of the bottom guide of landing door, which has the characteristics of convenient operation, accurate measurement, safety, etc., and helps to improve the inspection quality.

2. Provisions in safety technical specifications and standards

GB/T 7588.1-2020 Specification for Manufacture and Installation of Lifts states that when the normal guide device fixed on the door leaf fails, the horizontal sliding landing door and car door shall have a retention device to keep the door leaf in the working position. The complete door assembly with retention device shall be able to withstand the pendulum impact test meeting the requirements, and the impact point shall be selected for the test under the condition that the normal guide device is most likely to fail. A sign or mark identifying the minimum engagement depth shall be set on or near the bottom retaining device.

TSG T 7001-2009 Elevator Supervision, Inspection and Periodic Inspection Rules - Traction and Forced Drive Elevators, the No. 2 amendment, raised the importance of inspection. The inspection requirements are: when the landing door and car door are in normal operation, there shall be no derailment, mechanical jamming or dislocation at the end of the travel; When the landing door guiding device may fail due to wear, corrosion or fire, emergency guiding device shall be set to keep the landing door in its original position.

TSG T 7007-2016 Elevator Type Test Rules emphasizes the importance of the engagement depth of the landing door guide and retention device to the door leaf guide and retention. The minimum engagement depth allowed by the landing door guide and retention device shall be indicated in the configuration parameter table of the landing door type test.

3. Analysis of common measurement methods for engagement depth of the bottom guide of landing door

The engagement depth of the bottom guide of landing door can be divided into direct measurement method and indirect measurement method.

The direct measurement method is to measure the engagement depth of the bottom guide of landing door with a certain precision measuring instrument. The operation method is as follows: First, extend the head of the measuring ruler of the measuring instrument into the gap between the bottom guide of landing door and the bottom of the sill groove. Then, move the head of the measuring ruler vertically upward until the head of the measuring ruler fits with the bottom guide of landing door. Finally, record the value measured at the intersection of the measuring instrument and the horizontal plane at the top of the sill slot, which is the engagement depth.

The indirect measurement method is to measure the sill groove depth and bottom clearance with a measuring instrument of certain accuracy, and then subtract them to calculate the engaging depth of the bottom guide of landing door. The operation method is as follows: First, measure the depth of the landing door sill groove with a measuring instrument. Then, put the measuring instrument into the gap between the bottom guide of landing door and the bottom of the sill slot, and measure the bottom gap value. Finally, the depth of sill groove minus the bottom clearance is the engagement depth of the bottom guide of landing door. The calculation formula of engagement depth is as follows:

$$h=H-e \quad (1)$$

Where, h is the engagement depth, H is the sill groove depth, and e is the bottom clearance.

At present, the common measurement method for elevator inspectors is direct measurement with steel tape or indirect measurement with inclined feeler gauge. The above measuring instruments are relatively simple and have many shortcomings.

1. Since the bottom guide of landing door is located at the lowest end of the landing door, the inspector needs to lie down and stretch out his hand for measurement, and the scale value of the measuring instrument is difficult to read accurately with head up view, so the measurement error is large.

2. The distance between the bottom guide of landing door and the landing door sill is only a few millimeters. In a narrow space, it is difficult to put the steel tape and the inclined feeler gauge inside for measurement, resulting in no measurement conditions on site.

3. Due to the long width of the bottom guide of landing door, it is difficult to go deep into the whole bottom guide of landing door with a steel tape or inclined feeler gauge to measure the minimum engagement depth, so it is difficult to measure the minimum engagement depth.

Therefore, a measuring device needs to be designed in the inspection to facilitate the measurement of the engagement depth of the bottom guide of landing door and improve the measurement accuracy.

4. Measuring device and measuring principle

4.1 Measuring principle

In this paper, a device for measuring the engagement depth of the bottom guide of landing door is proposed, which can be measured either directly or indirectly. The measuring device is equipped with a retractable measuring head, which can move up and down and can control the length in the horizontal direction. A thin layer pressure sensor is pasted on the upper and lower surfaces of the retractable measuring head to obtain perceptual information such as whether the measuring head is fully fitted with the measured part. The measuring principle of the measuring device for the engagement depth of the bottom guide of landing door is shown in Figure 1.

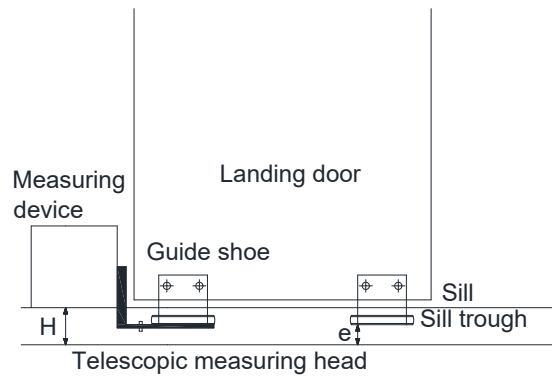


Fig. 1 Measuring principle

Direct measurement method: the measuring device for the engagement depth of the bottom guide of landing door moves the retractable measuring head to the top of the sill slot and sets it as 0, moves the retractable measuring head downward and extends it to the bottom guide of landing door, and at the same time, extends the measuring head horizontally until it covers the entire bottom guide of landing door. Due to the uneven wear of the bottom guide of landing door, move the retractable measuring head horizontally until the minimum engagement depth of the bottom guide of landing door is measured.

Indirect measurement method: First, the measuring device for the engagement depth of the bottom guide of landing door moves the retractable measuring head to the top of the sill slot and sets it as 0, and moves the retractable measuring head downward to the bottom of the sill slot to measure the depth of the sill slot. Then, when the retractable measuring head is located at the bottom of the sill slot, set it to 0, move the retractable measuring head upward until it touches the bottom guide of landing door, move the measuring head horizontally until it covers the entire bottom guide of landing door, and move the measuring head horizontally until the maximum gap between the sill bottom and the bottom guide of landing door is measured. Finally, the engagement depth of the bottom guide of landing door is calculated by subtracting the maximum gap between the bottom of the sill and the bottom guide of landing door from the depth of the sill slot.

4.2 Measuring device

The measuring device for the engagement depth of the bottom guide of landing door is shown in Figure 2. A thin layer pressure sensor is attached to the upper and lower surfaces of the end of the telescopic measuring head to obtain sensing information such as whether the measuring head is fully fitted to the measured part. Two motors are installed inside the measuring device. The motors are controlled by the internal controller of the measuring device and are used to drive the telescopic measuring head to move in the horizontal and vertical directions respectively. A displacement sensor is installed inside the measuring device to obtain the moving distance values of the telescopic measuring head in the horizontal and vertical directions.

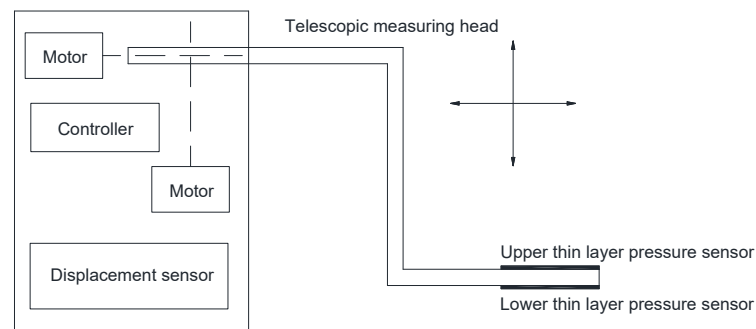


Fig. 2 The measuring device for the engagement depth of the bottom guide of landing door

4.3 Hardware composition

The hardware of the device for measuring the engagement depth of bottom guide of landing door is mainly composed of 2 thin layer pressure sensors, 2 motors, 2 displacement sensors, micro controller, touch screen, display, etc. Its structure is shown in Figure 3. The internal software is equipped with direct measurement method and indirect measurement method. the device for measuring the engagement depth of bottom guide of landing door measures according to the set measurement method and displays the measurement results on the display screen.

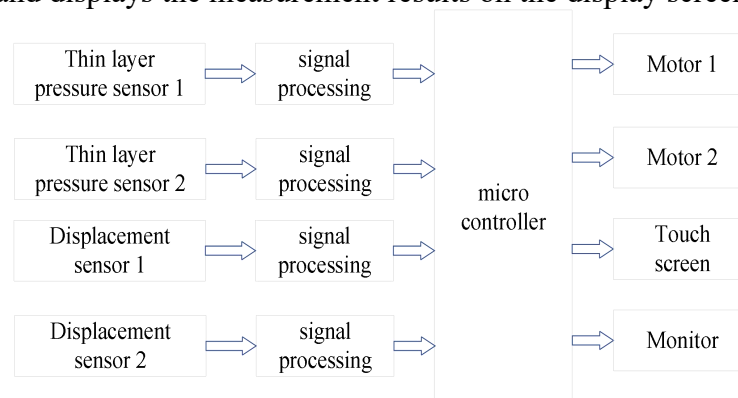


Fig. 3 The hardware of the device for measuring the engagement depth of bottom guide of landing door

5. Analysis of measurement results

Use steel tape, inclined feeler gauge and the device for measuring the engagement depth of bottom guide of landing door (hereinafter referred to as measuring device) to measure the engagement depth of several groups of the bottom guide of landing door at the inspection site. The measured data are shown in Table 1.

Table 1. Comparison of measured values of various measuring instruments

true value(mm)	16.5	19.2	20.3	17.5	15.3	12.5	11.5	14.5
steel tape	14.0	17.0	19.0	14.0	12.0	8.0	9.0	11.0
inclined feeler gauge	15.0	18.0	19.0	15.0	13.0	9.0	10.0	12.0
measuring device	16.9	18.6	20.5	16.9	14.8	11.9	10.9	14.0

The comparison between the measured data and the true value is shown in Figure 4, through which the accuracy of each measurement method can be found more intuitively. The engagement depth measured by the measuring device is closer to the true value, and its accuracy is the highest. The value measured by the inclined feeler gauge is closer to the true value than that measured by the steel tape. Therefore, the measurement accuracy ranks from high to low as measuring device, inclined feeler gauge, and steel tape. When the engagement depth of bottom guide of landing door is large, the deviation from the true value measured by the inclined feeler gauge and the steel tape is small. When the engagement depth of bottom guide of landing door is small, the deviation from the true value measured by the inclined feeler gauge and the steel tape is large.

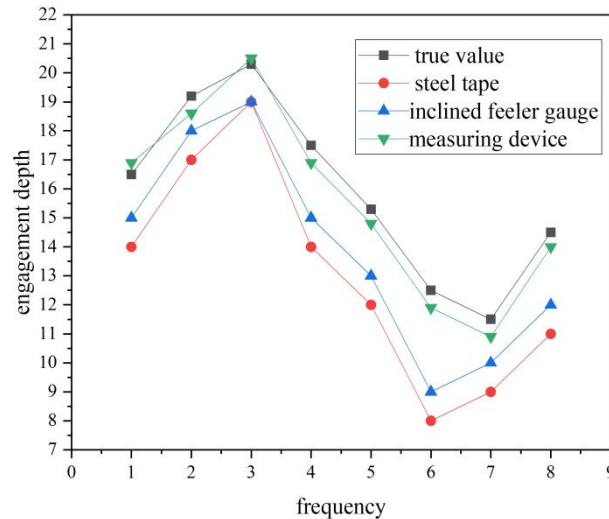


Fig. 4 Comparison between measured values and true values of various measurement methods

6. Conclusion

This paper analyzes the importance of the bottom guide of landing door and its engagement depth to ensure the strength of the landing door from the elevator standards and safety technical specifications.

Due to the drawbacks of conventional measuring instruments in the process of measuring the engagement depth of the bottom guide of landing door, this paper proposes a new measuring device, which is simple in structure and easy to operate. Through the measurement of the engagement depth of several groups of the bottom guide of landing door, it is found that the device for measuring the engagement depth of bottom guide of landing door has higher accuracy than the steel tape and the inclined feeler gauge. The strength of the landing door and the engagement depth of the bottom guide of landing door have been paid more and more attention by the Elevator Standards Committee. In the process of elevator inspection and detection, there is an urgent need for a measuring device that can easily and accurately measure the engagement depth of the bottom guide of landing door to ensure the safety of the elevator to a greater extent. The described device for measuring the engagement depth of bottom guide of landing door can be used for reference by relevant personnel.

Acknowledgments

This research was supported by The Scientific Research Project of Shanghai Market Supervision Bureau (2022-36) .

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