Analysis of prevention and control strategies for safe operation of old elevators based on evaluation data statistics

Chaojun Luo [1, 2, a], Zhangxu Liu [1, 2, b], Yongjun Qiu [1, 2, *], Zhangjian Wang [1, 2, c], Dugang Kang [1, 2, d]

[1] Chongqing Special Equipment Inspection and Research Institute, Chongqing, China

[2] Key Laboratory of Electromechanical Equipment Security in Western Complex Environment for State Market Regulation, Chongqing 401121, China

* Corresponding Author Email: qiuyongjun@cqtj.org, [a]luochaojun@cqtj.org, [b]liuzhangxu@cqtj.org, [c]wangzhangjian@cqtj.org, [d]kangdugang@cqtj.org

Abstract. In recent years, the safety problems caused by frequent failures of old elevators have attracted increasing social attention. The safety evaluation of old elevators is an effective method to comprehensively judge the safety status of elevators. Through the statistics of the relevant data of the safety evaluation conclusions of more than 100 old elevators, this paper focuses on the analysis of the typical potential safety risks and puts forward practical and effective measures and suggestions, so as to provide effective guidance for ensuring the safe operation of old elevators.

Keywords: old elevator, safety assessment, operation, strategy.

1. Introduction

The number of elevators in Chongqing has exceeded 200000 in 2022, and the number of old elevators with a service life of more than 10 years has accounted for 10% - 15%. However, there are many problems in old elevators, such as the wear and corrosion of some mechanical parts, the backwardness and aging of electrical control system, poor safety and reliability, and some safety protection functions fail to meet the requirements of current standards [1]. These potential safety risks will directly affect the safety of people in taking elevators. Once an accident occurs, it may cause personal injury and property damage, causing serious social impact.

Elevator safety assessment is an effective means to supervise and verify the use and management level of the elevator, the operation status of the equipment body, and the maintenance quality, and to find and reduce the safety risks in all links of the elevator [2]. Through safety assessment, it can further promote the implementation of the main responsibility of elevator users and maintenance units. By taking reasonable and reliable measures and Countermeasures [3], it can effectively improve the level of elevator use management and maintenance quality, and eliminate potential safety risks in time. Taking the "old elevator safety evaluation and hidden danger investigation" project in a district and county of Chongqing as an example, this paper analyzes the typical potential safety risk items of old elevators through data statistics, and puts forward practical and effective measures and suggestions, so as to provide effective guidance for the safe use of old elevators.

2. Old elevator safety assessment and hidden danger roubleshooting data statistics

The project of "safety evaluation and hidden danger investigation of old elevators" was implemented in 7 old residential areas in a district or county of Chongqing. A total of 120 elevators (113 machine rooms and 7 non machine rooms) were evaluated, and the service life of elevators was more than 10 years, as shown in Table 1.

Table 1. statistical overview of elevator safety assessment for hidden danger remediation in a district or county of Chongqing

Property unit	Elevator (set)		Total potential safety risks (items)	Service life (set)					
	without machine room	with machine roo		11years	12years	13years	14years	15years	16years
7	7	113	1248	16	7	16	8	59	14

In this project, a total of 22 major items, including 131 minor items, are involved in the safety assessment and hidden danger investigation of old elevators from three aspects: the use and management level of elevators, the operation status of equipment bodies, and the maintenance quality of elevators. A total of 1248 hidden dangers of safety risks are found, and their distribution and proportion are shown in Figure 1.

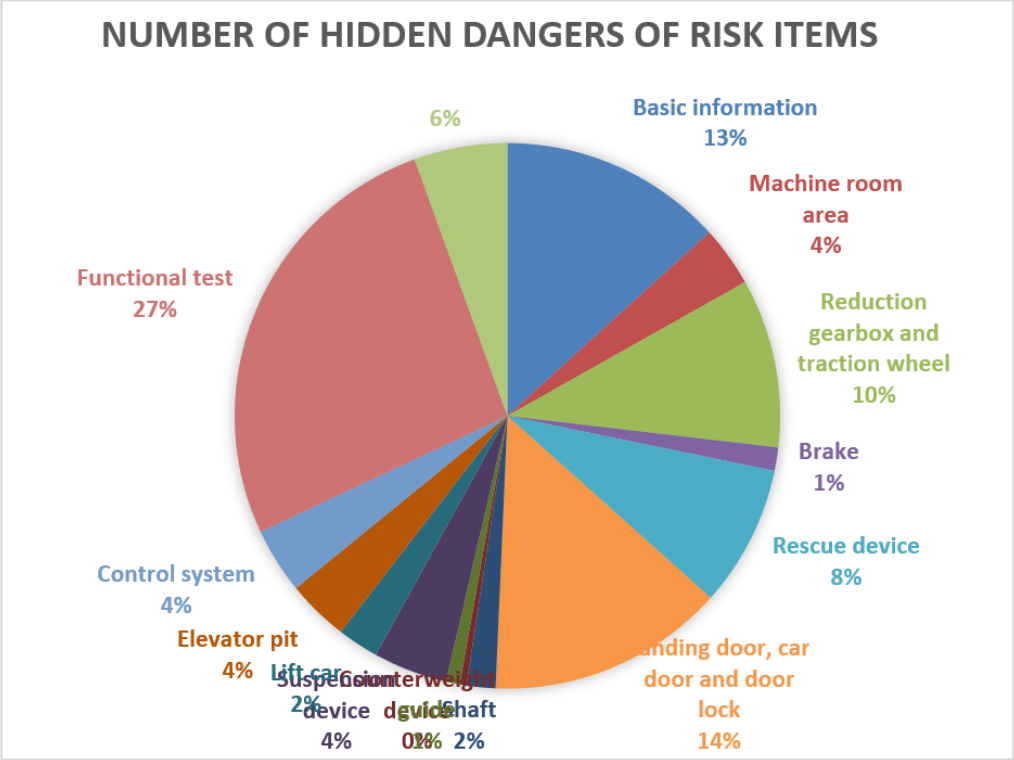

Figure 1. number and proportion of hidden dangers of each safety assessment risk item

3. Analysis of typical safety risk items of old elevators

According to the data analysis in Figure 1, among the 22 major items of elevator safety assessment, the safety assessment items that account for more than 10% of the total safety risk are items 1, 3, 8 and 18. The statistical situation is shown in Table 2.

Table 2. list of assessment items for more than 100 potential safety risks

Content of safety assessment project	Number of potential safety risks	Proportion of potential safety risks	Number of elevators involved	Proportion of elevators
Item 1 - basic information	163	13%	110	92%
Item 3 - reduction gearbox and traction wheel	142	12%	67	56%
Item 8 - landing door, car door and lock	173	14%	115	96%
Item 18 - functional test	325	26%	120	100%

From the analysis of Table 2, these four safety assessment items have a total of 803 potential safety risks, accounting for 65% of the total. At the same time, the number of elevator platforms involved in each item is large. Therefore, this paper will analyze these four typical safety risk items and put forward reasonable and effective measures and suggestions to ensure the safe operation of old elevators.

3.1. Analysis of "basic situation"

This item mainly makes a comprehensive evaluation on the use, management and maintenance of elevators from the management of files, records and other data, the replacement and supply of spare parts, faults and maintenance and other paper data. There are 110 old elevators with potential safety risks, accounting for 92%, of which 96 elevators have incomplete archives, accounting for 80%. Because the service life of the evaluated elevators has exceeded 10 years, and some elevator users have been replaced many times, there may be the loss of elevator files, records and other data that have not been reissued during the handover process; There are also difficulties in re filing archives due to the cancellation, closure and change of some elevator manufacturing units; At the same time, there are also a few elevator use and management units that have not paid attention to the management of elevator archives, resulting in the lack of elevator archives. This item does not meet the relevant requirements of safety assessment due to the above reasons.

3.2. Analysis of "reduction gearbox and traction wheel"

This item mainly evaluates the safety of reducer and traction wheel from the aspects of oil leakage, gear oil, gear pair clearance, meshing surface state, gear pitting, traction wheel, etc. According to table 2, there are 67 elevators with 142 potential safety risks. Most of the old elevator transmission mechanisms use worm gear boxes for power transmission, which has a long service life, resulting in the aging of the oil seal of the reducer, the viscous gear oil of the reducer or more impurities, resulting in the oil leakage of the reducer or the oil of the reducer does not meet the requirements of the safety assessment. At the same time, some traction wheels are seriously worn and greasy due to long service life, frequent operation and other reasons, resulting in this item not meeting the requirements of safety assessment.

3.3. Analysis of "landing door, car door and lock"

This item mainly carries out safety assessment from the electrical and mechanical components related to landing doors, car doors and door locks. From the analysis of Table 2, there are 115 elevators in this project, with a total of 173 potential safety risks. Due to the long service life of the old elevators, the frequent operation, the large flow of people in the use environment of some elevators, and the high difficulty of use and management, the contact oxidation of the electrical safety device of some elevator door locks, the opening and closing of the door wheel roller, the door slider, the door motor system and other components do not meet the safety assessment requirements. At the same time, because the service life of the elevators is more than 10 years, the car door opening limiting device and the related functions of the car door opening in the amendment No. 1 of GB 7588-2003 can not be required [4], and the small item of this major item - "car door opening limiting device" has 114 elevators that are not configured, so it does not meet the requirements of safety assessment.

3.4. analysis of "function test"

This item mainly carries out safety assessment from the aspects of traction capacity, balance coefficient, leveling condition, overload protection, braking test, upward overspeed, car accidental movement protection, door bypass function and door circuit detection function. According to table 2, there are 120 elevators in this project, with a total of 325 potential safety risks. The weight of some elevators on the side of the car changes due to car decoration, increase or decrease of cooling equipment, resulting in the elevator balance coefficient tested on site does not meet the requirements; Some elevators have poor reliability of overload protection devices due to long service life and wear,

corrosion and aging of mechanical and electrical components; At the same time, because all elevators have been used for more than 10 years, the functions related to car accidental movement protection, door bypass function and door circuit detection in the amendment No. 1 of GB 7588-2003 are not required, while 120 elevators are not equipped with the above functions, so they do not meet the requirements of safety assessment.

4. Overall analysis and measures and suggestions

4.1. Equipment body

Due to the long service life, frequent operation, complex service environment and other factors, the mechanical and electrical components of some old elevators have aging, wear, corrosion and deformation in varying degrees. It is recommended to repair or transform the elevators according to the safety assessment report of each elevator. At the same time, it is recommended to configure the car accidental movement protection function, car door opening limit function, landing door and car door bypass function, door circuit monitoring function, brake failure protection function required by GB7588-2003 amendment No. 1, so as to further improve the safety of elevator travel.

4.2. Use management

It is suggested that the use and management unit should improve the relevant technical data of the elevator to facilitate the inspection of government supervision units, use and management units, inspection and testing units and maintenance units, which is conducive to improving the efficiency of troubleshooting and the level of use and management of the elevator, and ensuring the operation safety of the elevator. At the same time, the user unit shall cooperate with and supervise the maintenance unit to rectify the problems raised by the safety assessment in a timely manner; Strengthen the supervision and management of maintenance contents, projects and maintenance work; Timely conduct emergency rescue drills, regularly organize and carry out special equipment safety education and training [5], and make corresponding records to improve the awareness of safety responsibility.

4.3. Maintenance

It is suggested that the maintenance unit should strictly comply with the relevant requirements of TSG t5002 "elevator maintenance rules" [6], carefully perform the maintenance duties, and rectify the potential safety hazards of the equipment body found in the safety assessment in a timely manner, make records, and properly archive. The quality inspection (inspection) personnel or management personnel of the maintenance unit shall irregularly inspect the maintenance quality of the elevator and keep records on file.

5. Conclusion

Through the statistics of safety evaluation data, this paper analyzes the typical safety risk items that may exist in old elevators, and puts forward suggestions to eliminate or reduce safety risks, aiming to attract the attention of relevant parties in the aspects of equipment body, use management, maintenance, so as to take reasonable and effective measures to further improve the safe operation of old elevators.

References

[1] Luo Chaojun, Liu Zhangxu. Discussion on the safety risk assessment method and application of old elevators [j]. China special equipment safety, 2017, 33 (10): 58 - 60.

[2] Huang Yingxin, Lin dengtian, Zhang Jingkai. Safety assessment and analysis of old elevators based on data statistics. China Equipment Engineering, 2020, (18): 126 - 127.

[3] Laiyueyang, ligangfeng. Analysis of safety risk assessment of old elevators [j]. electromechanical technology, 2011, 34 (6): 98 - 100.

[4] GB 7588 - 2003 safety code for elevator manufacturing and installation [s] (including No. 1 Amendment).

[5] TSG 08-2017 management rules for the use of special equipment [s].

[6] TSG t5002-2017 elevator maintenance rules [s].