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# EVALUATION OF PERIODIC CONTROL RESULTS OF ELEVATORS, CASE OF ÇORUM PROVINCE

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# EVALUATION OF PERIODIC CONTROL RESULTS OF ELEVATORS, CASE OF ÇORUM PROVINCE

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### ABSTRACT

In this study, the annual periodic control results of the elevators in Çorum in 2017, 2018 and 2019 are evaluated. The sources of the deficiencies encountered in the operation of the elevators and the relevant regulations are explained.

The purpose of the elevator inspections and the processes followed are explained, and the equipment used is introduced. In addition, the problems that control engineers encounter during inspections are also mentioned. With the TS EN 81-20 standard, additional security measures for elevators are discussed.

The inspection results of the electric elevators in Çorum in 2017, 2018 and 2019 were examined and the deficiencies are listed in graphics. Elevators have been inspected for defects based on inspection reports. It is emphasized why these deficiencies exist in elevators and why periodic controls are necessary. The dangers in the elevators are mentioned and examples of the accidents are presented.

Keywords: Elevator inspection, Elevator defects, Risk assessment, Periodic control

## INTRODUCTION

It is known that there are cupboards descending and ascending between the floors in the palaces of the Roman Empire. At the beginning of the 17th century, the French Velayer developed this primitive tool and called it the "flying chair", which was turned and moved by hand and worked with a counterweight.

In 1853, Elisha Otis built a two-stop elevator and explained the safety system he produced against the breakage of the rope [1]. In 1864, the Frenchman Edoux used the word Ascenseur to describe his invention, which uses the energy of city water under pressure. In 1880, Siemens took the elevator technology one step further by using electricity. At the exhibition in Paris in 1889, the French Eiffel placed an elevator inside the tower, which he named. The use of elevators has been expanded from industry to commerce and public use. The first electric elevator in our country was built in Pera Palace Hotel in 1892 [2].

Elevators that do not require human power and work with compressed air were developed in the 17th century. With the widespread use of electricity, hydraulic elevators have been replaced by electric elevators. Nowadays, it is a great necessity to have elevators in buildings, the traffic calculations of which are made according to the building situation and the number of which is determined. The breakdown of the elevator in a ten-story building reveals the importance of the issue, as old and sick people go up and down in a four-story building.

While elevators with a speed of 1 m/s are used in a normal building, a speed of 21.1 m/s has been reached with the elevator in Guangzhou CTF Financial Center. This elevator, developed by the Tokyo-based company Hitachi, was selected as the fastest elevator in the world by Guinness World Records on September 10, 2019. This elevator can take a distance of 440 m from the ground floor to the 95th floor in 42 seconds by reaching a speed of 76 km per hour [3].

While the periodic controls of the elevators are carried out, the evaluations made by determining the relevant findings cover the maintenance and breakdown activities of the elevators and the work of the engineers who carry out these activities. Failure to carry out inspections at a sufficient level, performing maintenance services by unauthorized and inadequate persons and companies, lack of project design, and use of non-standard materials increase the risk of accidents in elevators [4].

To give an example of the dangers that the engineers who perform the periodic control of the elevator encounter in the field;

-Mechanical hazards; Angled parts, acceleration and deceleration, falling objects, cutting parts, high pressure, machine mobility, slippery surface, sharp edges, moving elements, rotating parts

-Electrical hazards; electrostatic or electromagnetic events, short-circuit conditions, live parts

-Thermal hazards; materials or objects with low or high temperature

- Hazards caused by vibration, noise, and materials/ substances

-Ergonomic hazards; access, flickering light, bright light, shadow, local lighting, mental overload, repetitive activity, posture, visibility

-Environmental hazards; smoke, fog, lightning, humidity, pollution, snow, heat, water, wind, lack of oxygen [5].

Eris B. et al. in their article titled "Occupational Safety in Elevator Controls", described the hazards experienced and foreseen by the engineers performing periodic elevator inspections and the possible consequences of the hazards. They talked about the rules that the employees should follow in terms of health and safety [5].

Tekin, in his thesis titled "Results of Periodic Controls of Elevators in Isparta and New Generation Safety Measures in Elevators", stated what the deficiencies are according to the results of periodic control of elevators in Isparta province and what to do for corrective actions, and investigated how the measures that can be taken on a provincial basis will spread to the general public [6].

In his article, Çeri talked about maintenance and repair in elevators in general, mentioned how important maintenance and repair practices are for elevators, and conveyed what kind of accidents can occur in maintenance and repairs that do not comply with the standard [7].

Karahan created a primary risk analysis table by determining hazards and risks for elevator maintenance works in his thesis titled "Assessment of Risks in Elevator Maintenance Works and Suggestions for Solutions". He emphasized that inappropriate or insufficient lighting may cause occupational accidents [8].

Cicik determined the risk factors as a result of the observations made in the elevator assembly works in five different construction projects under construction in Ankara and Malatya [9].

elevator installation companies operating in İzmir drive machine, control panel, speed regulator, within the scope of the thesis study titled "Evaluation of Elevator Assembly Processes from Occupational Safety and Ergonomic Aspects". The assembly processes of electric elevators with 4-16 stops and a capacity of 400-1.000 kg were evaluated in terms of occupational safety and ergonomics [10].

## MATERIAL AND METHODS

# **Periodic Control of Elevators**

Elevator periodic inspection is the annual inspection that shows that elevators carrying people, people, and loads or only loads are operating safely and in a way that does not endanger life and property safety. Control studies; It is carried out by A-type inspection bodies authorized by the Ministry of Industry and Technology, accredited by the Turkish Accreditation Agency, and contracted with the relevant administrations [8].

Type A inspection bodies attach information labels prepared in the form of a coated sticker, at least 16x8 cm in size, with the necessary explanations in black on a green blue yellow, or red background, to each elevator that is periodically inspected. These

organizations provide the necessary equipment for periodic control. Required equipment includes a lux meter, tachometer, force gauge, triangle switch, low voltage detector, flashlight, and personal protective equipment.

In the TS EN 81-20 standard, the features that must be found in disabled lifts have also become mandatory. According to the zoning regulation, it is aimed to construct disabled ramps for disabled people to access the buildings and to enable disabled people to access the elevators safely.

#### Definition of elevator and elevator types

Elevators are vehicles that serve at certain levels, are inflexible, have a car that moves on fixed rails that form an angle of more than 15° in the horizontal plane, and carry people and goods [12]. In electric elevators, the principle of the drive motor moving the car in the desired direction is valid. These elevators, in which the counterweight and the car work together, are called friction driven elevators. In drum elevators, a chain or rope works by wrapping around the pulley [13] [14] [15].

In hydraulic elevators, there is a lifting mechanism that moves the car directly or indirectly. Hydraulic fluid is transmitted to this mechanism and the movement is provided by an electric pump. Hydraulic elevators are preferred in small buildings due to the small footprint and quiet operation of the drive mechanism [13].

#### Basic components of elevators

Key components of elevators include hoistway, Seren studied at 20 different construction sites of 9 machine room, cabin, guide rails, balancing weight, electrical panel and installation, landing and cabin doors, suspension ropes, limit breakers, buffers, and parachute brake assembly [13].

#### Elevator Legislation

Information about elevators in our country was included in the TS 863 standard for the first time in 1971 by the Turkish Standards Institute. The first regulation of the sector was published by Bandırma Municipality in 1975 with the name of "Elevator Installation Technical Regulation". In 1989, T.C. The "National First Elevator Regulation" was published by the Ministry of Industry, and the "95/16/ Elevator Regulation" became mandatory AT throughout the country in 2005. Various changes were made in the 95/16/AT Elevator regulation in 2007, 2008, 2009, 2011. Elevator operation, maintenance, and periodic control regulations were published in 2015. In addition, the regulation on amending the elevator periodic control regulation, which includes the procedures and principles regarding the periodic controls of elevators and the authorization and inspection of type A inspection bodies that will take part in these controls, was published in 2022.

# Some Examples of Safety Measures in Elevators

It is seen that innovations, increased measures, and many concepts are defined in detail in the TS EN 81-20 standard.

-The illumination intensity for the machine and pulley room passageways should be at least 50 lux. Thus, the risks that may arise from ergonomic and mechanical hazards on the access roads to the engine room can be reduced [11].

-The entrance door to the engine room must be at least 2 m high and 0.6 m wide. When the engine room floor cover is closed, it must be able to carry the load of two people, each 1000 N, in an area of 20 m  $\times$  0.20 m [11].

-There must be permanent electric lighting of at least 200 lux required to operate machine areas and reel rooms at floor level, and at least 50 lux at floor level between work areas [11].

-At least 50 lux lighting has been made mandatory between the working areas in the engine room. At least 200 lux lighting is required in front of the emergency test panel. Thus, it is aimed to reduce the risks that ergonomic hazards can create.

-The ropes may have slipped over the drive pulley or the machine may have been stopped with an electrical safety device. In this case, the counterweight or the empty car must be prevented from reaching the dangerous position [11].

-The main switch of the elevator power circuit and the circuits connected to it, the cabin lighting circuit, and the electrical installation rules applied to the circuits connected to it should also be applied to the well lighting and the circuits connected to it. With these measures, it is aimed to reduce the risks that may arise from electrical hazards.

Fire extinguishing systems should only work when the elevator is stopped the elevator electrical supply and lighting equipment are turned off, and the automatic fire and smoke detection system is turned off [11].

- Emergency doors may be used when the horizontal distance between two consecutive cars does not exceed 1 m. Each cabin must have means of determining the cabin position that allows the rescued persons to be brought to the level of the rescue ground. Emergency doors must be at least 1.8 m high and 0.4 m wide [11].

In addition to these, the suitability of the well wall, the use of laminated glass on the well wall, the protrusions on the well wall, the guide rails, the fasteners, the safety area at the top of the pit, the pit ladder, the pit emergency stop device, the inspection control station, the bypass device, the cabin and the regulations regarding landing doors, overspeed regulator suitable for the cabin and interior lighting are explained in the same standard.

## **Periodic Control Method of Elevators**

In the periodic inspection of elevators installed before 15/8/2004, TS EN 81-80 standard requirements, TS EN 81-1 standard requirements, and 1/9 standard requirements for elevators supplied to the market between 15/8/2004. Also, 1/9/2017 TS EN 81-20 standard requirements are sought for elevators supplied to the market after.

Employee in charge of inspection works are responsible for taking safety measures according to Occupational Health and Safety instructions by protecting the safety of themselves, the environment, and the inspection. Occupational health and safety measures are taken by the elevator installer or its authorized service, which has signed the maintenance contract, while performing fault repair, maintenance-repair, and periodical control operations. These measures are taken in accordance with the Occupational Health and Safety Law dated 20/6/2012 and numbered 6331 and the provisions of the relevant legislation.

#### **RESULTS AND DISCUSSION**

# Periodic Control Results of Elevators in Çorum

All periodical control results of the elevators in Çorum in 2017, 2018 and 2019, including the preregistration periodical controls, are examined. As a result of the controls, the results were expressed graphically according to the label colors attached to the elevators.



Figure 1. 2017 elevator periodic control results

In 2017, a total of 3017 elevators were periodically checked, including periodic checks before registration. As a result of the controls, red labels were attached to 2365 elevators, yellow labels to 347 elevators, blue labels to 176 elevators and green labels to 129 elevators. According to these results, only 10% of the elevators inspected could pass the inspection as slightly defective or flawless.



Figure 2. 2018 elevator periodic control results

In 2018, a total of 3557 elevators were periodically checked, including periodic checks before registration. The reason for the increase in the number of elevators inspected compared to the previous year is the addition of the periodical checks of the newly built elevators to the number of pre-registration checks and the existing elevators that have been newly detected. As a result of the controls, red labels were attached to 2114 elevators, yellow labels to 232 elevators, blue labels to 1053 elevators, and green labels to 158 elevators. According to these results, 34% of the elevators were directly inspected as slightly defective or flawless.



Figure 3. 2019 elevator periodic control results

In 2019, a total of 3990 elevators were periodically checked, including periodic checks before registration. As a result of the controls, red labels were attached to 2244 lifts, yellow labels to 734 lifts, blue labels to 766 lifts, and green labels to 246 lifts. The rate of elevators that passed the inspection as slightly defective or faultless was 25%. Compared to the previous year, it is noteworthy that the rate of elevators that were directly examined as slightly defective has decreased and the rate of defective elevators has increased. It can be said that the color changes made in the elevator control list by the Ministry of Industry in 2018 caused this result, albeit partially.

While the number of elevators controlled in line with the data obtained from the inspection institution increases every year, it is seen that the

rate of red labels received by the elevators has decreased. When the control reports are examined in detail, rather than the labels received by the elevators during the periodic controls, it is seen that the total number of nonconformities written has decreased considerably in the following years. In other words, while too many serious faults or defects are written on an elevator that was given a red label in the first years of the inspections, fewer faults or serious defects are written in the recent inspections. There are also elevators that have been given a red label for only one serious defect. This situation also shows the false perception of people that the elevator given a red label has a lot of shortcomings, and the elevator that is given a yellow label has few shortcomings.

#### Explanations about the shortcomings encountered:

The inspection hatch at the top of the elevator shaft must be smaller than  $50 \times 50$ . Situations such as being larger than these dimensions and not having a cabin or counterweight buffer have been encountered. There are also cases where the bumper in question is deformed.

There is a second safety system in the floor door locks that prevents the elevator from moving even when the plug contact connection is provided. In the examinations, it was observed that the second safety device did not work, especially in the first years.

Regulator system; It consists of many components such as lower pulley, rope extension contact, rope-cab connection, upper pulley, and contact. In the controls made, it was encountered that the elevator rated speed and the regulator operating speed were different when they should have been the same. There are situations where the rope throw safety contact and the regulator contact are not suitable or do not work.

One of the defects encountered is that the breakers that will stop the engine before contacting the bumpers when the elevator exceeds the level of the lowest or the top floor are not suitable.



Picture 1. Deformed rope and worn pulley

There are cases where the suspension ropes are deformed, there is excessive lubrication, and there are missing nuts, gupilya, and terminal blocks in the cabinet and counterweight connections. There have been cases where the on-board maintenance control did not work, there were no direction signs, the stop and revision buttons were not protected against accidental operation, and the revision limit breakers did not work. The most common deficiency in 2017 is the unsuitability of the cabin skirt sheets. Even if there is no skirt sheet, it is considered as a serious defect if it does not comply with the standards.

Since 200 lux lighting is required in front of the floor level and control, electrical panels, the engine rooms seem to be bright, but the measurements made with the device could not provide sufficient lighting intensity. Situations were encountered when the rescue instruction label was not prepared in accordance with the standard of the lift and it was requested to attach the appropriate label. In order for the person staying in the elevator to be rescued easily, there are cases where there are no direction signs on the flywheel indicating the direction of movement of the car, they are wrong or there are no rope floor markings.

In case there is no one of the 3 phases required for the elevator motor to work or the phases are reversed, the elevator should not move in the opposite direction of the desired direction. In this case, it has been encountered that the required phase sequence protection relay is not available or does not work.

In cases where the cabin load exceeds 10%, the door must be opened by giving an audible and visual warning and an overload warning in the cabin and the elevator must not move. During the inspections, elevators that did not meet this requirement were observed. It has been determined that some elevators do not have the necessary guardrail for the personnel on the car to work safely.



Picture 2. Absence of guardrail on the cabin and maintenance control

When the elevator exceeds 115% of its rated speed, it has been encountered that the brake system that activates and locks the car to the rails does not work or is not in accordance with the standard. In particular, while the sudden braking safety device should be used in elevators with a maximum speed of 0.8 m/s, there have been cases where it is used in elevators with a speed of 1 m/s.

It has been encountered that the elevator safety circuits (stop, inner door, outer door) are not protected against electric shocks with a 30 mA residual current relay or the residual current relay is canceled by shunting.

It is requested in elevators after 2012 that the system to prevent the car from moving unintentionally during loading and unloading while waiting at the stop with the elevator door open should not work. It has been seen that this system does not exist, is broken, or has been canceled.

Emergency lighting, alarm, and communication in the cabin are fed by a 12V dry battery on the cabin so that it can be activated when the elevator electricity is cut off. Since the life of these used batteries is short, they are included in the inspection reports every year as a defect.

There have been cases where the mounting bolts of the drive machine's machine stand are mounted in reverse, the brake lever does not or does not work, and the brake adjustment is not appropriate.



Picture 3. Worn pulley and lack of rope tension adjustment

There are cases where there is no 30 mA residual current relay in the electrical panel, it is canceled by shunting, 300 mA is used instead of a 30 mA residual current relay, and the lighting circuits are not protected by a residual current relay.

#### **Elevator Accident Examples**

Two hijacked planes on September 11, 2020, crashed into the twin towers of the World Trade Center, causing serious damage to the elevator system, which has a total of 198 elevators. An estimated 200 to 400 people died in the express elevators leading to the 78th-floor sky lobbies or in the elevators near the upper floors. At least 21 people were stranded and managed to escape. 80 people survived because the doors were open [16].

In the elevator accident that took place in Wuhan, China in 2012, 19 people lost their lives in the elevator falling from 100 meters at a construction site [17].

At a construction site in Istanbul, an elevator descending to 32 floors caused the death of ten people [18].

Our country, which ranks first in the world and Europe in sectors such as mining and construction, unfortunately, ranks first among European countries in elevator accidents. 70% of fatal elevator accidents in Europe are experienced in our country. In our country, where an average of 200 accidents are detected annually, 20% of the accidents result in loss of life [19].

## CONCLUSION

It is necessary to take precautions against the foreseen dangers and possible consequences related to these hazards during the periodic checks of the elevator and to avoid behaviors that may lead to work accidents. In addition, before the observation, the maintenance staff should be given protective materials such as helmets, work clothes, safety belts, dust masks, earplugs, protective glasses, steel-toed shoes, and gloves. With the Regulation on the Amendment of the Elevator Maintenance and Operation Regulation published in the Official Gazette dated November 5, 2011 and numbered 28106, the annual controls of elevators after January 1, 2012; As of the date of the elevator's release to the market, at the end of the first year, and then at least once a year, it is required that the building be made by the A-type inspection institutions by the local administration [20].

Inspection of newly assembled elevators every year has been effective in preventing the elevator company from dismantling parts after installation. It is also obligatory to guarantee 3 years for newly installed elevators. The use of the elevator, which is marked as unsafe by getting a red label, is stopped by the building supervisor. The building supervisor will make the elevator safe within a maximum of sixty days. At the end of the period, the A-type inspection organization carries out a follow-up control, and the elevator that is not secured is sealed by the relevant administration. So the elevator is out of use [21].

According to this statement in the Elevator Periodic Control Regulation, Çorum Municipality has sealed the structures that have passed sixty days and still have not received a blue or green label. Elevators that have been banned from service can only be opened by obtaining the signature of the building manager stating that the deficiencies will be corrected within ninety days with the "Reseal Unseal Report". It is an expected result that this sanction will increase the rates of blue and green labels received by elevators.

When the 2017 and 2019 inspection reports are compared; It can be said that the objections and expenses made in the first years of the elevator controls decreased over time. There are elevators that are regularly maintained and whose deficiencies are corrected, as well as elevators that are poorly maintained, do not have a maintenance company, and are operated despite significant defects. Considering the qualified and regularly maintained elevators, the inspections may seem unnecessary. With the inspections made once a year, the control of the buildings without a maintenance contract cannot be done and these structures are forced to sign a maintenance contract. Even though regular monthly maintenance is carried out, the quality of the maintenance may be insufficient since the results of the studies are not inspected. In addition, deficiencies arising from the caregiver are also revealed in the examinations made every year.

Even if the deficiencies in the elevators are reported by the maintenance companies, there are also cases where they are pushed into the background by some managers due to financial difficulties. This causes the elevator to operate in an unsafe manner. With annual inspections, this situation also disappears. During the inspections, it was observed that there were elevator operators who changed parts unnecessarily to earn money, although there was no problem with the elevator part. For example, although there is no problem with the suspension ropes or the drive pulley, there have been cases where the elevator operator wanted to make unnecessary changes by convincing the manager.

As can be seen, elevator inspections are necessary in many ways and enable users to use elevators safely.

The elevator is a complex product that combines many materials with its ever-changing technological structure and its importance is increasing day by day. It is not possible to inspect and control the elevator without knowing it. Vocational high schools and schools that deal with the issue of elevators at the academic level are almost nonexistent in Turkey. Apart from minor efforts based on Vocational High School, the subject has been neglected [22].

Maintenance fees are objected to in all types of buildings and settlements where elevators are used. Regardless of the structure, location, certificate status of the elevator maintenance company, technical staff qualification, and failure responseability, the choice made only according to the price can affect the performance of the elevator [23].

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