The Elementary Analysis of Safety Protection Function of Mine Elevator

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ABSTRACT: This paper systematically describes the importance of safety protection function of mine elevator which is used in special and complex occasion. Generally speaking, the safety protection function of mine elevator consists of two parts, mechanical safety protection device and electrical safety protection device. Mechanical safety protection device is mainly composed by the governor and safety gear, bumpers, brakes, landing door locks and car door electrical interlock, door safety devices, top safety window, protective railings, apron. While electrical safety protection is composed by direct electric shock protection, indirect shock protection, electrical fault protection, electrical safety devices. In order to reliably accomplish the action, the coordinate of electrical safety devices and interlocks devices are required for some mechanical electrical safety devices. This paper briefly describes each function of the device and its requirements.

Keywords: Mine Elevator, Safety Protection, Design, Research

CLC: TB126 WM: B

0 Introduction

In recent years, with the rapid progress of China's industrial modernization, the demand for mineral raw materials expands continuously. As a special elevator lifting equipment with high mechanical and electrical integration products, the mine elevator has already stepped into the mining area. In addition, the world's mineral industry speeds up to transfer towards developing countries, especially China. Mine elevator, as one kind of lifting equipment mining machines, which is used to deal with patio personnel, materials and some small equipment in the beginning, now is used to convey ore fines in the bottom of the well and some large equipment. However, the serious lag contradiction of our professional safety protection research on mine elevator is also increasingly prominent.

We analyze, absorb and recreate the mine elevator technology dominated by only a few developed countries in the world. Based on the technology research and design work of the mine elevator products, we introduce safety function design of the mine elevator.
1 The Importance of the Mine Elevator Safety Protection

Elevator, as the vertical lift transport in high-rise buildings in the land, its safety and reliability always attract the attention of the public. The history of the lifting equipment can be dated back to the invention of ancient China, LULU. In 1831, in the World Expo in London, the British engineer Fordarneil invented mine safety elevator, successfully resolved the problem of the car automatic hover when the cable breaking. Until 1889, DaNast Hall in New York is equipped with the first electric elevator manufactured by Otis in America. Its DC motor drives the rod reel with worm gear reducer, suspends and lifts car by the winding rope. It is the prototype of the modern elevator and is widely regarded as the birth of the modern elevator.

With the rapid development of elevator technology, international standards, national standards, industry standards and enterprise standards of elevator have been continuously improved, elevator safety can be guaranteed institutionally. Meanwhile, with the rapid development of mining machinery industry, domestic and international protection for the mine elevator safety research has become relatively backward. In addition, every country is facing different regulatory situation against mine safety management of mine elevator. In our country we haven’t the formed a unified product standards and regulations, most of the current the mine elevator refers to office buildings or residential district (civil). Therefore, it is of great reality and necessity in mine elevator safety research.

2 The Safety Protection Division of Mine Elevator

Mine elevator is a kind of mine lifting equipment. With regards to the safety, the whole process, that is, the initial product design, product reliability test for detection, manufacturing, the on-site installation and commissioning and after-sales maintenance, cannot be short. However, owing to the lack of the mine elevator product standards and testing regulations, and the ignorance of the mine elevator installation, maintenance and use for most mining companies, it strengthens the importance of mine elevator safety. Otherwise, it is fairly difficult to avoid the risk of personal and property damage during the decades running in the complex well environment.

The safety protection of mine elevator can be divided into two types by protection object, personal safety protection elevator and device safety protection elevator. Personal safety protection elevator mainly refers to a series of protective measures that taken to prevent the elevator user, maintenance personnel, equipment personnel around from damaging. Device safety protection elevator mainly refers to a series of protective measures that taken to prevent the elevator itself, goods in transportation, mines that installing the elevator from damaging. We can classify the elevator into mechanical safety protection and electrical safety protection according to design forms. On the basis of the safety importance, the elevator can be divided into general safety measures elevator and necessary safety measures elevator.
The necessary safety measures for an elevator vary according to the type of elevator, such as passenger elevators, freight elevators, lifts, elevators, and other simple elevators, and the safety requirements are also different. The necessary safety measures for an elevator refer to essential safety measures that must be set in the elevator. Without these safety measures, the elevator cannot be tested as a qualified product, and it is more likely to cause casualties and property losses once an accident happens in such elevators without safety measures.

3 The Safety Device Measures of Mine Elevator

3.1 The Protection of Speeding and Rope-Broken

Elevator over-speed protection systems, which mainly consist of the governor, safety gear, governor tension pulley, steel wire ropes, safety gear transport mechanism, electrical safety switches and other components, are the most important security measures for mine elevators. The principle is that once the elevator is speeding or all of the steel wire ropes break down, the governor will cut off the power, then trigger the safety gear’s action through steel wire ropes of the governor to force the elevator car to brake and more and more tighter in the direction of its movement and finally firmly stuck in the running rail. According to the elevator car’s endurance for the weight of people and goods and reliability of operation, the relevant standards for safe distance of safety gear’s process from rigger to stop are clearly defined. And National Mine Safety Standard Center has product certification, type testing reports and so on for selected components. Considering the special requirements of mine environment, all of the configured security components have metal surface corrosion treatment to prevent the damage to elevator and mine from falling events. At the same time, this content is also clearly defined in the mine-elevator standards drafted by my company.

3.2 The Protection for Over-Travel

It’s necessary to set protection device in order to prevent serious consequences and structural damage when the elevator runs beyond the top or the bottom because of the failure of control. The protection device to avoid over-travel is generally made in the forcing-change-speed switch that is near the up-and-down station, limit switches, extreme switches.

3.3 The Protection for Pit-Cushion

There is a bumper in the hoistway pit. When there is a distance between bumper and elevator car, the distance between Counterweight’s hit-plate and bumper’s surface will be 150~400mm for energy-type bumper and 200~350mm for energy-storage bumper. And two groups of bumper devices are settled, Counterweight bumper and car bumper. It mainly aims at solving
the problem caused by the hit from run-stalling car to the bottom. In addition, to eliminate water pooled in the elevator pit, pumps can be set in the lower part of the pit when there is too much underground water.

3.4 Electrical Safety Devices

Security measures for mine elevator electrical installations and lines should be taken to avoid electric shock and equipment damage accidents. According to the requirements of GB7588-1995, elevators should take the following electrical safety protection measures.

(1) The Protection of Direct Electric Shock. Insulation is a basic measure to prevent direct electric shock and electrical shorts.

(2) The Protection of Indirect Contact. Indirect contact means that normal contact won’t be shocked but it will get electrified when the equipment is running abnormally and human contact with exposed conductive parts, such as metal, metal conduit, trunking and so on. In the power supply system of neutral point directly grounded, the most common protection measure from indirect contact is to connect the exposed conductive parts of electrical equipment that will be energized when there is a failure to power transformer neutral point electrically.

(3) Electrical Safety Devices. The device for loss of voltage protection is to protect it when the elevator suddenly appeared in motion no voltage or low voltage. The device for short circuit protection is to protect it when short circuit occurs in the elevator circuit or live conductors with metal.

The device for overload protection is to protect it when the elevator overloads after a certain time. The device for phase sequence and phase failure protection is to protect the elevator when the three-phase power supply elevators appear reversed phase sequence and phase failure. There are electric locks for floor door, car door, every elevator car door and landing door stations are equipped with electrical interlock upside. It’s only when the car doors and all of doors from all layers closed, and all of electrical interlocks turned on, the elevator can run. This can avoid passengers-cut and drop-fall accidents when the door is not closed or not closed tightly.

Forced Conversion Speed Switch, which is the first safeguard to prevent from over-travel, is generally set after normal speed switch of the end station. Once the switch strikes, the car begins to operate in low speed.

Limited Switch, which is the second safeguard to prevent from over-travel: When the car does not stop at the end of the station and hit Limited Switch, Limited Switch immediately cuts off
the direction of the control circuit and makes the elevator stop running. Elevator can run in the safe direction all the same.

Extreme Switch, which is the second safeguard to prevent from over-travel: If the elevator cannot stop running after Limited Switch works, then the elevator hits Extreme Switch to make the drive host and brakes out of power and stops. Only after adjustment from professionals, the elevator can resume operating in normal way.

Overload Protection Device: If the car load exceeds the ratings, the elevator cannot run.

Governor Cutting Off Rope Protection Safety Switch: When the rope of governor is loose or broken, it can open the safety switch and cut off the safety loop power supply, so that the elevator cannot run.

Emergency Stop Button: The operation boxes, car top, pit of the elevator are equipped with self-locking emergency stop button. When we press the button we can cut off the control power. And the elevator cannot run.

Car Automatic Door Anti-pinch Device: When the elevator is closing automatically, if someone hits the safety edges (or photoelectric switches) which are installed on both sides of the car door, the switch starts and the door open again. It can stop persons or things from being clamped.

Safety Window and Safety Door Switch: As long as the Safety Window or Safety Door opens, security loop power supply is cut off so that the elevator cannot run. It aims to avoid accidents when Safety Window or Safety Door open and result into the sudden starting of the elevator[1].

3.5 Sonar Alarms and Rescue Device

When someone is trapped in the elevator car, the alarm or communication device should be able to timely notify the management staff and safely rescue the person from the car through rescue device.

(1)Alarm Device: Elevator must install emergency lighting and alarm devices, which are charged by emergency power.

(2) Rescue Device: When trapped in elevator car, commonly people have rescue by themselves, meaning that the manipulation of personnel within the capsules should climb up to top security window and open layer door. With the development of the elevator, elevators without operator controls are widespread used, self-help approach is not only very dangerous but also impossible. So nowadays elevators are definitely designed to be rescued from
Rescue device includes tractor emergency manual operation device (loose brake wrench) and manual unlocking device (copper triangular key) used for mine ingate (layer door) [2].

3.6 Stopping-Switch and Maintenance-Operation Equipment

Stopping-Switch is commonly known as emergency-stopping switch, it's required to install stopping-switch in the car top, pit stop switch and the engine room. The bottom of the mine are mostly perennial water, the requirements for running stopping-switch and overhaul devices are particularly high, so we generally use nylon waterproof housing for easy inspection and maintenance. The operational status setting is controlled by overhaul running gear installed in the car roof or elsewhere.

4 Conclusions

This paper makes an analysis on mechanical safety protection device and electrical safety protection device, describes the overall design of the mine elevator, and depicts design focus and concrete realization of each function component of the mine elevator in the underground well environment in detail. After we finish installing the elevator and doing some experiments, we make a conclusion that the elevator meets the demands of GB/T7588-2003 elevator safety elevator manufacturing and installation specifications and LHEC joint mine elevator technology standard requirements, achieves the practicality in mine equipment, and makes contributions to other similar mine elevator in the design and development.

Reference:

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