Study on Counterweight Structure with Buffer Device

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Abstract. At present, a buffer device is installed at the bottom of the elevator shaft to buffer the falling counterweight. When the elevator hits the buffer, the buffer absorbs or consumes the kinetic energy and potential energy of the elevator, so as to make the elevator or counterweight slow down safely until it stops. The corresponding counterweight is fixedly installed at the bottom of the elevator shaft. However, the counterweight installed at the bottom of the elevator shaft has certain disadvantages. In order to overcome the defects of the above existing technology, a counterweight structure with buffer device is studied in this paper. Compared with the prior art, the structure has the advantages of reducing construction time, high safety, simple structure, etc., and has universal popularization significance.

1. Introduction
The buffer is the last protective device in the elevator pit. When the elevator hits the buffer, the buffer absorbs or consumes the kinetic energy and potential energy of the elevator, so as to make the elevator or counterweight slow down safely until it stops [1]. Generally, the buffer is set in the pit, and some elevators are set at the top of the car or the bottom of the counterweight [2]. It is installed in the hoistway pit of the elevator, directly below the car and counterweight. When the elevator goes beyond the bottom or top floor of the terminal landing due to wire rope fracture, traction friction, insufficient holding brake braking force or control system failure during upward or downward movement, the buffer will act as a buffer to prevent the elevator car or counterweight from directly hitting the bottom or roof and protect the safety of passengers and equipment [3]. However, the counterweight installed at the bottom of the elevator shaft has certain disadvantages. First, it needs to be installed separately; Second, it is necessary to ensure that the car or counterweight can fall directly above the buffer device when it falls rapidly [4]. Therefore, there are high requirements for the installation of buffer devices. At present, buffer devices need to be installed separately, which increases the construction time and is inconvenient to use. In order to overcome the defects of the above existing technology, a counterweight structure with buffer device is studied in this paper [5]. Compared with the prior art, the structure has the advantages of reducing construction time, high safety, simple structure, etc., and has universal popularization significance.

2. Technical scheme of counterweight structure with buffer device
The purpose of this paper is to provide a counterweight structure with buffer device in order to overcome the defects of the above existing technology. It can be realized through the following technical scheme:

The utility model relates to a counterweight structure with a buffer device, which comprises a counterweight frame, a counterweight block group arranged in the counterweight frame and a buffer
device installed at the bottom of the counterweight frame. The counterweight frame is composed of two counterweight longitudinal beams vertically arranged on the left and right, a counterweight top beam and a counterweight bottom beam. The buffer device comprises an intermediate buffer installed in the middle of the counterweight bottom beam and two side buffers installed at the bottom of the left and right sides of the counterweight bottom beam. The lower end of the telescopic rod of the intermediate buffer is provided with a buffer head, and the outer sleeve of the telescopic rod is provided with an articulated sleeve, which is hinged with the telescopic heads of the two side buffers.

The counterweight group comprises a plurality of counterweight blocks stacked in the counterweight frame, and the center of the counterweight block at the bottom of the counterweight group is provided with a counterweight through hole for inserting the tail of the intermediate buffer.

After passing through the mounting hole in the middle of the counterweight bottom beam, the intermediate buffer is fixed at the bottom of the counterweight bottom beam through the buffer nut to play a main bearing role when impacted.

A reinforcing ring is also arranged between the lower surface of the counterweight bottom beam and the buffer nut to cooperate with the buffer nut to increase the impact resistance. The articulated sleeve is clearance matched with the telescopic rod, so that the articulated sleeve can slide up and down outside the telescopic rod.

Both sides of the articulated sleeve are respectively provided with articulated ear plates hinged with the telescopic head of the side buffer, and the tail of the side buffer is installed at the bottom of the left and right sides of the counterweight bottom beam through the articulated seat. A plurality of mounting holes are arranged at equal intervals at the bottom of the left and right sides of the counterweight bottom beam, and the hinged seat adjusts different mounting positions through the mounting holes.

The counterweight top beam is provided with a pulley for installing a steel wire rope. The outer side of each counterweight longitudinal beam is provided with a guide fitting with the counterweight guide rail. At least two guide pieces are arranged.

3. Working principle of counterweight structure with buffer device

In this paper, a counterweight structure with buffer device is designed, as shown in Fig. 1-fig. 3. Description of marks in the figure: 1. Counterweight longitudinal beam, 2. Pulley, 3. Counterweight block, 4. Guide piece, 5. Counterweight bottom beam, 6. Intermediate buffer, 7. Side buffer, 31. Counterweight block through hole, 51. Mounting hole, 52. Stiffening ring, 61. Buffer nut, 62. Telescopic rod, 63. Buffer head, 71. Hinge seat, 8. Hinge sleeve. The structure is described in detail below in combination with the accompanying drawings and specific embodiments.

As shown in Figures 1 and 2, a counterweight structure with buffer device is designed in this paper. The structure includes counterweight frame, counterweight block 3 and buffer device installed at the bottom of counterweight frame. The upper end of the counterweight frame is provided with a pulley 2 for installing the steel wire rope. The counterweight frame includes two vertically placed counterweight longitudinal beams 1. Two counterweight longitudinal beams 1 are used to fix both ends of a plurality of counterweight blocks 3, and at least two guide parts 4 are arranged on the outside of each counterweight longitudinal beam 1 for cooperation with the counterweight guide rail.

The bottom of the two counterweight longitudinal beams 1 is connected with the counterweight bottom beam 5, and the buffer device is installed on the counterweight bottom beam 5. The buffer device includes an intermediate buffer 6 in the middle of the counterweight bottom beam 5 and two side buffers 7 symmetrically arranged on the left and right sides of the intermediate buffer 6. The intermediate buffer 6 and the side buffer 7 can adopt the structure of air cylinder, oil cylinder, damping spring, etc. The outer surface of the intermediate buffer 6 is provided with a buffer nut 61, which is installed at the bottom of the counterweight bottom beam 5. When the intermediate buffer 6 is impacted, the buffer nut 61 acts on the lower surface of the counterweight bottom beam 5 and plays a main bearing role. At the same time, in order to improve the impact resistance of the counterweight bottom beam 5, a reinforcing ring 52 is arranged on the lower surface of the counterweight bottom beam 5 for matching with the buffer nut 61.
As shown in Fig. 3, the upper end of the intermediate buffer 6 is inserted inside the bottom counterweight 3, so the counterweight through holes 31 are arranged in the center of the counterweight 3 at the lower part of the counterweight group. The lower end of the intermediate buffer 6 is provided with an extendable telescopic rod 62, and the outer surface of the telescopic rod 62 is sleeved with an articulated sleeve 8. Both sides of the hinge sleeve 8 are respectively symmetrically provided with hinge ear plates, and the two hinge ear plates are respectively hinged to one end of the side buffer 7. The other end of the side buffer 7 is installed on both sides of the bottom of the counterweight bottom beam 5 through the hinged seat 71, and the bottom of the counterweight bottom beam 5 is equally spaced with two rows of mounting holes 51. By selectively installing the hinge seat 71 in the mounting hole 51, the distance between the hinge sleeve 8 and the bottom of the counterweight bottom beam 5 can be adjusted. A clearance fit relationship is adopted between the articulated sleeve 8 and the telescopic rod 62, and the telescopic rod 62 can slide freely in the articulated sleeve 8.

The bottom of the telescopic rod 62 is provided with a buffer head 63. When the telescopic rod 62 shrinks to a certain extent, the buffer head 63 butts upward against the lower surface of the articulated sleeve 8, so as to realize the support of the side buffer 7 for the buffer head 63.

In the normal state, the telescopic rod 62 is in the extended state, and there is also a certain distance between the articulated sleeve 8 and the buffer head 63. Only when the telescopic rod 62 shrinks to a certain extent, the buffer head 63 will move to the position of the articulated sleeve 8 and the side buffer 7 will play a role. To sum up, the structure integrates the buffer device at the shaft bottom on the counterweight side into the counterweight itself, which can reduce the use of counterweight blocks on the one hand, reduce the installation time of buffer device for on-site construction on the other hand, and improve the efficiency.

![Figure 1. Structural diagram](image1)

![Figure 2. Structural diagram of buffer](image2)
4. Conclusion
This paper studies a counterweight structure with buffer device, including counterweight frame, counterweight block group arranged in counterweight frame and buffer device installed at the bottom of counterweight frame. The counterweight frame is composed of two counterweight longitudinal beams vertically arranged on the left and right, a counterweight top beam and a counterweight bottom beam. The buffer device comprises an intermediate buffer installed in the middle of the counterweight bottom beam and two side buffers installed at the bottom of the left and right sides of the counterweight bottom beam. The lower end of the telescopic rod of the intermediate buffer is provided with a buffer head, and the outer sleeve of the telescopic rod is provided with an articulated sleeve, which is hinged with the telescopic heads of the two side buffers. Compared with the prior art, the structure has the advantages of reduced construction time, high safety, simple structure, etc. Compared with the prior art, the structure has the following advantages:

- The bottom of the counterweight of the structure is equipped with a buffer device, so it is not necessary to install a buffer device separately at the bottom of the elevator shaft, which reduces the construction time. The buffer can be assembled on the production site during counterweight production, and the assembly quality is more guaranteed. Even if the buffer device has been installed in the elevator shaft, the structure can still be used by making the existing buffer device face the buffer head.
- The buffer device of the structure includes an intermediate buffer and a side buffer installed on both sides of the intermediate buffer. Only when the intermediate buffer shrinks to a certain extent, the side buffer will act on the buffer head through the hinged sleeve to avoid the bottom of the buffer device.

References
[1] W, Yane. (2005) Requirements of top spacing of traction elevator on counterweight buffer distance [J]. Hoisting and transportation machinery, 35: 64-67.
[2] H, Changqian., T, Huaping., N, Tuo, et al. (2010) Finite element analysis of contact collision of rubber buffer [J]. Modern manufacturing engineering, 11: 34-35.
[3] X, Qiang. (2010) On the identification of elevator counterweight buffer [J]. Science and technology information, 41: 55-59.
[4] G, Bei. (2016) Determination of permanent signs near elevator counterweight buffer [J]. China elevator, 71: 89-92.
[5] L, Jianhua., W, Hui. (2020) Counterweight buffer for safety elevator: cn211169399u [P]. 2020.