

---

# Improvement of braking device for mine electric locomotive

Zhaosong Li <sup>a</sup>, Yulu Zhang <sup>b</sup>, Qingshuai Kong <sup>c</sup>

School of Mechanical and Electronic Engineering, Shandong University of Science and Technology, Qingdao 266590, China.

<sup>a</sup>1071348034@qq.com, <sup>b</sup>760759123@qq.com, <sup>c</sup>876120103@qq.com

---

## Abstract

In the light of the frequent occurrence of vehicle accidents, long braking distance and easy wear of the brake shoes in the mining electric locomotive, the structure and principle of the existing single side brake system are studied and analyzed. According to the actual working conditions of the mine electric locomotive, a set of bilateral foundation braking device with reasonable structure and reliable performance is designed. The device improves the braking performance of the mining electric locomotive effectively. Meanwhile the braking ratio and braking force are increased, the braking distance is shortened, the wear of the brake shoe is reduced, the condition of vehicle slipping is avoided, and the reliability of the brake is improved.

## Keywords

Mine electric locomotive, Brake rigging, Braking distance.

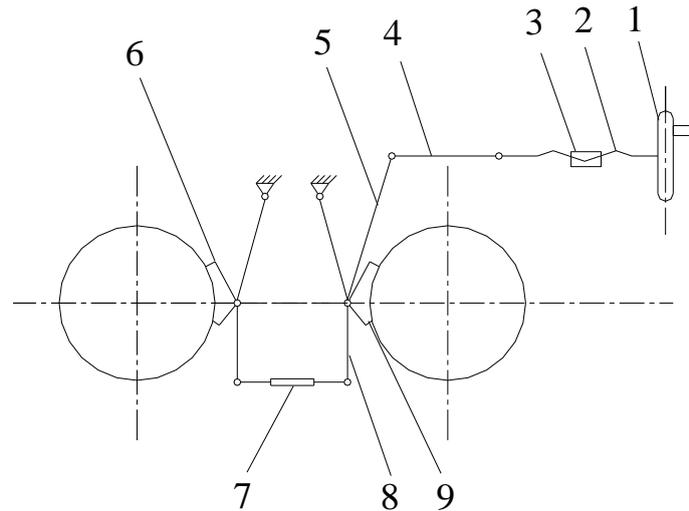
---

## 1. Introduction

The electric locomotive transportation is the main way of mine transportation in our country and it plays an important role in the coal mine production process. Its main function is to undertake the transportation of coal, materials, personnel, equipment and so on under the mine, it has the advantages of large traction force, easy maintenance and convenient operation [1]. With the rapid development of the coal industry, in order to ensure the safety of underground transportation, new requirements for the performance of mine electric locomotive are put forward. However, the current mining electric locomotive has the problems of long braking distance, easy wearing and easy sliding of the brake shoe generally, the transportation efficiency of the electric locomotive is restricted seriously and it also brings hidden danger to the safety of the mine transportation. Therefore, a scientific and rational method is adopted to improve the braking device of the current mining electric locomotive, it has a great significance to solve the problem of the electric locomotive in the braking process effectively.

## 2. Performance analysis of traditional single side base braking device

The structure of the existing single side braking device is shown in figure 1. When the braking mode is arranged on the wheel set, a wheel corresponds to a set of braking devices, so a group of braking devices is also called a set of braking units. As can be seen from figure 1, the brake device drives the pull rod by rotating the brake hand wheel, and the lever is used to press the wheel tread of the brake shoe, and the braking moment is formed by the friction between the brake shoe and the wheel.



1-handwheel, 2-screw, 3-nut, 4-pull rod, 5、 8-brake lever, 6、 9-brake shoe, 7-positive and negative adjusting screw

Fig.1 Single side braking device

The braking device has the advantages of simple structure, small quality, low cost and convenient overhaul. But there are still many deficiencies, mainly in the following aspects:

#### Irrational structure

One single side brake type is also called single side brake shoe type, that is, only one side of the wheel is provided with brake shoes. When the braking device is used for braking, the axle box is forced on one side, and the bearing bush is easy to run off, causing partial wear, at the same time, the pressure on the unit area of the brake shoe is large, and the wear of the brake shoe is large. In this case, on the one hand, the braking temperature will rise sharply, and the braking effect will decrease sharply, on the other hand, local wear is serious due to unbalanced force on the brake shoe, the brake shoe replacement principle is to wear the most serious parts as evaluation criteria, thus causing great waste of resources.

#### Inconvenient operation

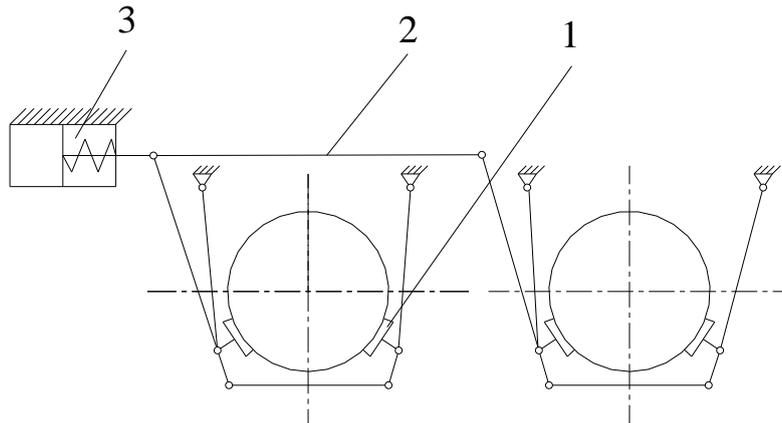
In the braking process of the electric locomotive, the driver needs to turn the brake hand wheel to drive the pull rod to realize the braking and the operation is very difficult. At the same time, the brake relies on the arm force, compared with the pneumatic brake, there exists the problem that the braking force is too small and the reaction is slow, the effective braking of the electric locomotive cannot be realized.

#### The system response speed is slow

Single side braking device is composed of a manual brake drum through the screw pull the brake rod, the brake pressure to the wheel tread. Single side braking device. The normal distance between the brake shoe and the wheel tread is 3~5mm, and the hand wheel must be rotated 3 times to produce braking effect, it takes about 3S, which increases the braking distance. Cannot meet the 《Coal mine safety regulations》 (2008 Edition) 351st stipulates: “Electric locomotive transportation..... The braking distance of the train shall not exceed 40m when transporting materials, and shall not exceed 20m when transporting personnel” [2].

### 3. Improved bilateral brake device

According to the insufficiency of the single side braking device, structural modification is carried out, the reconstructed structural form is shown in figure 2. The main improvements are mainly in the following two aspects:



1-brake shoe, 2-pull rod, 3-cylinder

Fig.2 bilateral brake device

(1)Change the single side braking device mode to bilateral braking. As the traditional brake mechanism uses single side brake, the axle box is forced by one side, causes the bearing deviation, the partial abrasion and so on. By adopting the bilateral braking structure, the shoes on both sides of the brake shoes are more distributed evenly, thereby avoiding a series of problems caused by the deviation of the brake shoes. Secondly, the contact area of the brake shoe on the wheel tread is doubled, and the temperature variation during braking is reduced significantly. Third, increase the number of brake pads, under the same braking force, the braking effect is more obvious.

(2)The hand wheel brake is changed into pneumatic brake, and the pneumatic brake can realize the instantaneous braking of the mining electric locomotive. Compared with the hand wheel brake, the pneumatic brake has the advantages of short braking time and large braking force. Secondly, pneumatic brake is used instead of hand wheel brake, which is more in line with ergonomic requirements [3], reduces the labor intensity of the driver of the electric locomotive effectively and makes the operation more convenient.

#### 4. Comparison of braking performance of two kinds of braking device

The two devices are compared from the following aspects.

Braking rate

$$\gamma = \frac{F_1}{F_2} \tag{1}$$

In the formula:  $F_1$  represents the brake shoe pressure,  $F_2$  represents the cylinder thrust.

(1)Braking ratio

$$\phi = \frac{\sum K}{(P+G)g} \tag{2}$$

In the formula:  $\sum K$  represents the brake shoe total pressure,  $P$  represents the quality of electric locomotive,  $G$  represents the traction load of electric locomotive, represents the gravitational acceleration.

Braking force

$$F_b = \sum(k\phi_j) \tag{3}$$

In the formula:  $\phi$  represents friction coefficient.

Braking distance

$$S_{mn} = S_m + S_n = \frac{v_0 t_k}{3.6} + \sum_{n=1}^E \frac{4.17(v_n^2 - v_{n+1}^2)}{F_b + \omega_0 + i_j} \tag{4}$$

In the formula:  $n$  represents the serial number of the speed section,  $E$  represents the total speed section number,  $v_n$  represents the Initial speed at each speed interval,  $v_{n+1}$  represents the end velocity of each velocity interval,  $F_b$  represents the braking force under unit mass of

train,  $w_0$  represents the basic unit resistance of train unit,  $i_j$  represents the braking lot line slope thousands of points, uphill take positive, downhill take negative.

The technical parameters and design features of the two braking devices are shown in Table 1.

Table 1 Contrast of two kinds of brake devices

Project	Single side braking device	Bilateral brake device
Braking rate	7	8
Braking efficiency	0.85	0.85
Brake shoe pressure per wheel	65.5	74.8
Braking ratio	107	122
Braking force	56	64
Braking distance	19.3	18.5
Quality	88	180
Structural advantages	It has the advantages of simple structure, small quality, low cost and convenient overhaul	The phenomenon of eccentric wear of bearings is eliminated, the braking force is increased, and the braking distance is shortened.
Structural defects	When the braking force on one side, the axle box is in poor state of force and Easy to make bearings eccentric wear.	The structure is complex, the quality is big, the cost is higher, and the overhaul is difficult

## 5. Conclusion

In view of the present braking situation of mine electric locomotive, the existing braking device is improved. Bilateral brake device is designed, which makes the braking performance of the mine electric locomotive improved remarkably, the braking distance is shortened greatly, and the consumption of the brake chip is reduced obviously. In addition, the hand wheel brake is changed into pneumatic brake reduces the braking time and increases the braking force effectively. The improved braking device improves the safety and reliability of the electric locomotive operation. Therefore, the design idea of the braking device is correct and has certain engineering significance.

## References

- [1] L. Lu, K.R. Bi, E.L Zhang, et al. Analysis and optimization of calculation parameters for electric locomotive transportation in coal mine, *Coal Technology*, 2005, 24(5):43-45.
- [2] J.K Zhou, G.L Bai, et al. Analysis of calculation parameters of electric locomotive transportation in coal mine, *Automation Technology and Application*, 2001(3):35-37.
- [3] J.L Yuan, J.Z Li. Discussion on braking process of coal mine electric locomotive based on ergonomics, *Coal Engineering*, 2011, 1(2):109-110.