Analysis and Research on Poor Shunting of Track Circuits in High-speed Railway Stations Based on Computer Technology

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Abstract. Poor shunting of track circuit in high-speed railway station is a common problem, which has puzzled the traffic and electrical departments for many years. 25 Hz phase sensitive track circuit is the main part of electrified section in the station, while 480 track circuit is the main part of non electrified section. At present, the inspection of train occupation caused by the poor shunting of track circuit in high-speed railway station has become a major safety problem. Through continuous statistics and analysis, circuit experts have analyzed the causes of poor shunting of internal track circuit. Through the continuous research on the bad track circuit shunting, the high-speed railway has taken some measures to reduce the bad condition of the entry, such as adjusting the transmission voltage of the existing track circuit or using the electronic high-voltage pulse track circuit. However, we have yet to find a safe, reliable and economic programme. Therefore, this paper first uses computer technology to analyse the principle of bad circuit shunt. Then, this paper lists some classifications. Finally, this paper puts forward some solutions.

Keywords: Track in High Speed Railway Station, Bad Circuit Shunt, Solutions, Computer Technology

1. Introduction
Poor shunting is a common technical problem attached to high-speed rail circuit, which is the most important technical equipment of China's high-speed rail. Poor shunting will result in inevitable technical defects of high-speed rail circuit, which will exist for a long time[1-2]. Therefore, the poor shunting of high-speed rail in China has become the main problem, which is caused by many factors, such as rail surface rust, rail area pollution, wheel pair rust, the impact of changing track and switch, improper adjustment of track circuit parameters, back flow interference in Electrification Section, etc[3-4]. According to statistics, the poor shunting of high-speed rail in China is mainly caused by oxide rust layer or insulating layer, which accounts for 92.7% of the reasons. The direct reason for the occurrence of oxide rust on the rail is that there are few vehicles. The main reason for the track in the station is that there is a bad conductive layer on the rail surface, which will affect the contact resistance between the wheel set and the rail, and eventually lead to the abnormal resistance. When the train is occupied, the track circuit cannot form an electrical short circuit, which will not achieve the
function of train occupation inspection. Therefore, there will be many kinds of faults in high-speed railway, such as wrong unlocking in advance, switch switching in the middle, resulting in the accident of switch extrusion and disconnection. When the rear of the train is not clear, there will also be a wrong indication that the turnout section is idle, which will cause side conflict accident.\[5-7\]

2. Causes of poor shunting of track circuit
There are four main causes for poor shunting of track circuit, as shown in figure 1.

![Figure 1. Causes of poor shunting of track circuit](image)

2.1. Shunting resistance of train
When the train (vehicle) is rolling on the track, the resistance acting on the two rails is the sum of the shunt resistance, the resistance of the locomotive wheel set itself, and the contact resistance between the wheel set and the rail. When the shunt resistance is less than the standard shunt resistance, the track circuit will rely on shunt. Therefore, the shunt resistance will be greater than the standard shunt resistance, which will lead to poor shunt.

2.2. Rust on rail surface
Rail is an important part of track circuit, and high-speed rail shunting is realized by rail. However, in the open air, the rail will naturally rust due to wind and rain erosion, which will form an oxide layer. However, when the train is shunted, the oxide layer will separate the wheel set from the rail surface, which will increase the contact resistance. As a result, the shunting is not good.

2.3. Dust pollution
In the production process of the enterprise, the enterprise will produce a large number of dust, which will be scattered on the rail surface or locomotive wheel. As the rusty oxide layer, the contact resistance between the wheel and the rail surface increases when the train (vehicle) is shunted, and the track circuit is shunted poorly.

2.4. Traffic volume
There will be friction between the train and the rail when entering and leaving the station. In the process of friction, the train will remove the rust and pollution on the rail surface. Therefore, the degree of eliminating rust and pollution depends on the size of traffic flow and speed. When the traffic flow is large and the speed is high, the high-speed railway can effectively remove the rust and pollution on the rail surface.
3. Principle analysis of bad circuit entry

3.1. Constant pressure breakdown test of Bad Shunting section

This test is carried out for the section with poor circuit shunting, and the test is as follows. The voltage changes before and after the train shunting are classified. If it is less than 5 V, the shunting residual voltage will be low; if it is more than 5 V, the shunting residual voltage will be high; if there is little change, the shunting will not respond. Through the breakdown voltage of the poor conductive layer, the rail surface acting pressure will be affected. We can apply a constant pressure of 24.5KN to the rail surface, as shown in Figure 2.

![Figure 2. Rail surface simulation](image)

We keep raising the voltage. When the voltage increases to a certain value, the electrical characteristics of the poor conductive layer will change, and the current will increase sharply. By continuously recording the voltage values at both ends of the dielectric layer and the standard sampling resistance, we can get the characteristic curve of the dielectric layer. The principle of the test circuit is shown in Figure 3.

![Figure 3. Principle of test circuit](image)

3.2. Main technical indicators

The oxide film has breakdown characteristics. When the voltage is in a certain range, the rail current is very small, but the corresponding ratio of voltage and current is large. When the voltage exceeds this range, the current will suddenly increase. When breakdown occurs, the current will continue to increase. Therefore, the slope of the coordinate curve slows down and the resistance decreases. For the bad conducting medium, the voltage does not break down suddenly. However, when the current continues to increase, the resistance will decrease. In this paper, the relationship between voltage and current is obtained, as shown in Figure 4. Then we get the relationship between current and resistance, as shown in Figure 5.
Figure 4. Voltage vs. current diagram

Figure 5. Current versus resistance

4. Comparison of existing solutions for Bad Shunting

The comparison of existing solutions for poor shunting is shown in Table 1.

| Scheme name                                      | Technical route                                           | Project cost |
|-------------------------------------------------|-----------------------------------------------------------|--------------|
| Track circuit intelligent monitoring box         | Improve the return coefficient of track relay in track circuit | low          |
| 3V track circuit                                | Increase the rail surface voltage and use high voltage moderate |
| High voltage asymmetric pulse                   | Using the instantaneous power of high voltage pulse signal to break down the bad conductive layer moderate |
| Combination of axle counter and track circuit   | Train wheel counting based on electromagnetic induction principle high |

5. Conclusion

Through the use of computer technology analysis, we can draw the following conclusions: under special regional and seasonal conditions, we should take different ways to deal with the bad shunting of track circuit, which will strengthen the implementation and confirmation of safety precautions. Through effective prevention, we can reduce the impact of Bad Shunting of track circuit. We should correctly analyze the cause of the fault, which will accurately find and handle the fault point. By properly handling such faults, we can reduce the safety impact of such faults.

References

[1] He Guiyang, Hua Zexi. Analysis of solutions for Bad Shunting of track circuit[J]. Railway computer application, 2012, 21 (1): 46-48.
[2] Zhang Fuchun, Zhao Dexin. Reducing bad shunting section of 25 Hz phase sensitive track circuit[J]. Railway communication signal, 2008, 44 (11): 52-53.
[3] Li Xiaobing. Countermeasures and management measures for Bad Shunting under TBTC[J]. Railway communication and signal engineering technology, 2008, 5 (4): 41-43.
[4] Li Wenzhou. Analysis of the idle red light band of track circuit[J]. Mu Yisu technology, 2011, 27 (23): 62-63.
[5] Hu Yongsheng. Study on the treatment scheme of Bad Shunting of track circuit[J]. Railway communication signal, 2008, 44 (5): 24-26.
[6] Zhao Jie, Qiu Bo, Diao Guangwei, et al. Discussion on solutions to poor shunting of track circuit[J]. Railway communication signal, 2010, 46 (5): 50-51.
[7] Qin Qingsen, Gu Hai. Discussion on the realization of safe driving in case of Bad Shunting of track circuit[J]. Railway transportation and economy, 2008, 30 (6): 33-34.