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Education Researching on Safety of High-Speed Railway Trains Under Earthquakes

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Abstract

Currently, people lack understanding of the methods and measures for earthquake resistance and disaster reduction in railways when faced with earthquake disasters, especially for a systemic education view. With the advancement of construction technology and science and technology, the safety of railways under earthquake effects has been further ensured. Based on the safety of railways under earthquake effects, this paper aims to introduce the safety prevention of high-speed railway trains on the view of education.

Keywords: education research, earthquake hazard, high-speed railway, teaching reform

1. Introduction

When it comes to earthquakes, people often think of post-earthquake disaster phenomena, such as collapsed buildings, shattered debris, and terrifying fissures. However, people often overlook the connection between earthquakes and railways. In fact, earthquake resistance and seismic mitigation are crucial in ensuring unimpeded railway transportation. After experiencing an earthquake, people start questioning the safety of railways. However, in reality, railways can remain stable and intact during earthquakes through the use of seismic isolation devices, precise design and reinforcement measures, and earthquake early warning systems (Lizhong Jiang, Wangbao Zhou, Biao Wei, et al, 2020; Lingkun Chen, 2012). These measures mitigate or prevent the adverse effects of earthquakes on railways, ensuring the personal safety of railway passengers. Railways are a bright symbol of our country, and we believe that with the rapid advancement of science and technology, the "steel backbone" responsible for safeguarding people's lives and property will be endowed with even safer and more efficient intelligent capabilities to undertake more challenging tasks (Hui Wang, 2017; Baorui Hou, 2018).

However, there were almost no existing specific education suggestions have been developed for education on how to handle those above problem. Therefore, this paper focuses on this situation, and presents information on handling the safety problem of high-speed railway trains

under earthquakes.

2. Education Research Background

When earthquakes occur, they have a significant impact on buildings, structures, and all engineering facilities on the ground. The devastating 8.0 magnitude Wenchuan earthquake in 2008 caused destructive damage to local buildings and resulted in tens of thousands of casualties and immense economic losses. Frequent earthquakes and the resulting massive losses urgently require further development in earthquake resistance and disaster reduction. Nowadays, our buildings resist earthquake damage through structural design, node strengthening, and the use of high-performance materials. Additionally, earthquake early warning systems utilize the difference in propagation speeds between transverse and longitudinal seismic waves to provide precious time for people to evacuate buildings and find sheltered open spaces. However, the connection between railways and earthquakes is often overlooked. As of 2022, the total operating mileage of railways in China reached 154,900 kilometers (National Bureau of Statistics data), making railway safety, stability, and unimpeded operation exceptionally important. On January 8, 2022, at 1:45 am, a 6.9 magnitude earthquake occurred in Menyuan County, Haibei Prefecture, Qinghai Province, with a focal depth of 10 kilometers. Due to the earthquake, the Lanzhou-Xinjiang Railway was temporarily suspended. However, even after such a significant seismic disaster, the section of the Lanzhou-Xinjiang Railway affected by the earthquake was inspected and resumed regular train operations at 6:39 am on the same day. After the earthquake, surveyors discovered significant deformation and rupture of the ground near the earthquake epicenter, as well as tunnels measured in meters, while the bridge structure and pier components of the Lanzhou-Xinjiang Railway were not severely damaged. Therefore, how does the railway respond to earthquakes and remain calm in the face of danger? This requires us to explore the three treasures of earthquake resistance in railways.

3. Education on Three Treasure of Earthquake Resistance in Railways

3.1 Seismic Isolation Devices

When traveling by train, you may often see springs installed on the train. These seemingly ordinary springs play a crucial role and are referred to as seismic isolation devices, as shown in Figure 1. As an integral part of railways, seismic isolation devices can absorb and dissipate seismic energy while reducing train vibrations. These devices often take the form of spring structures on trains. When seismic waves from an earthquake are transmitted, these devices deform autonomously, cleverly absorbing and dissipating the energy transmitted by the earthquake, thus buffering and reducing the impact of earthquakes on railways. With the installation of seismic isolation devices, trains do not sway violently due to strong ground shaking during earthquakes, effectively mitigating train movement and ensuring the safety of passengers.

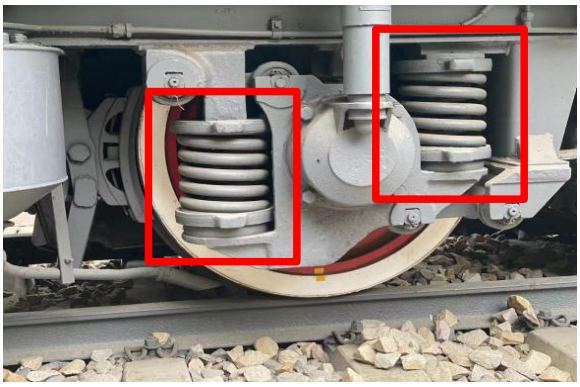

Figure 1. Railway seismic isolation device

3.2 Bridge Design

As we know, trains pass through many bridges during their journeys, and the second treasure of railway earthquake resistance lies in these bridge structures resembling bamboo shoots. Railway construction personnel separate long bridges into individual short bridges that are not interconnected. When earthquakes occur, these bridges can sway independently without affecting each other, thereby avoiding significant damage to the entire bridge structure. To ensure that bridges can withstand seismic impacts, railway technicians perform precise design and strengthening measures, including determining the length, span, height, etc., and installing limiting devices at both ends of the bridges to strengthen the bridge foundations. These measures prevent seismic forces from transmitting or minimally transmitting to various components of the bridge, ensuring the stability of the railway and reducing the

possibility of bridge damage and disruption. This is also the secret of rapid restoration of regular train operations.

3.3 Early Warning Systems

Earthquake early warning systems are one of the important means for railways to respond to earthquakes. These systems detect the occurrence and development of earthquakes through sensors, data analysis, etc., and provide warnings several dozen seconds before the arrival of seismic waves (Li Sun, 2011). This allows trains to have time to respond, activate emergency measures such as the braking system, and minimize accidents such as derailment or overturning even while in motion during an earthquake. The application of earthquake early warning systems significantly enhances the safety of trains and passengers during earthquakes.

4. Conclusions

The education on safety prevention of high-speed railways under earthquakes is essential for railway construction and transportation, especially for the professional workers' training. Because earthquake resistance and disaster reduction in railways are crucial topics in ensuring unimpeded railway transportation. There are three treasures of railway earthquake resistance. The first is seismic isolation devices, which absorb and dissipate seismic energy, reduce train vibrations, and mitigate the adverse effects of earthquakes on railways, ensuring passenger safety. The second is precise design and reinforcement measures for bridges, preventing seismic forces from transmitting to various bridge components, ensuring bridge stability and safety, and reducing the likelihood of bridge damage. The third is the earthquake early warning system, which provides warnings several dozen seconds before an earthquake, allowing trains to take emergency measures such as activating the braking system. This greatly improves the safety of trains and passengers during earthquakes. The effective implementation of railway seismic measures enables railways to remain unyielding during earthquakes, ensuring unimpeded railway operation and passenger safety. As a shining symbol of our country, railways will continue to develop and innovate, assuming greater responsibilities for the safety of people's lives and property.

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