Study on the Application of Seismic Isolation Technology in Urban Bridges

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Abstract: The wide application of various advanced urban construction technologies and disaster prevention technologies has provided a strong guarantee for urban construction in China. Reasonable application of seismic isolation technology in urban bridge seismic work can significantly enhance the seismic performance of urban bridges and provide safe travel services for people. Therefore, this paper makes a detailed analysis on the effective application of seismic isolation technology in urban bridges, so as to ensure that the role of seismic isolation technology can be really applied to the seismic work of urban bridges, and lay a solid foundation for the further optimization and promotion of seismic isolation technology.

1. Introduction

Through the detailed analysis of the geological structure of China, it can be known that due to the large land area of China, many areas are close to the seismic zone, resulting in the lack of stability of the geological structure, and the land area within the range of destructive earthquakes is as high as 40%. In the process of urban construction, China must pay more attention to and make full use of seismic technology to ensure the smooth development of relevant projects and the safety of people's lives and property. Applying the seismic isolation technology to the seismic design of urban bridges can make the seismic concept permeate every link of urban bridge construction, and ensure that the overall seismic quality of urban bridge engineering is greatly improved. Therefore, it is necessary to adopt scientific means to carry out detailed analysis and systematic research on the role of seismic reduction and isolation technology in urban bridge seismic resistance, to clearly understand the causes of relevant problems, so as to take targeted measures to continuously optimize and improve the seismic reduction and isolation technology, keep the seismic resistance quality of urban bridges above the standard level.

2. Applicable Conditions of Seismic Isolation Technology

China has a vast land area, extremely rich geographical structure types, and diversified terrain and geomorphology. To a certain extent, it restricts the development of urban bridge seismic work. In order to effectively deal with these problems, China's urban bridge construction departments have formulated a series of scientific and reasonable urban bridge seismic design criteria according to the actual geographical characteristics of different regions. It is clearly proposed in the relevant guidelines that in the process of urban bridge construction in different provinces, cities and regions, different levels of urban bridge seismic capacity should be formulated according to their own earthquake occurrence probability, and advanced technologies should be continuously integrated to further improve and enhance the actual seismic capacity of urban bridges. In the process of urban bridge construction, strengthening the flexible application of seismic isolation technology can further improve the seismic capacity of urban bridges.

According to the actual investigation and research, although the seismic isolation technology has high universality, not all urban bridges can be used in the seismic design. The application of seismic isolation technology must meet any of the following conditions. First, if the piers used in urban bridge structures are steel structures, the basic vibration frequency period of the bridge can be shortened, and the seismic isolation technology can be used. Second, when the height difference of urban bridges is obvious, the seismic isolation technology can be used. Third, when the ground motion characteristics of the urban bridge construction location are obvious, the seismic isolation technology can be used at the location where the energy is mainly concentrated in the high-frequency period[1].

3. Arrangement and Selection Principles of Seismic Reduction and Isolation Devices

When the seismic isolation device with strong seismic reduction effect is installed in the urban bridge construction, the optimal location should follow the following principles. First, installing the seismic isolation device at the bottom of the urban bridge pier can minimize the gravity impact of the whole bridge structure. Second, installing seismic isolation devices at the top of urban bridge piers can reduce the inertial force of the bridge superstructure to a certain extent. However, no matter where the seismic isolation device is installed in the urban bridge, it should be regarded as an effective measure to improve the comprehensive performance design level of urban bridges and the seismic dissipation force.

In the process of applying the seismic reduction and isolation technology, technicians should give priority to the seismic reduction and isolation device with relatively simple function principle to ensure that the seismic requirements of urban bridges can be fully met with the assistance of the mechanical performance of the seismic reduction and isolation device. In addition, the technical personnel shall ensure that the performance of the selected seismic isolation device is highly consistent with the normal load demand of the bridge[2].

4. Detailed Component Design and Structural Design of Seismic Isolation Technology in Urban Bridge Seismic Construction

4.1 Cooperate with Traditional Seismic Construction Measures

First, sufficient space shall be reserved between the urban bridge beam and the anti-seismic block, so as to ensure that the isolation system can fully play its anti-seismic role in the event of an earthquake disaster. If the damage degree of the earthquake disaster is too great, and the function of the isolation system can't be handled, the seismic structure of the bridge itself will play its role.

Second, in the design of urban bridge seismic structures, designers must ensure that the materials used have strong cushioning and energy absorption, and avoid using materials with large rigidity[3].

4.2 Structural Measures for Isolated Bridges

First, sufficient space shall be reasonably reserved between the beam ends and abutments and between the beam ends and beam ends of urban bridges to ensure that the capacity of the seismic isolation device and the seismic dissipation force are further improved.

Second, in the simply supported beam isolation system, it is suitable to use the longitudinal continuous reinforced structure.

Third, the lateral support mode shall be reasonably applied at the bearing position of urban bridges, and sufficient space shall be reserved between the bridge beams and the lateral support mode to ensure that the capacity of the seismic isolation device and the seismic dissipation force can be effectively improved.

Fourth, we should focus on strengthening the lateral connection of the assembled simply supported beams, and combine the effective ways to prevent the side inclination of the bridge.

Fifth, in the process of installing the anti-falling beam device, it should be ensured that the outer distance between the two ends and the pier and abutment is always minimum, so as to minimize the damage caused by the bridge falling during the earthquake[4].

5. Application of Seismic Isolation Technology in Urban Bridge Design -- Taking Xiazhang Sea-Crossing Bridge as an Example

5.1 Seismic Wave Input

Through the detailed analysis of the actual application level and specific practice results of the seismic isolation technology in the current seismic construction of urban bridges in China, it can be known that the seismic isolation technology can be applied to the seismic design of the north approach bridge of Xiazhang sea-crossing bridge in the way of two-level fortification and two-end design. Among them, the actual ground motion parameters of the north approach bridge of Xiazhang sea-crossing bridge are taken as the basis and source of the "ground motion input" of the seismic isolation technology, and the "time history response" of the input is comprehensively analyzed by the "consistent excitation method". The corresponding fortification standard and the peak acceleration of the landmark are as follows:

When the fortification standard is 50 years, the peak value of ground horizontal acceleration is 0.188g. When the fortification standard is 100 years, the peak value of ground horizontal acceleration is 0.343g. Through analysis, it can be found that the input mode of seismic wave is mainly vertical + transverse bridge input and vertical + longitudinal bridge input. In the process of calculating the dynamic value, 5% will be set as the damping ratio[5].

5.2 Analysis and Comparison of Seismic Reduction Effect of Hyperboloid Sphere

By analyzing the seismic wave results obtained by vertical + horizontal bridge input and vertical + vertical bridge input, it can be found that:

In the first stage, the shear force of NBP7 structure with ordinary steel bearing is 2917KN, and the shear force of NBP8 structure with ordinary steel bearing is 2763KN, and the seismic reduction coefficient is 1. In the second stage, the shear force of NBP7 structure with ordinary steel bearing is 6870KN, and the shear force of NBP8 structure with ordinary steel bearing is 6490KN, and the seismic reduction coefficient is 1;

In the second stage, the shear force of NBP7 structure adopting hyperboloid bearing is 1329KN, and the shear force of NBP8 structure adopting hyperboloid bearing is 1249KN, and the seismic reduction coefficient is 0.44. In the second stage, the shear force of NBP7 structure adopting hyperboloid bearing is 2997KN, and the shear force of NBP8 structure adopting hyperboloid bearing is 2941KN, and the seismic reduction coefficient is 0.44 and 0.47[6].

The earthquake has the most obvious impact on the second fixed pier of Xiazhang sea-crossing bridge. The longitudinal seismic reduction effect of the maximum bending moment at the bottom of the pier can be found through comparison:

In the first stage, the bending moment of NBP7 structure with ordinary steel bearing is 125752KN°m, and the bending moment of NBP8 structure with ordinary steel bearing is 110073KN°m, and the seismic reduction coefficient is 1. In the second stage, the bending moment of NBP7 structure with ordinary steel bearing is 297929KN°m, and the bending moment of NBP8 structure with ordinary steel bearing is 286183KN°m, and the seismic reduction coefficient is 1.

In the second stage, the bending moment of NBP7 structure adopting hyperboloid bearing is 33571KN°m, and the bending moment of NBP8 structure adopting hyperboloid bearing is 32431KN°m, and the seismic reduction coefficient is 0.29. In the second stage, the bending moment of NBP7 structure adopting hyperboloid bearing is 83481KN°m, and the bending moment of NBP8 structure adopting hyperboloid bearing is 83680KN°m, and the seismic reduction coefficient is 0.30 and 0.31[7].

6. Conclusion

Through the comprehensive exploration of the application of seismic isolation technology in urban bridges, this paper can clearly understand that one of the effective ways to improve the seismic quality of urban bridges is to give full play to the function of seismic isolation technology and provide guarantee for the safety of urban bridges. Therefore, in the process of using the seismic isolation technology, the construction personnel should comprehensively understand the actual design of urban bridges to ensure that the designed seismic isolation measures can meet the seismic requirements of urban bridges. On this basis, it is necessary to attach great importance to the problems existing in the implementation of seismic isolation technology, and organize professional and technical personnel to take corresponding measures to properly solve them, so as to ensure that the goal of continuously improving the seismic capacity of urban bridges is effectively realized, and provide technical support for the further improvement of urban construction level in China.

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