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Research on New Seismic Isolation Bearing

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Abstract

This paper reviews the current research status, development trend and future research directions of seismic isolation bearings. Firstly, the classification and performance index of seismic isolation bearings are introduced, and the research progress of seismic isolation bearings is outlined. Then, the diversification, intelligence and sustainability of seismic isolation bearings are discussed as the future development trend. In addition, this paper also provides an outlook on the future research directions of seismic isolation bearings, including improving the performance and stability of seismic isolation bearings and achieving adaptive and intelligent control. Among them, the application of new materials and intelligent technology is considered as one of the key points for future research. The review in this paper is detailed and has a high reference value for academics and engineers in the field of seismic isolation bearings, which helps to promote the research progress and technological innovation in this field.

Keywords

Seismic Isolation Bearing; Classification; Performance Index; Diversification; Intelligence; Sustainability; Multi-scale Analysis Method; New Materials; Intelligent Technology.

1. Introduction

Seismic isolation bearing plays an important role in earthquake disaster defense as a kind of structural seismic mitigation measure. In recent years, with the continuous development and improvement of building structural engineering design, the research on seismic isolation bearings has also received wide attention. This paper will review the research status, development trend and future research direction of seismic isolation bearings, in order to provide some reference for the research in related fields. As an important part of structural engineering, seismic isolation bearings can effectively reduce the impact of natural disasters such as earthquakes on buildings and bridges. In recent years, the research and application of seismic isolation bearings have received widespread attention, and with the continuous progress of science and technology and the growing demand, their development has also shown a trend of diversification, intelligence and sustainable development. Therefore, it is important to understand the classification, performance index, research progress and future development trend of seismic isolation bearings to promote the research and practice in this field.

2. Classification and Performance Indexes of Seismic Isolation Bearings

Seismic isolation bearings can be classified into three types: spring type, friction type and liquid damper type according to their structural characteristics. Among them, the spring type seismic isolation bearing absorbs the earthquake kinetic energy through elastic deformation, which has the advantages of simple and easy manufacture and good stability; the friction type seismic isolation bearing reduces the earthquake force on the structure through sliding friction, which has the advantages of wide application and adjustable structural stiffness; the liquid damper type seismic isolation bearing controls the vibration of the structure through liquid damper, which has the

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advantages of stable seismic performance and low energy consumption. The advantages of liquid damper type seismic isolation bearing are The performance index of seismic isolation bearing mainly includes seismic isolation effect, energy consumption capacity, stiffness and bearing capacity. Among them, the seismic isolation effect is the most basic index to measure the performance of seismic isolation bearing, which reflects the degree of mitigation of structural force by seismic isolation bearing; the energy consumption capacity is the ability of seismic isolation bearing to absorb and consume energy under the action of earthquake, which determines the durability and service life of seismic isolation bearing; the stiffness refers to the restraint capacity of seismic isolation bearing to the structure, which has a direct effect on the seismic isolation effect; the bearing capacity refers to the ability of seismic isolation bearing to the structure to bear the load. The bearing capacity refers to the ability of the isolation bearing to bear the load of the structure.

2.1 Rubber Seismic Isolation Bearing

Rubber vibration isolation bearing is a type of vibration isolation bearing widely used in building structure, which is mainly composed of upper and lower plates and rubber in the middle. The rubber material has good elasticity and durability and can absorb seismic energy through deformation during earthquakes, thus reducing the impact of earthquakes on buildings. Rubber seismic isolation bearings have the following advantages:

(1) It can adapt to different loading conditions and provide stable support;

(2) The rubber material has good elasticity and durability, which can maintain the seismic isolation performance for a long time;

(3) Easy installation and maintenance.

In recent years, there have been more and more studies on rubber vibration isolation bearings. The following are some advances in the research of rubber vibration isolation bearings:

(1) Research on the performance of rubber material: rubber material is the core material of rubber vibration isolation bearing, and its performance has an important impact on the seismic isolation effect. At present, researchers are conducting in-depth research on the mechanical properties, fatigue properties and aging properties of rubber materials to improve the performance and stability of rubber vibration isolation bearings.

(2) Optimized design of seismic isolation bearing: In order to improve the seismic isolation effect of rubber seismic isolation bearing, researchers have optimized the structure and parameters of seismic isolation bearing. For example, the seismic isolation effect of the vibration isolation bearing can be improved by adjusting the size of the pad, spring stiffness and other parameters.

(3) Application of multi-scale analysis methods: Seismic isolation bearing is a typical multi-scale problem, which requires consideration of multiple scale factors from macroscopic to microscopic. Therefore, in recent years, researchers have started to use multi-scale analysis methods to analyze and design seismic isolation bearings from different scales in order to improve their performance and stability.

(4) Application of new materials: In addition to traditional rubber materials, researchers are also exploring the application of other new materials, such as polymer materials and carbon fiber composites. These materials have better mechanical properties and durability, which can improve the performance and stability of the vibration isolation bearing.

(5) Application of intelligent technology: With the development of intelligent technology, researchers have started to explore the application of intelligent technology in seismic isolation bearings to achieve adaptive and intelligent control. For example, the state of the vibration isolation bearing is monitored in real time by sensors, and the bearing parameters are adjusted to adapt to different loading conditions.

In conclusion, as a type of seismic isolation bearing widely used in building structures, the research of rubber isolation bearings is also very important. Future research directions will include improving

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the performance and stability of seismic isolation bearings, achieving adaptive and intelligent control, etc.

2.2 Friction Isolation Bearing

Friction isolation bearing is the use of friction to offset the inertia force generated by the earthquake effect of the structure, so as to reduce the structural forces and deformation. The basic principle is that by installing the upper and lower parts of the structure respectively between two metal plates that can slide relative to each other, when the structure is subjected to seismic loading, the upper structure produces horizontal displacement and the friction force is generated to prevent further displacement of the structure and play a seismic isolation effect.

2.2.1 Classification and Characteristics

According to the different contact methods and friction coefficients between metal plates, the friction isolation bearing can be divided into two types: conventional type and slope type. Conventional type friction isolation bearing is installed on the horizontal surface of the metal plate, and the friction coefficient is controlled by the pressure regulator, so as to realize the horizontal displacement control. Slope type friction isolation bearing is to set the metal plate into a slope shape, so that it generates vertical reaction force during horizontal displacement, thus increasing the bearing capacity and stability of the bearing.

2.2.2 Friction Isolation Bearing has the Following Characteristics:

(1) High load-bearing capacity: Because the friction force between metal plates is used to offset the inertia force, so its load-bearing capacity is stronger and can withstand larger earthquake loads.

(2) good stability: friction isolation bearing has high stability, can effectively prevent the structure from unstable vibration.

(3) Good durability: the metal material used in the friction isolation bearing has high durability and can maintain good performance for a long time.

(4) Flexible control: By adjusting the pressure regulator, precise control of horizontal displacement can be realized, thus meeting the design requirements of different structures.

2.3 Liquid Damper Vibration Isolation Bearing

Liquid damper seismic isolation bearing is a common structural seismic isolation device, mainly composed of two steel plates on the top and bottom and a viscous fluid filled in the middle. The basic principle is to use the damping force generated by the viscous fluid in motion to slow down the impact of earthquake or other external loads on the building, so as to protect the safety and stability of the building.

The liquid damper seismic isolation bearing has the following characteristics:

High load-bearing capacity: Since the liquid damper can adjust the size of damping force by changing the viscosity and volume, it can meet the load-bearing needs of different buildings.

Good stability: The liquid damper isolation bearing has good stability during movement, which can effectively reduce the impact of external loads such as earthquakes on the building and improve the safety and stability of the building.

Good durability: The liquid damper isolation bearing is made of wear-resistant and corrosion-resistant materials, which can be used for a long time and not easily damaged.

Flexible control: Liquid damper isolation bearing can realize the control of damping force by adjusting parameters such as viscosity and volume, so as to adapt to different loading conditions. Liquid damper isolation bearings are mainly divided into two types: linear and non-linear. Linear liquid damper isolation bearings produce damping force proportional to velocity during motion, and their damping characteristics are relatively simple, but they cannot meet the seismic isolation requirements of certain complex structures. Nonlinear liquid damper isolation bearings produce

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damping forces that are not proportional to velocity during motion and can better accommodate complex loading situations.

3. Research Progress of Seismic Isolation Bearing

In recent years, the research on vibration isolation bearings has made great progress. Among them, the research on spring-type vibration isolation bearing mainly focuses on spring material, spring shape and spring quantity. The research on friction type vibration isolation bearings focuses on the friction coefficient, pressure distribution and durability of the friction interface. The research of liquid damper type vibration isolation bearing is mainly focused on the flow characteristics of damping liquid, leakage and inflation problems.

In addition, some new types of vibration isolation bearings have been developed gradually, such as magnetorheological vibration isolation bearings and fiber reinforced composite vibration isolation bearings. These new types of seismic isolation bearings have better performance and application prospects, but further research and verification are needed.

4. Diversification, Intelligence and Sustainable Development of Seismic Isolation Bearings

The future development trend of seismic isolation bearing is mainly reflected in three aspects: diversification, intelligence and sustainable development. Among them, diversification means that the types and performance of seismic isolation bearings will be more abundant and diversified to meet the needs of different building structures; intelligence means that seismic isolation bearings will have higher adaptive and intelligent level to realize real-time response and control of earthquake dynamics; sustainability means that seismic isolation bearings will be more environmentally friendly and sustainable in terms of service life and energy consumption.

The sustainable development of seismic isolation bearing is one of the hot spots of current research, mainly including the following aspects:

4.1 Research on Environmentally Friendly Materials

The materials used in the vibration isolation bearing, such as rubber and steel plates, produce a lot of waste and cause pollution to the environment. Therefore, researchers are exploring new environmentally friendly materials, such as recycled rubber, biodegradable plastic, etc., to reduce the impact of vibration isolation bearings on the environment.

4.2 Research on Energy Consumption Reduction

The manufacturing and installation process of seismic isolation bearings consumes a lot of energy, so researchers are committed to developing energy-saving technologies, such as adopting new processing equipment, optimizing the production process and other methods to reduce energy consumption.

4.3 Research on Long-term Stability

The long-term stability of seismic isolation bearing is directly related to its sustainable development. In order to ensure the long-term effectiveness of seismic isolation bearings, researchers need to conduct long-term monitoring and evaluation, and continuously improve the design and manufacturing process.

4.4 Research on Maintenance and Management

The maintenance and management of seismic isolation bearings is the key to their sustainability. Researchers are developing intelligent monitoring systems to monitor the operational status of seismic isolation bearings in real time and propose effective maintenance and management solutions to extend their service life.

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Future research directions Seismic isolation bearing is a kind of seismic isolation device used in buildings, bridges and other structures, and its main function is to reduce the influence of external loads such as earthquake and wind on the structure and improve its safety and stability. In the future, the development direction of seismic isolation bearing will include the following aspects:

(1) Improving the performance and stability of the bearing

The performance and stability of seismic isolation bearings is one of the key research directions. In the design process, the characteristics and use conditions of different buildings or bridges need to be taken into account and the design should be optimized in a targeted manner. At the same time, the manufacturing process and material selection of seismic isolation bearings need to be further improved to enhance their durability and reliability.

(2) Realize adaptive and intelligent control

Adaptive and intelligent control technology can help the seismic isolation bearing to better adapt to different load conditions and make intelligent adjustments according to real-time monitoring data. For example, technologies such as sensors can be used to monitor the vibration of buildings or bridges in real time and adjust the damping force according to the data to achieve better seismic isolation effects.

(3) Multi-field coupling analysis method is used

The multi-field coupling analysis method is a more advanced structural analysis technique that can consider multiple factors of the structure (such as earthquake, wind, temperature, etc.) simultaneously to predict the performance of the seismic isolation bearing more accurately. In future research, this method can be used for modeling and simulation analysis to better evaluate the effectiveness of seismic isolation bearings.

(4) Application of new materials

The application of new materials is also one of the important directions for the development of future seismic isolation bearings. For example, the use of high-strength and high-toughness steel or composite materials can improve the bearing capacity and durability of seismic isolation bearings. In addition, the application of other new materials, such as dampers based on shape memory alloys, can be explored.

In conclusion, the future development of seismic isolation bearings needs to focus on improving their performance and stability, achieving adaptive and intelligent control, adopting multi-field coupling analysis methods and the application of new materials, etc. With the continuous progress of technology and growing demand, it is believed that the application prospect of seismic isolation bearings will become more and more extensive.

In order to realize the diversification, intelligence and sustainable development of seismic isolation bearings, the future research directions mainly include the following aspects:

(1) Research on multi-scale analysis methods: Since seismic isolation bearings involve the intersection of several physics fields, more comprehensive and accurate multi-scale analysis methods need to be developed.

(2) Research on new materials: The development of new materials can improve the performance and application range of seismic isolation bearings, such as magnetorheological materials and nanomaterials, etc.

(3) Application of intelligent technology: Intelligent technology can make the seismic isolation bearing with higher self-adaptability and intelligence, such as sensor network, data processing algorithm, etc.

In conclusion, the sustainable development of seismic isolation bearings requires multidisciplinary cooperation and innovative thinking Only by continuously promoting scientific and technological progress can we bring a more sustainable and environmentally friendly future for human society.

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5. Conclusion

This paper has reviewed the current status of research, development trends and future research directions of seismic isolation bearings. The classification and performance indexes of seismic isolation bearings have been discussed, and the research progress of seismic isolation bearings has been outlined. Diversification, intelligence and sustainability are the future development trends, while multi-scale analysis methods, new materials and application of intelligent technologies are the focus of future research.

(1) The performance and stability of seismic isolation bearings are key issues, and multi-field coupled analysis methods and the application of new materials are needed to improve the performance and stability in the future.

(2) The adaptive and intelligent control of the seismic isolation bearing is the future development direction, and the real-time monitoring and adjustment of the seismic isolation effect can be realized by using sensors and control systems.

(3) The application of seismic isolation bearings in natural disasters such as earthquakes is also an important research direction, and their reliability and durability need to be further explored.

(4) The classification and characteristics of seismic isolation bearings need to be fully considered in the design in order to meet the needs of various building structures.

(5). Seismic isolation bearings can also be applied in the field of seismic isolation for transportation and machinery and equipment in order to improve their operation.

References

[1] Li H, Wang ZC. Research status and development trend of seismic isolation bearings [J]. Journal of Building Structures, 2018, 39(3): 1-10.

[2] Wang X., Chen S. H. Research progress and application prospects of aeroelastic seismic isolation bearings [J]. Engineering Seismic and Reinforcement Modification, 2019, 41(2): 57-63.

[3] Hu J. M., Zhu L. Research progress of new seismic isolation bearings [J]. Construction Technology Development, 2017, 44(3): 56-62.

[4] Chen BH, Zhang MZ. Application of multi-layer seismic isolation bearings in bridge engineering [J]. Bridge Construction, 2020, 50(3): 79-85.

[5] Liu W.D., Shao C.Y.. Experimental research and analysis of seismic isolation bearings [J]. Journal of Civil Engineering and Management, 2016, 33(5): 23-30.

[6] Zhang YL, Zhao GH. Research on the performance evaluation method of seismic isolation bearings [J]. Earthquake Engineering and Engineering Vibration, 2018, 38(2): 83-89.

[7] "Sustainable Development of Seismic Isolation Technology", Xu Xinyan, 2018.

[8] "Research on Sustainable Development of Seismic Isolation Bearings", Zhang Haifeng, 2019.