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The principle, application and role of seismic isolation technology in improving the seismic performance of buildings

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Abstract

Earthquakes are a common natural phenomenon in China, mainly due to the movement of the earth's crust, which has caused various social disasters. The experience of many earthquakes at home and abroad shows that seismic isolation technology can greatly reduce the seismic action of buildings and improve the seismic fortification ability of houses. Since some sudden earthquake disasters have caused great social damage, it is particularly important to strengthen earthquake resistance. As an advanced technology in modern seismic engineering, seismic isolation technology has significantly improved the seismic resistance and safety of buildings in the event of an earthquake through its unique principle and wide application. It is not only widely used in engineering practice, but also has great significance in protecting cultural heritage and improving the resilience of large-scale infrastructure. This paper explains the importance and basic connotation of seismic isolation technology in const.

Keywords

Seismic performance; Seismic isolation technology; Influencing factors.

1. Introduction

Over the past few decades, the massive damage caused to building structures by a number of major seismic events around the world has once again emphasized the importance of seismic design. With the development of technology, shock absorption and isolation technology has become a key tool to improve the seismic resistance of building structures. This technology can effectively separate the vibration of the building from the ground, reduce the direct impact of seismic forces on the building, and thus protect the safety of the building and people. However, how to optimize the use of costs and resources while ensuring safety has become a challenge in research and practice. This paper will discuss the application of seismic absorption and isolation technology in building structures, analyze its effects in different building types, and put forward optimization suggestions, aiming to provide a practical reference for architectural designers and engineers, hoping to provide a reference for seismic engineering design of architectural engineers and technicians, and promote the formation of a safer and more economical built environment.

2. The principle and classification of shock absorption and isolation technology

Seismic isolation technology is a key technology in modern construction engineering, which aims to improve the safety and reliability of buildings by isolating the impact of earthquakes on building structures through specific engineering measures. This technology is based on the principle of dynamics and fulfills its function by means of a specialized device installed between the building and the foundation. Seismic isolation technology is to install seismic isolation bearings between the foundation and the superstructure of the building, so that the superstructure of the building can move freely relative to the ground during an earthquake,

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thereby reducing the direct action of seismic forces. The types of seismic isolation bearings mainly include rubber seismic isolation bearings, slip seismic isolation bearings and lead core seismic isolation bearings.

Rubber seismic isolation bearing is a device that uses the elastic deformation of high-damping rubber material to achieve the seismic isolation effect, which can effectively reduce the acceleration response of the structure. Rubber seismic isolation bearings are usually composed of two metal plates and a rubber layer in the middle. The sheet metal is usually made of steel to withstand the loads of the building, while the rubber layer acts as a seismic isolation and cushioning. When an earthquake or vibration occurs, the elastic rubber layer of the rubber isolation bearing can absorb and disperse the vibration energy, thereby reducing the amplitude of the vibration transmitted into the building or bridge. This seismic isolation effectively protects the superstructure from the serious effects of external vibrations. Rubber seismic isolation bearings are widely used in high-rise buildings, bridges, power facilities and other engineering structures, especially in the seismic design of earthquake-prone areas or important facilities.

Slip isolation bearings reduce the transmission of seismic forces by allowing the building foundation to slide horizontally and are suitable for areas with high seismic dynamics. Slip isolation bearings usually consist of two metal plates, upper and lower and a sliding surface in the middle. The sliding surface can be a special low-friction material, such as polyethylene or polytetrafluoroethylene (PTFE), or a copper plate with organic lubricants. When an earthquake or vibration occurs, the sliding surface of the slip isolation bearing can reduce the horizontal force transmission of the structure, so that the structure can slide relatively freely on the support. This design effectively isolates earthquake-induced vibrations, thus protecting the integrity and safety of the superstructure. Slip seismic isolation bearings are widely used in earthquake-sensitive buildings and bridges that require a high degree of protection, such as hospitals, bridge girders, power facilities, etc.

The lead core isolation bearing is to add a lead core to the rubber bearing, and use the plastic deformation of the lead core to improve the energy dissipation capacity of the isolation system, so as to further reduce the impact of the earthquake on the building. The lead core seismic isolation bearing is composed of two metal plates and a rubber layer and a lead core in the middle. The rubber layer is usually located around the lead core as a shock isolation and cushioning material, while the lead core is placed inside the rubber layer. Under the action of earthquake or other vibrations, the seismic isolation effect of the lead core seismic isolation bearing mainly depends on two mechanisms, one is the elasticity of the rubber, the rubber layer can absorb and disperse the vibration energy, and reduce the structural load caused by the earthquake. The second is the hysteresis characteristics of the lead core, which has a large deformation capacity and low restoring force, which can absorb and dissipate vibration energy, and effectively reduce the acceleration and displacement response of the structure. The lead core seismic isolation bearing provides efficient structural seismic isolation protection by combining the elasticity of rubber and the hysteresis characteristics of the lead core, which is a very important technology in modern seismic engineering.

The design and application of seismic absorption and isolation technology need to be refined according to the specific conditions and ground motion characteristics of the building. In the design process, it is necessary to consider the working frequency, energy dissipation characteristics, stiffness characteristics and the influence on the use function of the building of the damping and isolation system. In addition, the seismic isolation device needs to be regularly inspected and maintained to ensure that it will function properly in the event of an earthquake.

Fig.1.1. The substation equipment is damaged.

Figure 1.2. Damage to medical equipment .

3. Application effect and optimization scheme of seismic isolation technology in building structure

The introduction of seismic isolation technology has greatly improved the safety and stability of building structures in the face of natural disasters such as earthquakes. By applying these technologies in building design and construction, the damage caused by earthquakes can be effectively reduced and people and property can be protected. However, in order to maximize the effectiveness of seismic isolation technology, its application in building structures needs to be finely optimized and adjusted to suit different building needs and seismic characteristics. The application effect of seismic isolation technology in building structures is mainly reflected in its ability to significantly reduce the seismic response of buildings, including reducing the displacement of building structures, slowing down the acceleration response of structures, and reducing internal forces.

Seismic isolation technology installs seismic isolation bearings between the foundation and the superstructure of the building, so that the superstructure can move freely relative to the ground within a certain range during the earthquake, so as to effectively isolate the direct transmission of ground vibration to the superstructure. This technology is particularly suitable for public buildings with high safety requirements, such as hospitals, schools, bridges, etc. In practical application, the optimization scheme of seismic isolation technology needs to be comprehensively considered according to the specific conditions of the building, the characteristics of ground motion, and the economic cost. Choosing the right damping and isolation system is critical to improving the effectiveness of your application. Different types of seismic isolation devices have different performance characteristics, so it is necessary to choose the most suitable system type according to the type of structure of the building, the function of use, and the seismic characteristics of the area.

For high-rise buildings, it is more appropriate to use shock absorbers such as viscoelastic dampers or metal dampers that can effectively control structural vibrations; For wide bridge

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structures, rubber isolation bearings or slip isolation bearings may be more suitable to achieve better seismic isolation. The design and parameter optimization of the damping system are also the key to ensure the application effect. The design of the system needs to be based on accurate dynamic analysis, taking into account the wide range of complex responses that can occur in the building under the action of an earthquake. Through simulation analysis and experimental studies, the optimal damping ratio, stiffness and mass distribution can be determined to achieve the best seismic isolation effect. At the same time, considering the uncertainty of seismic dynamic characteristics, a certain safety margin should be used in the design to ensure that the seismic isolation system can still function when the expected seismic intensity is exceeded.

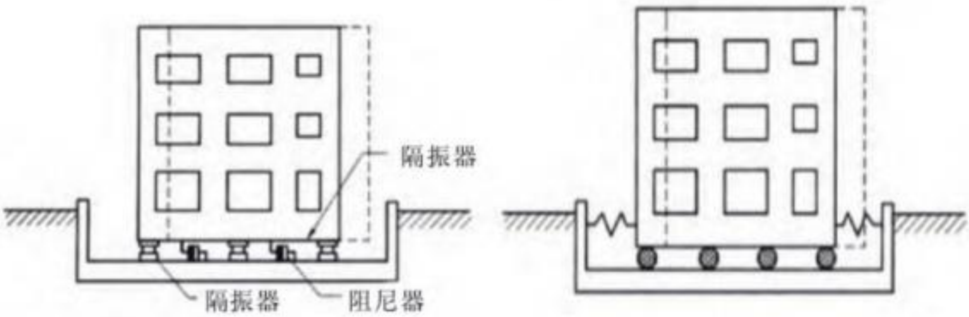

Fig.2 .Schematic diagram of the application of basic seismic isolation technology.

4. The role of seismic isolation technology in improving the seismic performance of buildings

As an important seismic measure in modern construction engineering, seismic isolation technology significantly improves the seismic performance of buildings in earthquakes through its special principles and applications, so as to protect people's lives and property safety and improve the long-term sustainability of buildings.

One of the core roles of seismic isolation technology is to effectively reduce the risk of damage and collapse of buildings from earthquakes. In the event of an earthquake, the shaking of the ground is transmitted to the building structure through the foundation of the building, generating horizontal displacement and inertial forces, which are one of the main causes of building damage. Seismic isolation technology absorbs and disperses the energy of earthquakes by introducing adjustable seismic isolation devices such as rubber bearings, metal springs, or friction slides between the building and the foundation, thereby reducing the strength and range of these forces into the structure. This damping effect significantly reduces the stress and deformation of the structure, effectively prevents serious damage to the structure, and enables the building to continue to be in a relatively intact condition after the earthquake.

Seismic isolation technology not only helps to protect the safety of the building structure, but also significantly reduces the hazards of earthquakes to people and equipment inside the building. In traditional non-seismic isolation structures, earthquakes can cause the destruction or collapse of structural elements such as walls, ceilings, floors, etc., increasing the risk of injury or death. The application of seismic isolation technology reduces the internal vibration of the building, reduces the probability of damage to non-structural components (such as brick walls, glass, etc.), and effectively improves the safety of personnel in earthquakes. In addition, seismic isolation technology can protect important equipment and machinery from damage or failure due to earthquakes, ensuring the functionality and operational safety of buildings after earthquakes.

Compared to traditional structural reinforcement methods, seismic isolation technology can significantly reduce the cost of repairs and repairs after an earthquake. Traditional

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reinforcement methods may require extensive structural modifications and reinforcements, and these changes may affect the appearance and functionality of the building. Seismic isolation technology saves a lot of maintenance and time costs by reducing the structural damage caused by earthquakes and reducing the need for subsequent repair and maintenance. In addition, seismic isolation technology also helps to extend the life of a building because it maintains the integrity and stability of the building structure, reduces the potential for structural fatigue and aging, and improves the long-term sustainability of the building.

The application of seismic isolation technology is not only a technical improvement, it also has a positive impact on the entire society and economy. By reducing the risk of damage and disasters caused by earthquakes, seismic isolation technology can protect critical infrastructure and critical facilities in cities, such as hospitals, schools, transportation hubs, etc., to ensure that they can continue to operate normally after a disaster, maintaining social stability and productivity. On the economic side, reducing earthquake losses and repair expenses will help reduce the cost of post-disaster reconstruction, save social resources, and enhance the city's resilience and development potential.

5. Conclusion

As an advanced seismic technology, seismic isolation technology has significantly improved the seismic resistance and safety of buildings in the event of an earthquake through its unique principle and wide range of applications. It is not only widely used in engineering practice, but also has great significance in protecting cultural heritage and improving the resilience of large-scale infrastructure. With the progress of science and technology and the development of engineering technology, seismic isolation technology will continue to play an important role in the future, which is an effective means to improve the seismic resistance of buildings and provide reliable technical support for the seismic design of buildings. Seismic isolation technology plays an important role in modern seismic engineering, and although there are certain challenges, its potential to improve the seismic performance of structures makes it an advanced technology worthy of promotion and application.

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