Research on Structural Seismic and Vibration Control Technology of Modern Buildings

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Abstract: In recent years, the overall development of China’s construction industry has been relatively good, but due to the continuous improvement of people’s daily life quality, the requirements for building structures have become higher and higher. This paper analyzes the structural earthquake resistance of modern buildings and the application of corresponding vibration control technology, and analyzes the specific application of vibration isolation and control technology to provide effective guarantee for the stability of modern building structures.

1. Introduction
In the context of the rapid development of China’s society and economy, the overall development of the construction industry is generally relatively improving, and has attracted widespread attention. At the same time, higher requirements are placed on modern buildings invisibly. Nowadays, the development of infrastructure and building construction in China is continuously accelerating. The construction departments have paid more attention to structural seismic and vibration control technology, and the application of some specific projects. It is well-known that in recent years, the frequency of earthquakes in China is relatively high. Once an earthquake occurs, it will directly affect buildings. If the structure of the building itself lacks stability and good earthquake resistance, it will inevitably cause casualties and seriously threaten people’s lives and property. Therefore, it is necessary to introduce and use some advanced technology to ensure the effectiveness of vibration control in the design and specific application of modern building structures to provide effective guarantee for the stability and quality.

2. Application effect of seismic isolation technology in structural earthquake resistance of modern buildings
With the continuous progress of science and technology, more and more new technologies are widely used in various fields, especially in the construction. The application rate of new technologies is generally high, so is the demand. In recent years, the incidence of earthquake natural disasters is relatively high. Once an earthquake occurs, it will not only directly threaten people’s lives and property, but also directly cause severe damage to buildings. Therefore, it is necessary to put forward higher requirements for the structural stability of modern buildings, so that they can also have a good resistance effect in the face of earthquakes¹. The specific application of building isolation technology can effectively prevent earthquakes and the huge energy from affecting the building structure as much as possible.
At present, under the situation of rapid economic development in China, very high requirements are imposed on the safety and stability of the building itself. For the construction enterprise, not only the targeted solutions to the earthquake is proposed, but also the rationality and science of the isolation scheme in the formulation and specific application. In this situation, some advanced technological means can be reasonably introduced and utilized, such as large-scale utilization of some specially processed steel structural plates and comprehensive rubber application technologies, which can play a good role[2]. More common are technical solutions such as laminated steel plate rubber bearings.

The construction and application of the friction pendulum system can be regarded as a sliding structure relying on the principle of gravity reset. As shown in figure 1, it can be clearly seen from figure 1 that the upper and the lower part are divided. Among them, the self-vibration cycle is involved. As the natural vibration period of the upper structure changes, the natural vibration period of the corresponding isolated structure will show the opposite change trend, that is, the shorter the above, the longer the corresponding overall self-vibration period will be. The expression is \( T = 2\pi \sqrt{R/g} \), R is the radius of the sliding sphere in the structure; g is the acceleration of gravity, and T is the period of self-vibration.

As shown in figure 1, it is found that the self-vibration period of itself will not be affected by the load value of any component in the upper half. That is to say, the connection between the upper member and the lower base is mostly connected in the form of horizontal contact, it mainly uses sliding to promote the conduction energy to achieve effective cancellation[3]. It should be noted that the obvious differences in practice, especially between the friction slider and the sliding surface, is during the setup and specific application of the roller device. The corresponding contact mode is line contact, but the roller in the actual application of ball device is mainly based on point contact. In the actual application, the most obvious shortcoming is that there will be severe restrictions on the support of large loads, and usually have a certain support effect on the tuning quality damper[4]. However, it also has very obvious advantages and characteristics, and its own cost-effectiveness is generally high when used with a wide range of applications. However, the structure does not have a self-resetting ability, elastic and elastic-plastic recovery can be used to achieve reasonable utilization of the structure.

3. Application effect of vibration control technology in structural seismic of modern buildings
For modern architectural structure, in order to fundamentally ensure the stability of the structure, it is necessary to actively take targeted measures, reasonable use of some advanced technical means to ensure the seismic effect. If it is directly from technical angle to analyze, the vibration control technique will be put forward. The transmission came from the huge earthquake kinetic energy
directly preforms in advance of vibration control components. It can also realize the physical structure of the component characteristics and reasonable use can be targeted to the seismic energy offset processing. Through scientific and reasonable use, the traditional situation of relying on the rigidity of the building itself is broke to resist the earthquake. However, it should be noted that this does not mean that the vibration control technology can be applied to any building structure, nor does it mean that the technology is universal\cite{5}. Since this technology is completely contained in the building, it can also be regarded as a very important part of the building itself. It is impossible to completely guarantee that other components of the building will not be affected in any way. The basic purpose of a building in the design and application of its own structural system is to promote the effectiveness of each of the different components. For example, a truss system of inclined bars and chords with an effective force state can be directly used, as shown in figure 2. In the anti-seismic wall of reinforced concrete, the cross reinforcement should be allocated and utilized scientifically and reasonably. The basic purpose is to promote its own anti-seismic.

![Figure 2 Schematic diagram of aseismic structure of high-rise pipe truss](image)

3.1 Friction dampers
In order to ensure the structural anti-seismic of modern buildings and maximize the effectiveness of the vibration control technology, it is necessary to combine the actual requirements to improve and optimize the current technical means. The friction damper can be regarded as a relatively traditional mechanism. In the practical application, it mainly combines the main components of the building effectively with a very simple elastic mechanism\cite{6}. The mechanical design can be used to maximize its role and value to achieve a very good seismic effect. In the practical application of these dampers, not only the material selection is very simple, but also the processing technology of the components composed of each other is not very complex. Therefore, large-scale production and utilization can be achieved in various types of structural buildings. In addition, when the friction damper is applied, though it does not have the ability to reset itself, it can rely on the structure of itself to achieve stiffness reset. However, the most obvious disadvantage of this structure is that it is difficult to achieve a fixed match with the tightening force, and it is also impossible to timely and effectively absorb and process the energy brought by earthquakes of different levels.

3.2 Soft steel and alloy damper
Soft steel is actually a common low-carbon steel. Due to its very low carbon, after statistical calculations, it is found that the carbon of soft steel is less than 0.25%, and it is still carbon steel. At the same time, its own ferry low, so it is called soft steel. It should be noted that if the carbon of the soft steel is in the range of 0.10% to 0.30%, then this ratio is suitable for being used in various types of
processing and forging with a good manufacturing effect. In the implementation of structural seismic measures for modern buildings, in order to obtain good seismic effects, it is necessary to make reasonable use of vibration control technology\cite{7}. If soft steel and alloy dampers are analyzed from the perspective of their own properties, they can be regarded as elastic and plastic dampers, which have very good hysteresis when applied, and can also be directly connected in series. Among the supporting members, reasonable use can be achieved at the top of the shear wall, the middle part of the beam, and some other parts with relatively large deformation. It can also be used in parallel with some basic isolation structures in combination with actual requirements. More common soft steel and alloy dampers include curved steel plate dampers.

3.3 Lead damper
Lead dampers were originally proposed by developed countries in the West. In the actual application of this type of damper, it is mainly used for the scientific and reasonable use of pure lead under the influence of constant yield stress out of the small hole. It can be directly regarded as having no compression elastic and plastic medium, and it does not have the characteristics of friction and compression. Therefore, when designing and analyzing, it is possible to design and use the shrink tube type and convex shaft type squeeze damper reasonably, and it has been used reasonably in many building structures. In the practical application, the damping member is generally good due to its own physical properties with very strong adaptability characteristics. There are certain similarities between its own mechanism and friction damping components. Before construction and application, the prestressed structure must be considered and set in advance. However, it is important to note that changes cannot be made after the settings and specific completion. In the process of setting the limits, it must be considered carefully and tried to avoid a series of effects brought by other factors, and reduce costs as much as possible to provide effective guarantee for the earthquake resistance as shown in figure 3.

![Figure 3 Schematic diagram of use of lead alloy damper](image)

4. Conclusion
The basic purpose of the proposed anti-seismic and vibration control technology and the scientific and reasonable introduction and use in the current modern building structural anti-seismic link is to achieve effective resistance to earthquake and minimize economic losses. Therefore, it is needed to proceed from multiple perspectives and links to ensure the effectiveness. This can not only deal with the harmful effects caused by different earthquake, but also provide protection for the stability of the building’s own structure and avoid serious safety accidents.

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