Application of Viscous Damper in Engineering

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Abstract

With the progress of society and science, construction by people became higher and larger. Thus came into being dampers, viscous dampers of which its manufacturing process is relatively simple, relatively inexpensive and very good control performance characteristics, has become the preferred anti-vibration device of many buildings and bridges. This paper introduces the types and background of viscous dampers and their applications in housing construction and bridge engineering, and discusses their performance and shortcomings.

Keywords

viscous damper; vibration device; housing project; bridge project.

1. Introduction

With the social progress, economic development and the rapid increase in population, people are increasingly demanding on the building. From ancient times to the present, the structure and shape of the houses have undergone enormous changes. From the previous narrow low vegetation construction, to now wide tall and tall concrete building, people's quality of life has been a qualitative improvement. However, in recent years a variety of natural disasters have always been tapping the people's ideals. Earthquakes, China's Wenchuan earthquake, the earthquake in Japan, the earthquake in Haiti have brought huge economic losses and personal injury, and by the global climate change, typhoon, the number of hurricanes increased significantly, these global natural disasters The impact on the global major projects is particularly acute. Significant projects tend to be unconventional on the building, the structure of the complex system, the structure is more prone to a number of irregular, due to structural weight is still structural design to pursue an important indicator, the structure of large area flexible layer has become one of the most important characteristics of many high-rise and super high-rise buildings.

Therefore, the demand for wind vibration and shock absorption of large high-rise projects is facing great challenges. The method of adding dampers is used to control the wind-induced vibration and earthquake of super large projects. Because of its practicability, effectiveness and economy, it has become the first choice of most engineers. Different dampers have different energy dissipation mechanisms, so it is of great social and practical significance to select the damper type reasonably for the major engineering structures to achieve the effect of wind resistance and shock absorption.

2. Classification of Dampers Commonly Used in Civil Engineering

There are many kinds of dampers. The existing seismic codes in China can be divided into displacement dependent model and velocity dependent model. The energy dissipation of displacement dependent dampers is related to their own deformation and relative sliding displacement. Metal dampers and friction dampers are often used. The damping characteristics of velocity dependent dampers are related to loading frequency. Viscous dampers and viscoelastic dampers are often used.

2.1 Viscous Fluid Damper

Viscous damper is a kind of speed dependent energy dissipation device, which mainly reduces seismic response. The damper block is built with silicone oil, and the kinetic energy is converted into heat

energy in the piston movement. It is the most widely used and effective damper in the structural damping system.

2.2 Metallic Dampers

Metal damper is a kind of displacement dependent damper, which is used to reduce the seismic response. At present has been developed and utilized mainly include: steel rod damper, lead damper, shape memory alloy, mild steel damper etc..

2.3 Viscoelastic Damper

Viscoelastic damper is a kind of speed dependent energy dissipation device, which can be used to reduce wind vibration and reduce seismic action. The viscoelastic damping material and the constrained steel plate are combined together, and the principle is that the viscoelastic material moves back and forth with the restrained steel plate, and the energy is dissipated by the shear hysteretic deformation of the viscoelastic damping material.

2.4 Friction Damper

The friction damper is a kind of damping device that combines the component and the friction plate to form a sliding friction mechanism under certain prestress, and works on the main structure by sliding friction. Its working principle is: in the small earthquake or wind loads friction damper to provide rigidity, but not to slip in the earthquake or earthquake under the action of friction slip to the main structure provided by friction energy dissipation and damping, so as to achieve the purpose of energy dissipation.

3. Advantages and Classification of Viscous Dampers

3.1 Advantages of Viscous Dampers

(1).The viscous damper is a kind of energy dissipation device, the input of seismic wave energy dissipation construction to protect the building, and does not need external energy to provide control, so it has attracted more and more attention.

(2).Viscous damper hysteresis curve is full of oval, show its strong energy dissipation capacity, and can adjust themselves according to the seismic intensity, seismic active.

(3).Not only the additional stiffness of the main building structure is not needed, but also a series of problems which are difficult to match the initial stiffness of the damper and the lateral stiffness of the structure are effectively solved;

(4).The use of "Killing with Kindness" concept, compared with the traditional seismic method, reduce the section size of the reinforcement member number and shear walls, beams and columns, can effectively save the cost;

(5).The utility model is not only suitable for the anti-seismic and windproof of the new building, but also has good effect on the seismic strengthening and the post earthquake maintenance of the existing buildings after the earthquake.

3.2 Classification of Viscous Dampers

Because of viscous dampers in liquid with large viscosity, when the earthquake happened due to the earthquake makes the relative motion of viscous dampers inside. These structures are in viscous liquid, which drives the liquid to move, so it can produce great viscous damping, and can effectively absorb the energy of earthquake or wind vibration, so that the structure can be protected. There are 3 kinds of commonly used viscous dampers: cylindrical viscous damper, cylinder viscous damper and viscous damped wall.

(1)Cylindrical viscous damper

The damper is composed of two cylinders of different size, large cylinder is fixed on the lower surface of the barrel is equipped with all kinds of high viscosity liquid, small cylinder immersed in viscous liquid, and fixed on the upper surface. The sealing device is arranged between the upper surface of

the roof of large cylinder and small cylinder, in order to prevent the outflow of foreign bodies into the barrel or viscous liquid. When the structure occurs, the damper by the piston in the viscosity of liquid with high concentration of movement to dissipation of energy. To achieve the purpose of seismic shock absorption.

(2) Cylinder viscous damper

The structure of the cylinder viscous damper is mainly used in the structure of the liquid cylinder, which can be divided into single-rod viscous dampers and double-rod viscous dampers according to the different piston rods. According to the structure of the energy dissipation structure on the piston, it can be divided into three types: gap type, gap type and mixed type. This viscous damper generally consists of cylinder, piston, damping channel, damping medium (high density of viscous liquid) and guide rod and other components. When the engineering structure due to earthquakes or wind load deformation occurs in the structure of the viscous dampers piston and cylinder between the relative movement, the pressure difference between the piston before and after the viscous fluid from the damping channel through the damping force, Thus consuming the energy of the earthquake or wind load to the structure, in order to achieve the purpose of reducing the structural dynamic response.

(3). viscous damping wall

The internal and external steel plate and steel plate in the viscous liquid between the three parts, the internal plate fixed on the upper floors, and external steel plate fixed on the lower floor, and the steel plate along the plane motion in which. In practical engineering, the reinforced concrete or fireproof material wall is often placed outside the damping wall. When the earthquake, the floor due to the interlayer displacement so that the steel plate relative to the outer plate relative motion, viscous fluid is shear wall, shear force generated energy consumption, so as to achieve the purpose of seismic input energy consumption.

4. Application of Viscous Dampers in Building Structures

4.1 Frame Supported Shear Wall Structure Engineering

In recent years, the structure of the high-rise building with shear wall, due to the architecture of the functional diversity (the bottom or bottom floors need as a shopping center or restaurant), the upper is used as a standard of residential, office and hotel etc.. Therefore, the following floors are usually designed as frame structures, and the floors above are supported by shear walls on the frame -- the frame supported shear wall structures. The lateral frame shear wall structure stiffness of shear wall in frame supporting floor prone to mutation, in strong earthquake or wind under the action of the bottom frame is often due to the small, lateral stiffness, ductility and shift reasons caused by insufficient strength is not enough structural damage or even collapse.

Moreover, in recent years, with the building diversity requirements, not only in the bottom or bottom of the layout of large space, but also proposed a large multi-storey space, that is called "high" conversion". The frame supported shear wall structure belongs to complex structure, and if the converted storey is improved, the construction difficulty of building will be greatly increased. Therefore, many scholars at home and abroad have done a lot of research on it. In view of the change of floor position change, it is found that the higher the floor height is, the higher the mutation is likely to occur. So researchers began to apply energy dissipation devices to complex structures, such as frame supported shear walls. The results show that the often large energy dissipation frame supporting layer of frame shear wall structure, structural damage in the frame layer, so the frame energy dissipation device layer equipment, which will make the viscous damper seismic safety is greatly improved.

4.2 Application of Reinforcement and Reconstruction Project

With the continuous improvement of engineering safety requirements and engineering seismic standards, many building structures need urgent reinforcement and reconstruction, and practical and effective seismic strengthening methods have been paid more and more attention. But in many cases,

a simple increased column and beam sizes will cause structural stiffness increase, reduce cycle, the results often cause earthquakes more, make the structure fall into this vicious spiral, sometimes in the usual way to solve. The seismic damper system can solve this problem better. If the liquid viscous damper has no stiffness in itself, it will not change the natural vibration period of the structure. On the other hand, the damper increases the damping ratio of the structure and plays the role of energy dissipation, so as to achieve the purpose of damping. This makes the system favored by structural engineers all over the world, and has been applied more and more in practical engineering.

5. Application of Viscous Dampers in Bridges

5.1 Application of Viscous Damper in Continuous Beam Bridge

Continuous girder bridges with stress form reasonable, simple structure, convenient construction and high structure stiffness and small deformation etc, in recent years, a span of 50 to 120 m prestressed concrete continuous girder bridge is more and more designers favor, widely applied in city bridge and across the river and cross sea bridge. It has become one of the focuses of research and application to improve the seismic performance of such bridges by introducing shock absorption and isolation devices. It is one of the aspects to introduce dampers to improve the seismic performance of bridge structures.

The viscous damper is an effective energy dissipation device, linear viscous damper has the advantages of the structure preserving linear response, viscous damping force and displacement is not sensitive to temperature, the synchronization in a wide frequency range. With the increase of span of bridge, especially the increase of span of continuous beam bridge, the traditional method of setting fixed support only on one pier is a difficult problem for seismic design of fixed pier. In the activities of the pier top dampers, one can reduce the seismic response of the bridge structure, on the other hand can make the movable pier share part of the earthquake, which is the effective measures to solve the seismic problem of long span continuous beam bridge.

5.2 Application of Viscous Dampers in Cable Stayed Bridges

Stay cable is the main bearing member of cable-stayed bridge, which has a large slenderness ratio and relatively soft characteristics. With the increase of span of cable-stayed bridge, the ratio of length to diameter of stay cable increases, stiffness and damping decrease continuously, the natural frequencies of the first few steps are below 2Hz, and the modal damping ratio is about 0.001 when the vibration reduction measures are not taken. The stay cables of low damping are easy to generate large vibration and even large divergence vibration in the wind, wind and rain, earthquake and traffic, which affect the service life of stay cables.

As long as the damping of the cable reaches a certain level, its vibration can be suppressed. Viscous dampers are suitable for permanent vibration suppression of stay cables because of their stable parameters, easy installation and good damping effect. The thin hole type viscous damper damping mode affected by the ambient temperature is small, viscous force generated by the fluid through the orifice to dissipate the energy of cable vibration, reduce the vibration amplitude, vibration and suppression of cable. Through parameter analysis and experimental research can determine the damping coefficient of variation of thin hole type damping form, combined with the optimal damping coefficient of theoretical model analysis of the precise control, realize the engineering application of viscous damper products.

6. Conclusion

To sum up, the rational use of viscous dampers in various fields of civil engineering can greatly improve the ability of seismic and wind resistant, anti-vibration structure, can strengthen the capacity of the structure under rare earthquake damage and collapse resistance. Although our current reference above damper has made some achievements, but also exposed the key problems like lack of corresponding design specifications, the corresponding test methods and test procedures and a series of industry development inevitable. In addition, the gap between our country and the foreign countries

in the production of dampers is very large. Whether we design, construct or test, we need to make further efforts to better apply the damper to the actual engineering.

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