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Research Status and Prospect of Structural Vibration Control

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Abstract

Since ancient times, earthquakes have caused great disasters for people all over the world. Vibration control of civil engineering structures is a new topic in the field of seismic resistance of Engineering structures, which is of great significance in effectively reducing disasters. This paper will focus on the analysis of recent research on structural vibration control in civil engineering, including active control, passive control, intelligent control and hybrid control, and briefly expound its advantages and related research content, and further explore its future development direction.

Keywords

Vibration control; civil engineering structure .

1. Introduction

Earthquakes and the secondary disasters caused by them are very harmful and directly endanger the safety of life and property of the public. However, the previous anti-seismic methods mainly focus on "resistance". That is to say, the load force and deformation of components themselves should be reasonably used to reduce the energy brought by earthquakes, resist the vibration caused by earthquakes, and then reduce the seismic response. Nowadays, with the development of science and technology, many scholars have gradually introduced vibration control into the field of seismic research, and developed it into an effective way to resist earthquake disasters, especially the hybrid intelligent control. In this paper, the core content of vibration control of civil engineering structures will be discussed and analyzed in depth, and its follow-up research and development direction will be briefly introduced.

2. Recent Research on Vibration Control of Civil Engineering Structures

During the whole period of earthquake occurrence, all engineering structures will be damaged to a certain extent due to their strong dynamic force and load action. It is difficult to prevent various kinds of damage caused by loads by common anti-seismic design in engineering structures. Therefore, in recent years, vibration control of civil engineering structures has gradually come into people's vision and gained widespread attention of the public. And it has been widely used in the seismic field of various projects. In fact, some of the stipulated parts of civil engineering structures are equipped with equipment structures or mechanisms with special control capabilities, such as vibration isolation cushions, energy dissipation braces, energy dissipation shear walls, etc., which adopt more scientific and reasonable control methods to ensure that each engineering structure will not be affected by acceleration and displacement caused by earthquakes or strong winds, thus ensuring the engineering structures themselves and instruments. Safety of equipment and personnel. The installation of these control devices or mechanisms can better differentiate the vibration action of the project in the process of earthquake, and then reduce the force borne by the project itself. The effective combination of adjusting the natural frequency or period of the structure, increasing the foot bone damping and

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increasing the control force can be used to reduce the different responses of the structure under the vibration conditions. Structural vibration control was widely used in machinery, ship and Astronautics at first. With the progress and development of this technology, it gradually spread to the field of civil engineering. Nowadays, civil engineering structural control is usually divided into four types: passive, active, hybrid and intelligent.

3. Exposition on Vibration Control of Civil Engineering Structures

3.1 Passive Control

This method is to add a subsystem in engineering processing or to improve some components of its architecture to change its own characteristics. Its advantages are that it does not use external energy, and has simple structure, low cost, easy maintenance and repair, etc. According to its mechanism, the control mode can be divided into three types: isolation, energy dissipation and energy absorption.

3.2 Active Control

Compared with passive control, active control architecture is more complex, requiring external energy to support it. The cost is higher and maintenance is difficult, but it has a good control effect for high-rise buildings. Its core components are sensors for detecting the dynamic response of the architecture, controllers for transmitting information from control superiors, controllers for outputting relevant instructions of actuators and actions for forming control capability.And so on. The mechanism is that the sensor detects the dynamic response of the structure and transmits the measured information to the computer. The computer calculates the final applied force according to the prescribed formula algorithm, and finally transfers it to the energy-driven actuator to generate the control force added to the structure. It has two main types: control force and variable structure performance. The former is to increase control force in the process of the structure being stimulated, so as to reduce the vibration of the structure faster; the latter is to use dynamic response to adjust the internal parameters of the building structure independently, so that the external energy required is lower than the control force type, and then to a large extent change the dynamic nature of the structure. Therefore, structural performance variability has a better development prospects.

3.3 Hybrid Control

This way is a hybrid control system, which combines the active and passive control methods organically. This way can have the advantages of both methods at the same time. It can not only consume a large number of vibration energy, but also ensure the reliability of the control. In addition, it solves the constraints of the simple use of passive control, reduces the control force, and thus reduces the external control equipment.

The resulting power, volume, energy and maintenance costs are more widely used.

3.4 Intelligent Control

It uses intelligent raw materials and control theory to change the dynamic properties of the structure by adjusting the internal parameters of the structure in the process of the structure itself being stimulated by vibration, and then achieves the way of reducing the vibration response. Intelligent control theory is used to concentrate fuzzy control, neural network control and genetic algorithm respectively. Intelligent raw materials are mainly controlled by material systems and piezoelectric materials. These raw materials have the ability to perceive internal and external information and to react quickly when the internal and external environment changes.

4. Development prospects

Essentially, the vibration control of civil engineering structure is a subject which involves many and extremely complex subjects. In the course of application, it will include computer technology, civil engineering, seismic project and materials science, etc. Therefore, the development prospect and direction are summarized and divided into the following points.

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(1) Vibration control of civil engineering structures based on energy recovery. This is mainly due to the fact that it is difficult to ensure the existence of sufficient external energy at the moment of the earthquake, so the active control system will lose its due role. But if we use energy recovery reasonably, we can overcome this problem fundamentally. Although there are still many problems to be overcome and overcome, such as energy balance theory research, how to recover vibration energy efficiently and so on, these problems will be gradually overcome with the progress of science and technology.

(2) Research on standardization and practicality of passive control technology. Nowadays, the passive control system is more widely used. Relatively speaking, its system is more perfect and its security and reliability are good. By testing this technology in actual projects, it can be further sorted out and standardized, and ultimately promote its application in the process of project implementation.

(3) Set up and analyze the mechanical model of ductility energy loss of the structure. After discussing the parameters such as index, strength, nature and characteristics which affect the energy loss construction, discuss the nature of the overall structure, and then discuss the architecture system with reasonable control equipment.

5. Concluding remarks

In summary, the analysis and discussion of structural vibration control in civil engineering has a very good prospect of application and development, which will bring great social and economic benefits, and the value of discussion is very high.

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