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Principles and State-of-the-art Practice of Seismic Design of Modern Building Structures

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Abstract:Principles and state-of-the-art practice of seismic design of modern building structures is studied in this paper. At present, the earthquake damage can be simply divided into two parts: upper vibration and bottom instability. According to the currently widely accepted classification of earthquake damage, the vibration of the upper structure can be considered through the structural design, while the instability of the bottom such as faults, landslides and ground subsidence, etc. It is very important to then ensure the safety of the seismic performance of super high-rise structures. In the context of the new era, the scale of super high-rise building projects and the complexity of the structural system are gradually increasing. Hence, this paper gives the novel suggestions and proposes the solutions, the details have been discussed.

Keywords: Modern Building Structures; State-of-the-art; Practice of Seismic Design; Principles; Information Structure

1. INTRODUCTION

When carrying out the steel structure design work, designers should clarify the key points of structural design according to the requirements of relevant national standards, and ensure the safety and reliability of the overall structure to the greatest extent. With the rapid development of high-rise buildings and the shortage of land resources, it is particularly important to build super high-rise structures in densely populated cities.

It is very important to then ensure the safety of the seismic performance of super high-rise structures. In the context of the new era, the scale of super high-rise building projects and the complexity of the structural system are gradually increasing. How to ensure the wind resistance and earthquake resistance of the super high-rise buildings through structural design and meet the expectations for the structural system of super high-rise buildings in the new era has triggered the attention of the scholars and designers of super high-rise buildings in China. High-rise buildings have different stress characteristics as the following aspects.

(1) From the structural point of view, a high-rise building is a vertical cantilever structure. The higher the height, the axial force generated by the vertical load will increase linearly. Therefore, the height of the high-rise building is positively correlated with the load change, and the horizontal load causes the structure to bend. moment.

(2) Although the change of height of the building determines the change of the force, the direction of vertical load will not change accordingly; unlike the horizontal load, which will generate different loads in any direction and thus have corresponding effects on the structure of high-rise buildings.

To this end, designers must conduct a comprehensive analysis of each component during the design process to then ensure the accuracy of the calculation results and the scientificity and rationality of the steel structure layout plan, thereby further prolonging the service life of the building. Sample of the Seismic Design of Modern Building is presented in the figure 1, and in the next parts, details will be discussed.

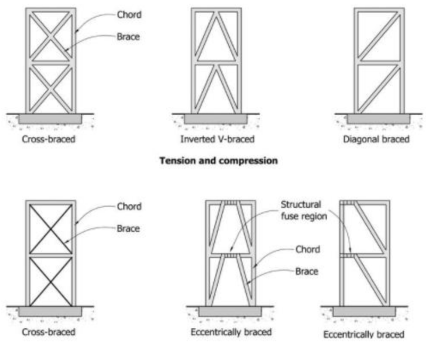

Figure. 1 The Sample of the Seismic Design of Modern Building Structures (Reference figure: https://www.pinterest.com/pin/272819689902522698/)

2. THE PROPOSED STRUCTURES

2.1 The Basic Features of Seismic Design

Compared with reinforced concrete structures, under the same load, steel structures have smaller cross-sectional dimensions and thinner thicknesses. However, this feature also leads to poor stability of the steel structure frame, and instability has become one of the main reasons for the destructive disaster of the steel structure. Therefore, the design of beam and column in steel frame structure must carefully analyze the interaction of each member in the frame from listed aspects.

(1) In addition to the seismic design based on rational analysis, the experience and lessons gained in engineering practice are especially valuable. The process of the earthquake action is complex, many theories have not been scientifically verified, and it is difficult to use quantitative calculation methods. Therefore, empirical results must be combined.

(2) Professional theoretical knowledge is the basic support of seismic design, which requires a lot of the calculation and deduction to fully reflect the seismic effect of the building structure. In many codes, the general theoretical analysis and

calculation formula related to seismic design are specified, and the limit value of design permission is given.

In general, mechanical problems can be divided into two categories: linear and nonlinear.

For linear problems, the deformation problem is less. In the practice, if the bounds do not satisfy the properties of the equation, then the problem is nonlinear. Seismic performance-based design is a new development of seismic design based on conceptual design. Seismic performance-based design is still based on the existing seismic design level and also economic conditions. The general design process is to understand the performance goals from the force-bearing body.

It mainly adopts various design methods and devices to make the whole structure or certain parts, and the key components have the least damage during the earthquake action. The level of the performance can be defined as following aspects.

(1) Once an earthquake occurs, the building will bear great external stress, which will seriously damage the beam-column structure of the building. If the damage of the column structure is large, it is very likely to cause the collapse of the entire building. For this reason, designers must implement the design and construction of steel structures in accordance with the principle of "strong columns and weak beams". Practice has proved that adhering to the design principle of "strong columns and weak beams" can reduce the load of column structures to a certain extent.

(2) It has the advantages of good anti-seismic performance and light overall weight, but the disadvantage is that the cost is relatively high. Due to the smaller cross-section of steel structural members, their advantages in ductility are more obvious. In the structural design, it is more suitable for the flexible schemes.

2.2 The Seismic Performance of Multistory Steel Frame Structures

By analyzing the change of the vibration frequency of the steel structure in different soil conditions, and analyzing the change of the structural foundation frequency under different soft and hard foundation conditions, we can draw a conclusion that the core model frequency is the largest under the rigid foundation condition, while the soft foundation as the model frequency is the smallest for soil conditions. By comparing and analyzing the overall indicators of the structure, such as period, total mass, stiffness-to-weight ratio, floor base shear force under earthquake action, interstory displacement angle under earthquake action, effective mass coefficient, ratio of overturning moment, ratio of zero stress area, etc. constant.

The transmission route of earthquake action should be designed reasonably. The stress of the multi-layer masonry structure can be divided into horizontal wall bearing, vertical wall bearing and horizontal wall bearing together. Generally, vertical wall bearing masonry structure is not chosen, and the other two bearing modes are more conducive to the transmission of earthquake action. But also conducive to the flexible layout of the room.

3. CONCLUSIONS

Principles and state-of-the-art practice of seismic design of the modern building structures is studied in this paper. At present, our country's construction industry is maintaining a trend of rapid development, and the number of buildings with irregular shapes is gradually increasing. While this type of building brings novelty to the public, it also puts forward the higher requirements for the application of inclined columns and the stability of the steel structures. This paper gives the novel suggestions for the structure optimization.

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