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Seismic design of reinforced concrete frame structure

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Abstract

The aseismic effect of high-rise concrete buildings is related to the safety of people's life and property. The development direction of high-rise concrete buildings in the future is mainly to improve the aseismic performance and isolation. In the preliminary design process of high-rise concrete buildings, the seismic design must be carried out in strict accordance with the national code. The construction process should also be carried out in an orderly manner according to the scientific construction organization plan, and appropriate structural types, foundation forms and materials should be scientifically selected to ensure that the buildings present a high level of seismic effect.

Keywords

Seismic design, structural style, Basic principles of structure construction.

1. Introduction

Earthquakes are destructive to buildings, and they are characterized by randomness and uncertainty. Earthquakes are often followed by aftershocks, which sometimes cause serious harm. At present, the use of concrete structure in high-rise buildings is a common form of building in China. The design of seismic effect of high-rise concrete buildings aims at reducing the damage caused by earthquakes and ensuring the safety of people's lives and property. In the process of structural seismic design, it is necessary to master the geological conditions of the site where the building is located, and apply scientific methods to steadily improve the seismic performance of high-rise concrete buildings, so as to avoid serious damage caused by earthquakes.

2. The goal of seismic design of buildings

The goal of aseismic design is a fundamental problem, which clarifies the expected performance of buildings under the action of earthquakes. The randomness and uncertainty of earthquake load occurrence are much greater than floor load, structural dead weight and wind load, etc., so it is not required that the structural deformation of buildings should be kept within a controllable range in any earthquake situation. This is neither scientific nor economical. Therefore, the reasonable seismic design goal is to make different standard requirements for the seismic performance and expected seismic effect of buildings according to different degrees of earthquakes. In article 1.0.1 of China's current code for 《building seismic design》 GB50011-2010, the basic seismic fortification target for seismic design is expressed as follows:

(the first level) when the main structure is not damaged or does not need to be repaired, it can continue to be used when the earthquake intensity is lower than that of the region;

(the second level) damage may occur when it is affected by seismic fortification intensity equivalent to that of the local area, but it can continue to be used after general repair;

(the third level) no collapse or life-threatening serious damage will occur when the earthquake is less severe than the earthquake intensity of the region.[1]1

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The above is the familiar "three kind of level" defense target, summed up as "small earthquake is not bad, moderate earthquake can be repaired, big earthquake can not fall"[1]256。Therefore, it can be learned that when the building encounters different degrees of earthquakes, the requirements for the seismic resistance of the building are not the same.Aseismatic design allows partial destruction of buildings on the basis of ensuring the safety of people's lives.

The “seismic code” also mentions:"Seismic fortification is based on existing scientific and economic conditions,"According to the 《 classification standard of seismic fortification of building engineering》 GB50223-2008, fortification buildings are divided into special fortification, key fortification, standard fortification and moderate fortification[2].In rural areas, most of the buildings belong to the standard fortification category.The standards of defense are also different.This is based on the importance of the building, combined with the corresponding economic conditions and classification.Moreover, the setting of the basic fortification intensity in each town of our country is closely related to the economic conditions and technical level.

China's current code for seismic design of buildings not only regulates the seismic measures of masonry buildings and reinforced concrete buildings, but also regulates the seismic measures of wooden structures and stone structures.This is precisely based on different construction techniques, local customs and economic conditions and put forward the specific seismic design requirements of different types of structures.

3. Reinforced concrete structure

Reinforced concrete structures often suffer serious damage under strong earthquakes, especially frame structures[3].These damages are often caused by wrong seismic design and poor construction quality.If the seismic design code is strictly followed, the reinforced concrete structure will exert its strong seismic performance.The local plastic damage of concrete, the need for some structural repair after the earthquake is acceptable, the overall safety will be guaranteed.

Concrete has high stiffness, good durability and strong compressive resistance.From the seismic point of view, it also has some defects.Firstly, concrete has low tensile strength and small deformation capacity.Secondly, concrete is a brittle material, once destroyed, it immediately loses its structural characteristics.

The tensile strength and ductility of concrete structure can be improved by adding steel reinforcement.The bond property between steel bar and concrete is very important to the ductility and strength of reinforced concrete.So should avoid using light round rebar.In order to bond with concrete, it is more advantageous to use more reinforcement with smaller diameter than less reinforcement with larger diameter.

Research in the earthquake zone shows that many structural components are destroyed before they can give full play to their structural performance. For example, the column can also withstand greater bending, but should be shear failure and loss of structural function.In order to give full play to the mechanical properties of reinforced concrete frame structure, the design should follow the principles of "strong column and weak beam", "strong shear and weak bending" and "strong joint and weak member"[4]125.

"Strong column and weak beam" refers to the failure of frame beam before that of frame column.In earthquake zones, some of the frame columns were destroyed before the beams, causing buildings to collapse without supporting structures.When the column ends hinge, the frame structure can consume a lot of earthquake action, thus reducing the probability of collapse of the building during the earthquake.Under lateral load, the column should be able to deform within the whole floor range, while the deformation of the short column is restricted by sill wall, mezzanine stair platform, etc.Under the same deformation, the short column is subjected to much more force than the ordinary column.Under strong earthquakes, short columns suffer large shear forces and consume little seismic

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energy.If short columns are unavoidable, they should be integrated with reinforced concrete shear walls to ensure the resistance of short columns to horizontal load[4]115.

"Strong shear and weak bending" means to strengthen the shear resistance of members, so that the bending failure of the structure precedes the shear failure. In the earthquake-stricken area, many reinforced concrete frame building pillars have suffered serious shear damage, steel bars twisted, concrete off. Thus, the pillar loses its support. In engineering design, the shear resistance of components can be improved by means of encryption stirrup.

"Strong node weak component" aims at strengthening the construction measures of nodes. In the earthquake, due to the high stiffness of the node will bear a large force, is vulnerable to damage in the frame area. The damage of joints will greatly reduce the seismic performance of buildings. Therefore, in the earthquake zone should strengthen the structural measures of the node.

In addition, filling and partition walls cannot be ignored in the frame structure. The lateral stiffness of the filled wall changes the performance of the frame to a large extent, which is not conducive to the seismic performance of the building. When the stiffness of the filled wall is too large, the deformation of the column will be limited locally, which leads to the shear failure of the column.

In modern architectural design, in order to achieve the light aesthetic effect, architects tend to use glass curtain or aerial at the bottom, while the upper part of the building USES solid filling wall. Under the static condition, the frame shear structure can completely meet the load bearing requirements. When the earthquake occurs, the stiffness of the upper filled wall is much greater than that of the glass curtain, and the bottom frame column will suffer serious shear damage. So, in seismic area should pay attention to fill wall to arrange, prevent its to the adverse effect that building aseismatic performance brings.

4. Building details and seismic design

Roof is an important part of architectural design. Roof modeling techniques are diverse, parapet and roof framework are its main modeling elements. However, due to the lack of structural constraints of parapet and frame, the flat roof form of the roof becomes the weak seismic performance of the building.

The destruction of flat roofs is caused by the "tail effect"[5]. Below seismic action, the seismic action that the structure of outstanding roofing suffers because of "tail effect" and be magnified, bring about damage then. So, buildings should strengthen the aseismatic measure of roofing part, especially parapet and housetop structure.

In order to improve the seismic performance of flat roof, parapet modeling should not be exaggerated, the height should not be too high, and should strengthen the integrity of roof construction and building. To improve integrity, parapets are usually cast in situ with concrete. Some architects like to set holes in their daughter's wall to enrich the changes of the facade, but this practice destroys the integrity of the parapets, which is unfavorable to improve the seismic resistance of the building. From the seismic point of view, roof frame design is not conducive to building seismic. Part of the roof structure is complex, insulation, waterproof and other structural layers, set roof structure increases the burden of the roof. Therefore, in earthquake prone areas, it is not appropriate to design architectural modeling through the form of roof framework.

In addition, pitched roofs are common roof forms. From the seismic point of view, it can basically avoid the adverse effects of whipping effect on buildings. If the roof is cast-in-place as a whole, the integrity and structural continuity of the house will be improved. This will be more conducive to building seismic.

5. Summary

According to the requirements of seismic resistance, the most reasonable construction scheme can be designed according to the requirements of different buildings and the corresponding geological

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conditions of each building, so as to promote the progress and development of the construction industry.

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