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The Problems and Strategies of Structure Design of High-Rise Buildings with Beam Type Conversion Layers

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Abstract: With the acceleration of urbanization, there are more and more high-rise buildings. The beam type conversion layers of high-rise buildings play the role of transitional connection. This conversion layers reasonably distribute the vertical load of the upper structure to reduce structural breaks and stress concentration and to achieve structural continuity and stability. The design of beam type conversion layers is the core of the modern high-rise building. This paper studies the problems of structure design of high-rise buildings with beam type conversion layers, and puts forward corresponding countermeasures.

Keywords: Beam type conversion layers; Structure design; Problems and countermeasures

1. Introduction

In the city, there are more and more high-rise buildings with multilayers and complex structure. The beam type conversion layers of high-rise buildings play the role of transitional connection. Generally speaking, different locations need to have different functions, such as, the bottom floors are used for the garage, catering, retail, etc., the middle floors are used for the office, business, etc., and the upper floors are mostly residence. Due to the different functions of each position, the structure of the buildings will be different, we need to meet a series of strength demand on high-rise building, including structural performance, safety and etc..To set up the conversion layer is the main way to effectively connect and transmit each layer of the structure. There are some classifications of conversion layers, this paper mainly study the beam type conversion layer structure.

2. Characteristics of High-rise Buildings with Beam Type Conversion Layers

2.1. Characteristics of high-rise buildings

The multiplicity and comprehensiveness of architectural functions in today's construction field has become particularly important. The bottom and middle of the high-rise buildings are usually sparse commercial construction modes. Most of the upper part of the buildings are relatively dense structure modes. And the construction itself has a contradiction in the stability of stress.

The application of beam type conversion layers of high-rise buildings can completely solve the existing contradiction problems. The research and development of beam type conversion layers and relevant technology field has very important effects and meanings. The biggest challenge is to analyze the bearing loads of building itself , most of the buildings in the lower part are often relatively dense and the upper structure are basically maintained the corresponding sparseness, to ensure the stability of the buildings.

Beam type conversion layers of high-rise buildings in the structural design not only need to effectively ensure the borne horizontal loads, but also guarantee that they can withstand the vertical loads. In the design of the beam type conversion layers of high-rise buildings, it is particularly key and important to control the bearing capacity to the reasonable category.

2.2. The stress characteristics of beam type conversion layers

1) The frame supported shear walls structure with a bottom large space regards conversion layer as the dividing line. And the deformation of the upper part of the shear walls do not change too much. The lateral stiffness of the underlying frame supported shear walls decreases very quickly, and inter-floor shear force generated by the horizontal external force between the floor and floor is distributed according to the equivalent stiffness proportion of the shear walls. So the horizontal force borne by the bottom shear walls would increase much larger and the horizontal force borne by the bottom framework would decrease rapidly with the change of stiffness.

2) The rigid floor of conversion layer makes the shear of the upper and underlying floor be redistributed and the distribution relation of the horizontal stress of the underlying floor is very different from super floor. At the same time, the force of rigid floor in-plane conversion layer is very big, which will produce relatively obvious deforma-

tion. Therefore the assumption that stiffness of floor plane is infinite is certainly impacted.

3) Because the lateral stiffness of the frame supported pillars is very low compared to shear walls, usually less than 1%, so the frame supported pillars bear a few horizontal force in accordance with the principle of proportional distribution of equivalent stiffness. When the floor of the conversion layer has a deformation, the horizontal displacement at the bottom of the conversion columns area will reach the maximum value, therefore the actual shear borne by the bottom frame supported pillars be much bigger than the results calculated by using theoretical analysis.

3. Design Principles of the Beam Type Conversion Layers of High-rise Buildings

Beam type conversion structure of high-rise buildings should meet the requirements of the corresponding design principles to play an efficient role, improve the space conversion capacity of high-rise building , and enhance the level of construction.

1) To reduce the use of vertical components as far as possible, in order to avoid the vertical components impact the conversion effect. The vertical components are the main sources of the stiffness mutation, so it is necessary to strictly control the use of the vertical component.

2) The structure design of beam type conversion layers needs to be strictly distributed in proportion, to ensure the balance of internal force transmission, play the advantages of the strength equilibrium of the conversion layers and effectively assume the internal force of the high-rise building.

3) The structure design of beam type conversion layers needs careful calculation, based on the calculation formulas, combined with the actual strength of high-rise buildings, to ensure the accuracy of the structure design.

4) To control the intensity distribution of structure design of the beam type conversion layers. The strength can improve the adaptability of the conversion layer, which should combine the force of basis of high-rise buildings, can't arbitrarily assign the intensity of structure. To control the strength of the structural design of the beam type conversion layers can ensure the performance of the beam type conversion layers, and to optimize the application of the d conversion layer in the high-rise building.

4. The Problems of Structure Design of Beam Type Conversion Layers

4.1. The problems of torsion

Over the years, the analysis of seismic damage shows that the torsion is an important reason leading to the damage of structure under the earthquake action.but there are many factors that cause the torsion of high-rise structure and that are difficult to calculate. Therefore, emphasizing the conceptual design of structure is particularly important. The main factors of torsion are as follows:

1) The excursion of stiffness center

There are many factors such as the limitations of construction and other conditions, controlling the size of the component is not precise enough, the material properties of the structure have a mutation and the conditions and ways of components under load are different and etc, which make uncertainty of the structural stiffness exist, resulting in stiffness center changes.

2) The excursion of mass center

Mainly due to the randomness of the mass distribution, there is a certain deviation between the mass center and geometric center of the structure, and the distribution of the weight and the load of the structure has a change.

When the center of mass and stiffness of the structure are not coincident, the equivalent force of the earthquake is applied to the center of mass. Therefore, it makes the center of the stiffness produce the torque, causing the force and displacement of the structure is not uniform in the same plane.

3) The degradation of structural stiffness is uneven

When the structure enters the plastic stage under earthquake action, no matter whether the structure is regular or not, it is possible to cause the torsion of the structure because of the change of the shape of the structure.

4.2. Problems of stress properties

In the initial stage of structure design, for the structure design scheme of high-rise buildings with beam type conversion layers , architects generally rarely consider the concrete structure of high-rise buildings, while consider the spatial structure of high-rise buildings too much. It makes the stress properties of high-rise buildings with beam type conversion layers exist some problems.

The position and the equivalent stiffness ratio of conversion layers are two main factors that affect the seismic performance of conversion layers structure. equivalent stiffness ratio has an important influence in the up-down shear distribution and stress-transfer pathway of conversion layers, while the conclusion of its research results are not coincident .

4.3. Problems of earthquake action

The earthquake itself is very complex, the current research on earthquake is not yet mature. when designer do the structure design, they tend to feel the supporting theory is not complete, and can not effectively control the security of the designed structure. The research of beam type conversion layers structure under the action of earthquake is not deep enough, which is much less than ordinary high-rise buildings. How to research the earthquake response and earthquake action calculation of high-rise buildings with beam type conversion layers under horizontal earthquake needs further study.

5. The Design Strategies of the Beam Type Conversion Layers of High-rise Buildings

5.1. Plane layout design

The plane layout design of beam type conversion layer is relatively simple. High-rise buildings generally use symmetrical ways. To control the error of both sides of the symmetry can reduce the force eccentricity ratio and stabilize the focus of the conversion layers. Plane layout design needs to do around the surrounding of the beam type conversion layer to enhance the intensity of the conversion layer and guarantee that high-rise buildings can maintain the high stability in the process of twisting.

The structure design of the beam type conversion layer can cause the displacement of high-rise building in the horizontal direction. Controlling the displacement distance to reach the torsion standard, and improve the torsional ability of the high-rise building. Therefore, the plane layout design of beam type conversion layer need to meet the actual needs of the high-rise building, we must use reliable control way to strictly control each data of plane layout and avoid the error in the structure design influencing the high-rise building stability.

5.2. Vertical layout design

Lateral stress of high-rise building is in a state of disequilibrium, under stress is much bigger than the above, it is easy to cause the stiffness mutation. But the beam type conversion layers of high-rise buildings does not conform to this type of stress distribution, so the vertical layout of beam type conversion layers has several ways as follows:

1) To reduce the vertical stress of the beam type conversion layer, as the research object, the above shear wall can be used to control the vertical force. For example, a project maintains the original number of shear walls, cuts the thickness of each shear wall, and reduces the vertical bearing capacity to reduce the vertical bearing capacity of the beam type conversion layer.

2) To enhance the stability of the beam type conversion layer and use the advanced concrete materials to ensure the stability of the structure. C40 belongs to relatively stable concrete, using C40 concrete can achieve grading requirements.

3) To control the thickness of the core tube,which is located in the shear wall. If the thickness of the core tube is more than 400 mm, the conversion layer of the structure can be effectively stabilized.

5.3. Design of seismic gradation

In the design and construction of high-rise buildings, the conversion layer be in a connecting part. Below the conversion layer is the framework of the shear wall, above all are the shear wall, whose complexity is the much higher. So the high-rise building with beam type conversion layer is facing the design problem of the seismic level. The basic design of the beam type conversion layer needs to correspond to the specification of the seismic gradation, so we must ensure that the seismic level is in line with the needs of the beam type conversion layer.

The common beam type conversion layer is designed according to the corresponding level of seismic. For special conversion layer, we need to clear the seismic gradation and use a higher gradation, such as high position conversion layer should be initiative to improve seismic rating because of high position conversion layer is in structure strengthen zone of high-rise building, which belongs to the key structural points and carries all the earthquake force. So we must appropriately improve the level of the according to the actual situation.

6. Conclusion

The beam type conversion layer plays an important role in the high-rise building , which can improve the construction index of the construction project, and guarantee the stability of the high-rise building. Construction companies should optimize the design of beam type conversion layer and make full use of it, to ensure that the high-rise building is a stable application structure. In the structure design of the beam type conversion layer, construction companies need to strictly follow the relevant design specifications, to avoid the design problems and optimize the structural design of high-rise buildings.

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