Seismic Performance of Column Joints with Restorable Functional Assembly Type Beam Column

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Abstract: The prefabricated column-column joint with recoverable function combines the advantages of assembly structure and section steel concrete structure, which has the characteristics of high bearing capacity and large stiffness, remarkable seismic and fire resistance, and good overall stability of the structure. In order to promote the assembly-type beam-column structure and improve the seismic performance of the assembly-type beam-column-column joints, this paper analyzes and studies the characteristics, methods and structures of the joint joints, and then popularizes the seismic performance and the assembly-type structure of the functional-assembled-column-column-column joints, which also provides a theoretical reference for the development of the assembly-type steel-concrete structures in China.

1. Introduction

In recent years, with the development of new materials and new technology, the construction of assembly structure has been widely used, and it has become a new development direction and trend of the current building structure, especially the assembly steel structure as a typical green building, which is completely in line with the standardized production design of modern buildings, can carry out the integration of production and decoration on the spot, and can also realize the information management and improve the management efficiency in the production management.[1]At present, the study of seismic performance of prefabricated beam-column structure has become a hot spot in the field of seismic research, and become an important direction of modern building innovation trend, but the research of prefabricated beam-column joint with recoverable function is relatively few, and there is no relatively mature technology. One of the difficulties is to make the structure of the building can be replaced after the local damage caused by the earthquake type damage, to realize the reversible transformation of the damage of the building, and to complete the rapid repair of the building structure which is difficult to repair or cannot be repaired.[2]This is quite different from the idea of simply pursuing the structural anti-collapse and anti-seismic ability in the traditional building structure design, which can give full play to the advantages of the fabricated steel structure building performance.

2. Research status

Many scholars at home and abroad have analyzed and studied the beam-column joints of the frame structure. After the joints are designed into semi-rigid joints by theoretical calculation, the seismic energy is reduced by using bolt rods and slips and their squeezing between walls. It is also proposed to add cover plate and weaken cover plate to the joint of cantilever beam. However, although this method has relatively good joint performance, the plastic hinge does not have a positive effect on the repair of joint after earthquake because it acts on unreinforced cantilever beam. I-beams and flat steel tubes can be considered in the study of energy-consuming components of replaceable connecting beams. These materials have good ductility and bearing capacity. More reasonable control techniques can be used to optimize the non-energy dissipation beams and the energy dissipation beams.[3]

However, the end-plate-anti-shearing method has a simpler and more reliable way, and the energy consumption of the energy dissipation beam section is more than 90% of the total energy

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consumption of the connected beam, and the replacement time required is relatively short. After decades of development, the flange of beam and column joints with cantilever beam section is often used mainly in the way of double cover plate connection and web plate as cover plate connection.[4]However, in the actual construction process, it is possible to form a new type of steel beam-column joint at the end of the column due to the accumulation of welds formed by welding, and then produce a complex stress field.

3. Development of Assembly Building

The housing conditions in many countries have been extremely poor in a situation in which human society has suffered severely and severely after the Second World War. With the gradual restoration of postwar reconstruction, the development of economic construction has promoted the recovery of population and the progress of science and technology. In order to meet the needs of different construction engineering and the environment of construction engineering, the prefabricated concrete structure building has emerged in this background and is widely used in various construction industries. At present, in the prefabricated frame structure, the prefabricated frame structure of Japan and the western countries is relatively mature, which is not only because the economic level of these countries and regions is generally high, but also because the regions of Japan and other countries are in earthquake-prone areas, and the use of prefabricated steel reinforced concrete structures has better seismic structure performance.

Figure 1 Traditional beam column construction

China's taiwan province is also an earthquake-prone area, so the technology of prefabricated concrete frame structure in this area develops rapidly, the biggest characteristic of adopting this kind of structure is that it will greatly shorten the construction time. Taking the civil buildings of the University of Taiwan as an example, it took only six months to complete the construction because of the prefabricated frame structure. The traditional seismic layer construction usually takes about 23 days to complete, but it takes only 3 days to complete the construction of the prefabricated frame structure, which greatly reduces the time required for construction and reduces the construction cost. The disaster response center in taipei has adopted a similar prefabricated frame structure, completed in just a year's time before and after construction, and has been recognized by the construction industry.

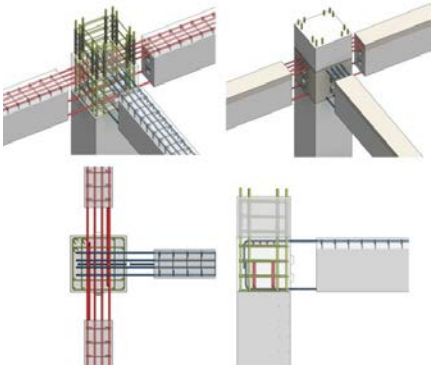

Figure 2 Good Chinese poetry

4. Design of Fabricated Beam-Column Structure

4.1. Construction Design of Assembly Beam Column Joint Joint

After many years of development, the structural design of prefabricated buildings in our country has made great progress, so it is necessary to perfect the connection construction operation to ensure the mechanical performance of the joint. After the prefabricated beams and columns are made on the production line, they are carried to the construction production site, and then the mechanical hoisting construction is placed to the assembly site according to the drawings. The prefabricated beam and column joints and sections are butted, fixed by welding, and finally reinforced by bolts. fixed at the joint by welding or steel bar binding, thus ensuring the integrity of the steel bar. When the steel bar is fully connected with the steel bar and the steel section, the formwork can be constructed and finally poured. In order to enhance the bearing capacity between the concrete and the joint, the interfacial agents such as expansion interfacial agent can be added to it.

Figure 3 Building beam column construction

4.2. Model Parameter Determination

Both linear and geometric nonlinear materials must adhere to the yield, reinforcement and flow criteria, which must not be changed. When using the finite element software to construct the model, we need to select the unit type and set the parameters of the corresponding material type and the interaction between the different materials. In the construction of model parameters, it is necessary to set and input repeated loads and submit operations, and use deformation, stress distribution, skeleton curve, failure form and other comparative analysis, we can get that the failure form of assembly type steel concrete joint is basically consistent. In the analysis of the detail part of the joint connection in the assembly Beam column joint, it is necessary to consider the seismic performance comparison analysis of the structure under the action of low repeated load. Before constructing the model, we need to choose the appropriate entity unit type, without considering the problem of large strain, we can choose the quadratic reduction integral unit to improve the operation efficiency. Because there may be a cross-section mutation in the model, it may lead to stress concentration. The beam-column joints of the assembled steel concrete or the steel beam-column joints are all subjected to the repeated load at the end of the beam.

4.3. Calculation Theory of Steel Concrete Beam Column Node Beam

In the composite structure of beam-column concrete joints, it is very remarkable that there are two kinds of materials with good properties in the structure, among which the steel materials with high strength and low weight have very remarkable fire resistance, which can form the economic components which are convenient to be applied in engineering practice. The beam-column joint of steel reinforced concrete makes full use of the joint action of steel and concrete to resist the external load. Because the beam and column joints will be in the complex stress state, both experiments also show that under the action of external force, the section steel concrete members will cause the section steel, concrete and so on to remain in the same plane under the unified section. In the calculation of section steel concrete beam-column joint beam, it is necessary to determine that the strain distribution of each section conforms to the assumption of flat section, and in the combined

section, the tensile or compressed section of the section must fully reach the design strength. In the design of the limit state of the building based on the principle of mathematical probability theory, it is necessary to consider the possible failure of the building structure based on the mathematical theory, which leads to the irreversible safety damage. In general, the limit state of the whole structure can be divided into the limit state of normal use and the limit state of carrying capacity. In combination with the probability calculation, the structural failure rate can be obtained, and the structure calculation can be divided into more reasonable structures according to the situation. There are two methods to carry out the normal section calculation, the formula calculation method and the curve law algorithm are used in the routine.

5. Conclusion

Building structure is a new type of structure under the background of residential industrialization, among which the construction technology of recoverable assembly beam column node needs to be discussed and considered. As far as the current functional construction technology is concerned, most of the joints of Beam column joints are welded, bound, and interface agents are used. The most influential factors for the bearing capacity performance of assembly Beam column joints are joint position, steel yield strength, concrete strength grade and so on. The structure of column-column joint with assembly has good seismic performance and post-earthquake recovery. The finite element analysis method can also be used to construct a suitable structural analysis model, and the force analysis and structural characteristics of the assembled beam-column joints are carried out through the model construction.

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