

Study on Seismic Performance of Prefabricated-Reinforce Concrete Junction

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Prefabricated reinforced concrete structures is a common structural system, currently developed in Europe countries, precast concrete structures has become the main form of new buildings. Precast concrete structures can be divided into monolithic assembly (after pouring monolithic) and fully assembled in two forms. In general, the whole assembly of precast concrete structures can achieve the same or nearly the same cast concrete structure seismic performance. For the whole precast concrete structures, seismic performance will depend to a large extent connected beam-column joints structure. In this paper, a complete set of in-situ assembly of high strength concrete beams, precast concrete structure of high strength concrete after pouring monolithic assembly of beams and high-strength precast concrete beam and column assembly fully assembled full scale model of the seismic performance comparison test, the results for the engineering application of precast concrete structure has good reference value.

1. Introduction

Prefabricated concrete structural design is an important technology for building structures industrialization of our country in the mid-1980s, the application of more prefabricated panel buildings, prefabricated wall structure, due to a defect on the connections, to the 1990s cast structure is gradually replaced (Lignos, 2013). Prefabricated reinforced concrete structures is a common structural system, currently developed in Europe countries, precast concrete structures has become the main form of new buildings. Situ concrete construction method, there is more than the amount of workers, environmental pollution, quality problems and other issues, needs to be improved. building industrial production model to improve the technological content and the process of building factory production ratio, reducing the amount of labor, increased the workload of mechanical work, is one of the effective technical architecture productivity around the country have established many prefabricated concrete structures manufacturing enterprises, prefabricated wall panels (Sun, 2015), floor the more research and application, relatively few studies on fabricated frame structure. Existing technology is mainly fabricated frame reinforced by reservation, on-site pouring way to achieve. Installation process of such technical complexity, more wet operations not easy on-site installation, failed large-scale promotion (Kheni, 2015).

Summarizing existing connection based on the concept of prefabricated reinforced concrete frame structure part, that reinforced concrete prefabricated column frame structure is decomposed into two parts and precast beams, beams and only reinforced the core area disposed within the range of the connection zone member, in reinforced concrete structures is not continuous, non-reinforced connecting region of SRC (Ricci, 2013). There are no similar studies at home and abroad on the connection method, in order to fully understand the mechanical properties of such structures (Pucinotti, 2015), effectively guide its application.

The paper carried a prefabricated reinforced concrete section node frame specimen low cycle seismic performance reciprocating test for comparison also performed two reinforced concrete frame structure node specimens under the same conditions of low cyclic loading test by test, verify the seismic performance of steel reinforced concrete prefabricated part of the frame structure and the reliability of the connection node design (Sun, 2015).

2. Experiment overview

2.1 Experimental design and processing

Select prefabricated reinforced concrete frame structure part of the beam-column node three specimens, which numbered SI1, SI2, SI3 (Zeng, 2013). No two specimens of reinforced concrete frame structure beam-column nodes were RI1, RI2, specimen size design and reinforced configuration shown in Figure 1.

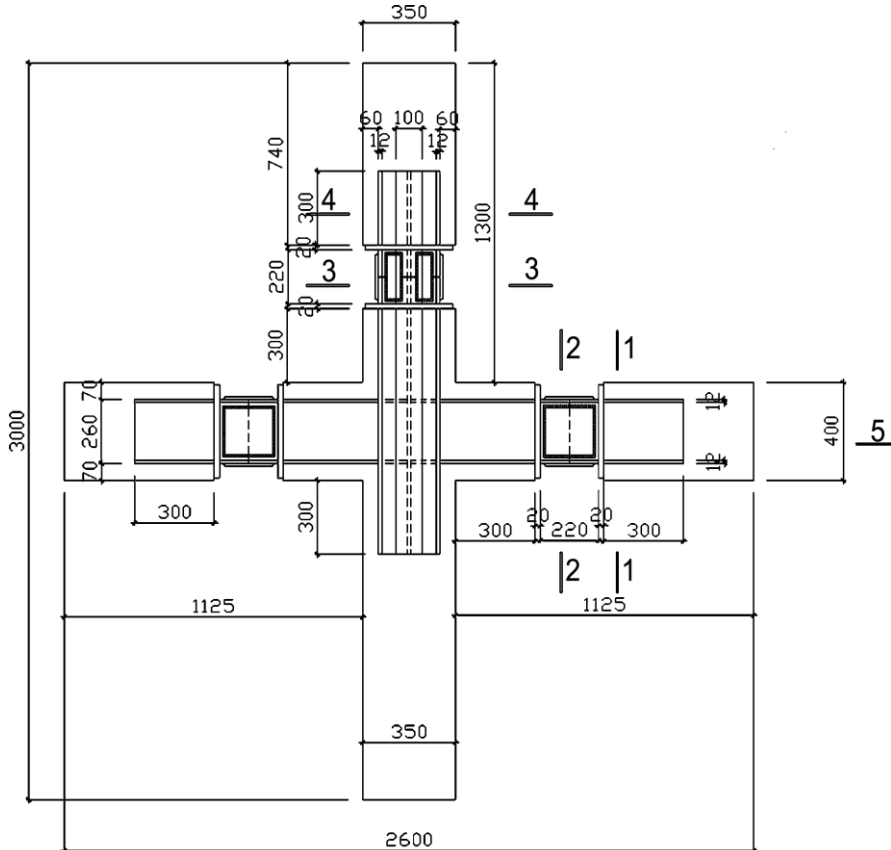


Figure 1: Specimen steel, reinforced sizes and configurations

Prefabricated reinforced system of reinforced concrete frame structure part of the specimen cross section is located in the center position of the beam reinforced with welded I-beam, flange width of 150 mm, beam height 260mm, web and flange plates thickness are 12 mm (Zhang (2012)). beam connecting region using the up and down both sides of the web and flange welded 12 mm thick steel plate is connected (Lu (2015)). the SRC column using 12 mm thick steel plate welded into the cross-shaped symmetrical reinforced height 230 mm, flange width of 100 mm, the main connection area using the cross-shaped steel reinforced web and flanges are welded to 12 mm thick steel plate connected to the connection area of unreinforced concrete reinforced by 20 mm thick conversion steel and reinforced concrete beams and reinforced longitudinal bars embedded in the connection.

Reinforced concrete frame structure specimen size reinforcement and prefabricated reinforced concrete frame structure partially identical specimens, but reinforced configuration, no connection area (Xiong, 2014).

2.2 Data acquisition and material test

Data were collected from this study is (1) capitals load beam end load and displacement. FSC-digital multi-channel electro-hydraulic servo control system recorded every 0.5 s 1 data collection, including the value of the load point and load displacement. crack observation (2) concrete surface before the surface of the concrete test member brush white stone mortar, painted 50 mm × 50 mm square, the test once every cycle, recording concrete crack the case, and photographed retained (Darbhanzi, 2014).

Beams are concrete strength grade C30; using self-compacting concrete, cube compressive strength of 33.5 MPa, an elastic modulus of 31.1 GPa. Q235b reinforced welded steel plate, the longitudinal reinforcement beams in the level of HRB335, stirrups level of HPB235. (Due to the reinforced concrete beam-column joints

long before the publication of the new design of concrete structures made good, so the low level of reinforcement.) Material test results are shown in Table 1.

Table 1: Material test results

Type	Level	Yield Strength/MPa	Ultimate Strength/MPa	Elasticity Modulus/GPa
Steel (12mm)	ribs Q235b	275	440	206
Steel (20mm)	ribs Q235b	290	440	206
Longitudinal reinforcement beam-column (22mm)	HRB335	433	593	200
longitudinal reinforcement beam-column (18mm)	HRB335	404	623	200
Beam (8mm)	stirrups HPB235	369	526	210
Beam (6mm)	stirrups HPB235	335	475	210

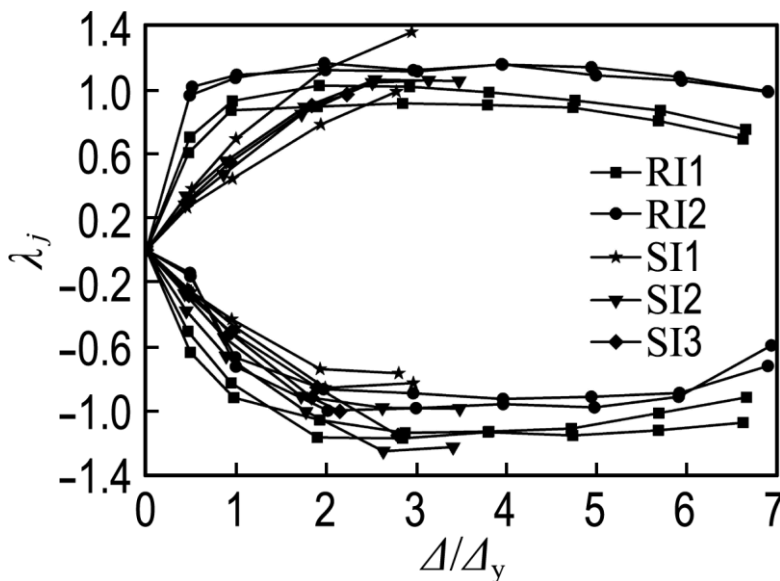


Figure 2: Nodes specimen strength degradation curve

3. Experiments and results

3.1 Bearing capacity degradation analysis

In this paper, the bearing capacity degradation coefficient, that with each level of load cycles resulting peak load and the ratio of the income level of the first cycle peak loads, to analyse the specimen strength degradation characteristics (Zhu, 2012):

$$\lambda_{ji} = F_{ji} / F_{j1} \quad (1)$$

Where: F_{ji} stage load peak load of the ij cycle; F_{j1} stage load 1st cycle peak loads.

With the load displacement increasing strength and stiffness of the specimen with increasing cycle number will gradually decrease. In order to quantitatively reflect the same degree of stiffness and strength degradation

loaded displacement of different degradation specimen loading cycle, strength degradation coefficient and μ_{qi} stiffness degradation coefficient μ_{ki} as follows:

$$\mu_{Qi} = \frac{Q_i^j}{Q_{i-1}^j}, \mu_{ki} = \frac{k_i^j}{k_{i-1}^j} \quad (2)$$

Figure 2 is a specimen of nodes with a total carrying capacity degradation coefficient λ_j load displacement $\Delta/\Delta y$ by changes in the specimen SI1, SI2, SI3 and specimens RI1, RI2, contrast visible: Prefabricated reinforced section Reinforced concrete frame node specimens degradation trends gentle, slow degradation of the strength retention is better. Also found that the axial compression ratio on the Carrying Capacity of degradation is not obvious. Specimen energy dissipation factor E can be defined as:

$$E = \frac{Area(ABCD)}{Area(\Delta OFC + \Delta OEA)} \quad (3)$$

3.2 Ductility and stiffness degradation analysis

Stiffness reflects member deformation resistance under conditions of constant displacement, with the increase of load cycles, joint stiffness (flexural rigidity of the beam) will be reduced. The smaller the reduced rate, the more stable hysteresis curve of consumption in this paper, the better the ability to be able to loop stiffness control displacements expressed similar stiffness degradation:

$$k_j = \frac{\sum_{i=1}^n F_j^i}{\sum_{i=1}^n \Delta_j^i} \quad (4)$$

Where: F to load the displacement $\Delta/\Delta y = j$, the peak load value of the i-th cycle; Δ_j^i to load the displacement $\Delta/\Delta y = j$, the peak displacement value of the i-th cycle; n is the number of cycles. Ring stiffness larger node energy consumption better.

Ductility is a reflection of the structure, a member of inelastic deformation capacity measure indicators, after yielding inelastic deformation capacity, good ductility, but the ductility requirement is not the bigger the better, there is a certain carrying capacity and a range of ductility, called effective ductility.

This test uses the displacement ductility factor μ to represent member ductility, which is defined as the ratio of the vertical displacement of the beam end limit and yield displacement:

$$\mu = D_u / D_y \quad (5)$$

Where: Specimen ultimate displacement D_u defined as the specimen load displacement skeleton curves corresponding segment decreased 0.85 times the maximum carrying capacity of displacement; the specimen yield displacement D_y determined using the energy equivalent method.

In Figure. 3, the specimen SI1 loading process, when the end of the beam displacement of 10 mm loop, two cracks appear in the connection area on both sides of the beam, the beam cross-section along a vertical crack development, from the top beam began to surface, about 200 mm, width less than 0.1 mm. beam-column joints core area appear oblique crack, about 250 mm, and the horizontal plane was about 45°, the slow development of the crack width did not exceed 0.2 mm. beam clamp terminal region appear throughout the inner beam section inclined cracks, since the SRC region too, did not continue to undermine the development of crack; when loaded into a 30 mm displacement, reinforced pillar lower edge position horizontally and diagonal cracks, and to carry out rapid, cracks width and quantity are increasing, and eventually developed into the main crack specimen damage when loading to 50 mm displacement, destruction of the specimen along the cracks.

Beam-column assembly node region shear deformation under the effect of the horizontal Figure. 4, the use of regional nodes are arranged in a diagonal direction as shown in the electronic micrometre to measure the relative displacement of the diagonal measurement point, the shear deformation can be drawn as follows:

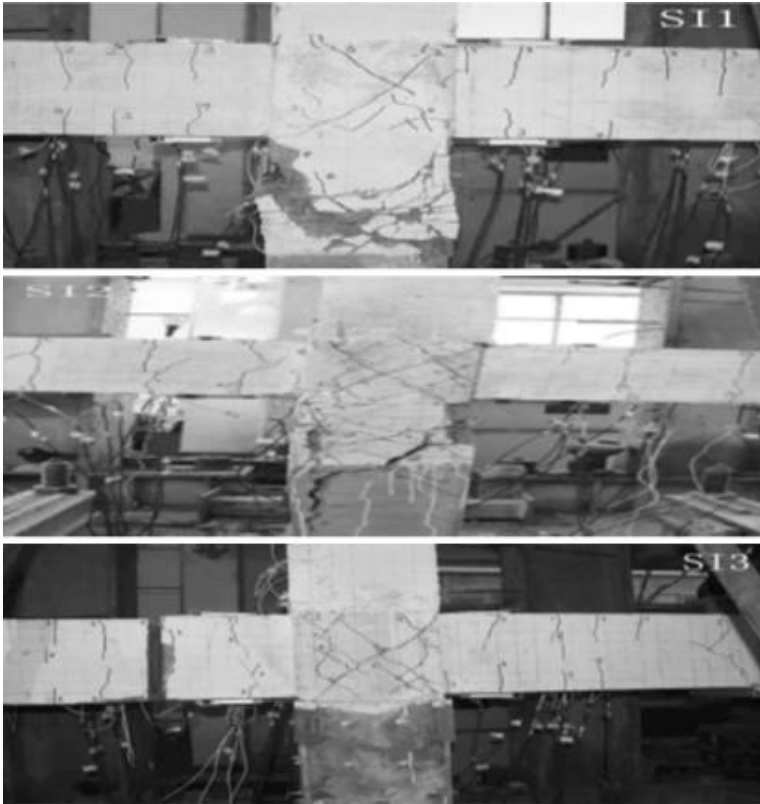


Figure 3: Section reinforced concrete frame node specimens' cracks and destruction

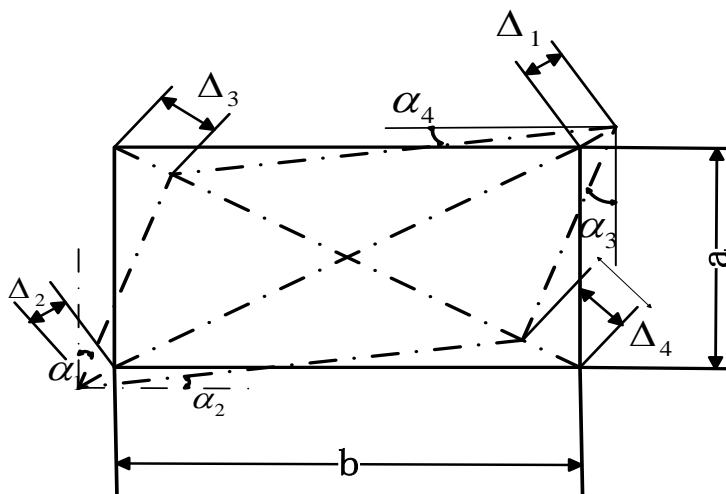


Figure 4: Shear deformation of the core point schematic

4. Conclusions

Connecting region Prefabricated reinforced concrete frame structure part of Reinforcement Steel-free connections to meet the needs of the overall seismic structure, reliable connection. 3 specimens, *SI1* and *SI2* connecting region did not appear damaged, *SI3* connection area damage because of the lower part of the column of steel reinforcement, so the contrast intensity beam-column joints connecting area and the core area of the connecting area of cracks is always less than 0.2mm, meet regulatory requirements, the situation on the steel reinforced concrete from peeling does not appear, shear key reliable anti-slip effect, can be

connected by means of connection of reinforced concrete structures of unreinforced steel reinforced concrete structure. Carrying capacity of steel reinforced concrete prefabricated part of the node frame specimen is 2 to 3 times reinforced concrete node specimens. Under cyclic loading, carrying capacity degradation is slow, gradual degradation trends, maintain a good carrying capacity. Axial compression ratio change degradation on prefabricated reinforced concrete section node frame specimen carrying capacity is not obvious.

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