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Experimental study of a fabricated confined concrete beam-to-column connection with end-plates

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HIGHLIGHTS

- A new-type of fabricated beam-column connections is presented in this paper.
- To investigate the seismic behavior of the precast connection, seven specimens are tested by pseudo-static test.
- The test results indicate that the hysteresis curves of precast connection are plump, and all specimens failed in bending with a beam plastic hinge.
- So the fabricated connection exhibits satisfactory ductility and energy dissipation capacity.
- Besides, the flexural capacity of unbonded prestressed confined concrete beam is analyzed.
- And based on the theory of concentrated plastic zone, the formula of flexural bearing capacity is proposed.
- The theoretical results agree well with the test data, which can provide reference for research.

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ABSTRACT

At present, the building industrialization has become the development direction of construction industry, the precast prefabricated buildings become the focus of the construction industry once again because of its unique characteristics. A new-type of fabricated beam-column connections with end-plates is presented and introduced on this background. To investigate the seismic behavior of the new-type precast connection, seven specimens are tested by pseudo-static test. The hysteresis curves are recorded during the test, and the seismic indicators, such as ductility and energy dissipation capacity, are determined. The test results indicate that the hysteresis curves of precast connection are plump, and all specimens failed in bending in a malleable way with a beam plastic hinge, which is fully consistent with the criterion of strong column weak beams. Additionally, the fabricated connection exhibits satisfactory ductility and energy dissipation capacity, showing better seismic performance. Besides, the flexural capacity of unbonded prestressed confined concrete beam is analyzed, and the formula of flexural bearing capacity is proposed based on the theory of concentrated plastic zone. The theoretical results agree well with the experimental data, which can provide reference for theoretical research.

1. Introduction

The advantages of the precast fabricated concrete structure include less field wet operation, faster construction progress, high production efficiency, better component quality, which reflects the concept of green development, and is widely used at home and abroad. In the precast assembly structure system, the precast concrete frame is the main structure form, but because the connection reliability of the fabricated structure is poor, it is difficult to meet the force requirements under the earthquake action, so the application of the precast frame structure in seismic area is limited. The experimental study and earthquake damage investigation show that the precast concrete frame structure has good seismic performance as long as the precast concrete structure joint has reliable connection. At present, domestic and foreign scholars have conducted a lot of researches on assembly nodes, which greatly promoted the development of prefabricated structure. The experimental investigation of one-third-scale precast concrete beam-column connections conducted by R. Vidjeapriya and K.P. Jaya. showed that ultimate load-carrying capacity of the monolithic specimen was superior to that of both the precast specimens. But the precast specimens exhibited satisfactory energy dissipation and ductility compared with the monolithic specimen [1]. The

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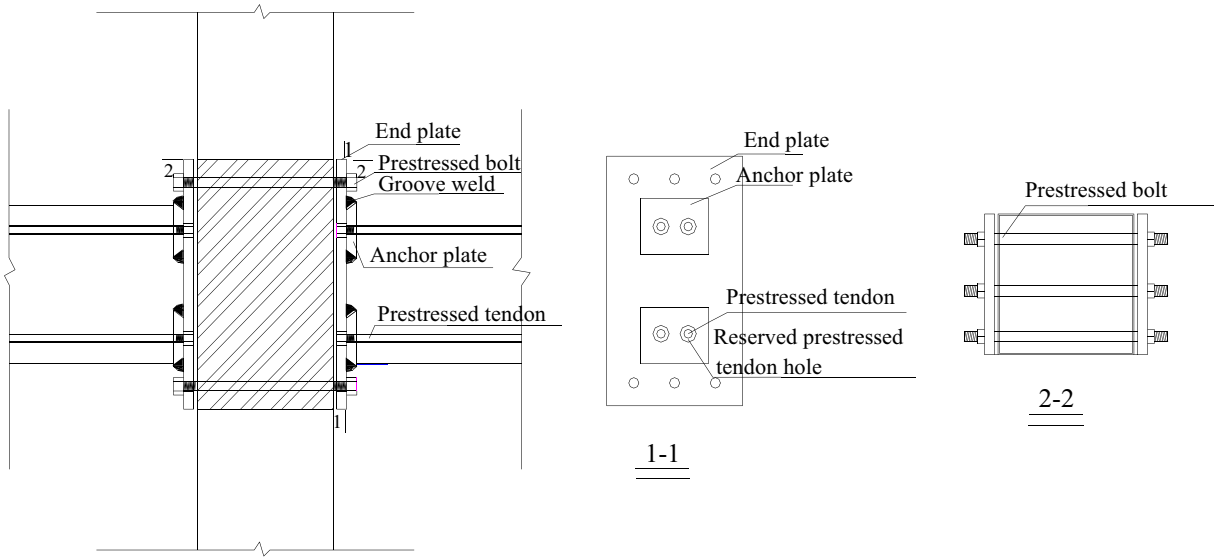

Fig. 1. The detail figures of connection.

(a) Reinforcement skeleton of column (b) Reinforcement skeleton of beam

Fig. 2. Reinforcement skeleton.

Table 1
Details of specimens.

Specimen	Strength of concrete (Mpa)	Cross section	Size (mm)	Longitudinal reinforcement	Stirrup	Stirrup Spacing (mm)	Stirrup encryption spacing (mm)	Stirrup ratio (%)
column	60	rectangle	400 × 400	20d22HRB600	d5HTH1100	50	30	0.39
RC-01 (beam)	60	rectangle	450 × 380	12d22HRB600	d5HTH1100	50	30	0.39
#PAN-01 (beam)	35	rectangle	450 × 200	4d20HTH1080 4d18HRB400	d10HPB300	110	90	0.71
#PAN-02 (beam)	35	rectangle	450 × 200	4d20HTH1080	d5HTH1100	50	40	0.39
#PAN-03 (beam)	35			4d18HRB400		60	50	0.33
#PAN-04 (beam)	35					70	60	0.28
#PAN-05 (beam)	35					90	70	0.22
#PAN-06 (beam)	35					100	80	0.20

seismic behavior of four assembly beam-to-column connections was studied by Yu Jianbin [2]. Test results demonstrated that the hysteresis curve of the new precast connection is full. In the early stage of loading, the equivalent viscous damping coefficient was smaller than the cast – in-place joint, but the equivalent viscous damping coefficient of the assembly node was equal to that of the monolithic node when the ultimate load is reached, which showed that the prefabricated beam-to-column joint had better energy dissipation capacity. Jiang H.T. studied a new type of fabricated node based on the existing joint form, and the specific structure of the new type of beam column joints was proposed [3]. The failure modes, hysteretic curves and skeleton curves of the seven specimens under earthquake action were studied by quasi-state test. Finally, all specimens have realized the design objectives of strong column weak beam, showing better seismic behavior. Besides, the worldwide scholars have made a deep research on