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Seismic Performance Study of Fabricated High-strength Reinforced Concrete Shear Wall Horizontal Connection Seam

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Block prefabricated shear body and connected to form two types of nodes: one is the shear vertical connecting node, namely, the lower connecting precast shear walls; the other is the level of shear wall connecting node that is connected with the pre-shear layer adjacent to the non-shear and between precast shear walls or with an adjacent layer. Under horizontal earthquake, prefabricated shear vertical connecting node will be directly involved in stress and deformation. Since the horizontal seam to weaken the shear plane, if not handled properly connected measures, it can easily become the weak parts of shear walls, and even affect the overall structural performance. To understand the power transmission mechanism prefabricated shear horizontal seam structure, energy dissipation mechanism and seismic performance, reliable and exploring measures to improve or perfect the various prefabricated ability to work together to improve the structural integrity and seismic performance, prefabricated vertical shear connection has been completed based on the seismic performance of the test, carry out a new connecting node structure prefabricated shear wall structure horizontal seam, by conducting relevant tests, finite element methods and theories analytical tools, be horizontal shear wall structure evaluation and design method of prefabricated joints seismic performance.

1. Introduction

Prefabricated buildings in research and application, while gradually warming, we must address its structural integrity problems (Canbolat, 2005). Prefabricated building structures not much different in situ structure under vertical loads, and integrity in the horizontal load is long been questioned and the general engineering households (Aicher, 2013). For the earthquake-prone country, frequent situation, to promote its development and application, the core work that is, to solve the seismic issue, good seismic capacity through the design and construction measures (Li, 2016). Shear wall structure to ensure the overall stiffness of building structures, seismic action can be effectively transmitted to the foundation, the structure itself is protected from damage or reduce the extent of the damage, which will help after the earthquake repair (Marthong, 2013). Meanwhile, the shear wall structure of the building due to its good features and use of functions, more and more domestic developers and residents of all ages, widely used in China and high-rise multi-residential structures (Choi, 2014). Therefore, the prefabricated concrete shear wall structure and technology combine to form a new type of prefabricated shear wall structure technology system, will have broad prospects for development in our country, with good research value (Sun, 2015).
Shear is the main force member senior member of the House shear wall structure, but also its primary seismic energy dissipation member (Kheni, 2015). Because assembly-tiered precast shear wall member, so the horizontal seams connecting structure and level of performance will determine the integrity of the shear wall structure bearing capacity and deformation capacity (Ricci, 2013). Therefore, to explore a reasonable level of vertical reinforcement connections and patchwork treatment of partial-situ concrete, prefabricated shear impact study on the seismic behavior is particularly necessary. Foreign scholars have done similar research (Pucinotti, 2015). This article will introduce a new form designed by the authors U-shaped closing bars connecting interior shear wall structure assembled horizontally connected, and the U-shaped closing bars of connection test seismic performance, comprehensive evaluation of the seismic performance.

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Combined with test results, with horizontal seams prefabricated shear wall structure direct displacement sectional deformation capacity design seismic design based on analyzes derived such prefabricated shear bearing capacity of normal cross section is calculated, including the stage moment and curvature formulas to determine the calculation method of constrained edge member, summed up the design process step-sectional deformation capacity.

The theoretical calculations and experimental mean comparison, experimental and theoretical values agree, the test can basically reflect the general pre-shear deformation capacity, such as prefabricated shear displacement provides a theoretical basis based deformation capacity design method. Seismic design method for optimizing structure prefabricated concrete shear wall structure with horizontal seams and prefabricated concrete shear wall structure of horizontal seams and seismic performance evaluation made recommendations, such as crimping technology; local non-stick indirect pulp lap anchor knot reinforced connection technology: fastening closed stirrups technology.

2. Interior horizontal connection

2.1 Interior closed bars

Two left lower corner of the upper shear prefabricated wall panel, a right edge portion is no concrete vertical U-shaped closing bars, horizontal and vertical distribution of steel U-shaped closing ends of steel connections, respectively, the vertical U-shaped stirrup closed steel connection into a whole; shear wall upper prefabricated corrugated metal wall panel has a central pulp anchor pipe, the lower anchor pulp corrugated tube located in the lower shear upper prefabricated wall panel and communicating with the outside, the corrugated pulp anchor pipe the upper portion of the pouring port communicates closed above the upper prefabricated shear vertical side wall panel has a U-shaped steel pouring hole reserved (Sun, 2015).

Shear lower middle portion of the plate with a portion of the interior wall of prefabricated vertical slurry anchor steel, prefabricated wall panel corresponding to the upper bellows (Zeng, 2013); prefabricated wall panel shear walls on both sides of the lower portion corresponds to the upper prefabricated interior shear walls plate left and right lower corner has two vertical U-shaped closing part reinforced, shown in Figure 1.

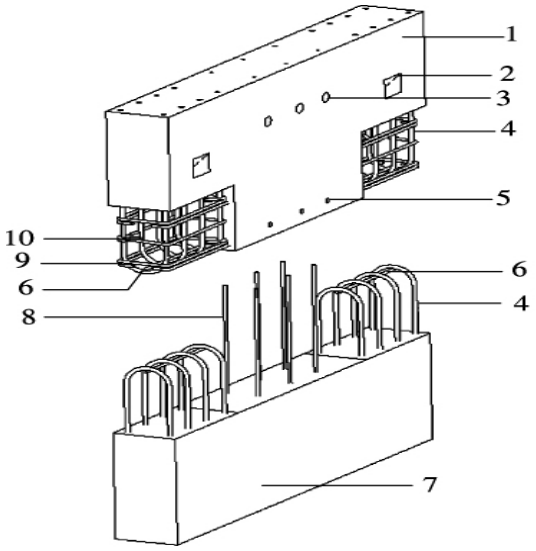

Figure 1: Interior tendons schematic closure

1- Shear upper prefabricated wall panel;
2- reserve pouring hole;
3- corrugated metal slurry anchor pipe;
4- vertical U-shaped closing bars;
5- grout;
6- horizontal reinforcing steel;
7- Shear the lower wall of prefabricated wall panel;
8- vertical slurry anchor reinforcement;
9- reinforced horizontal distribution;
10- stirrups

The combination of shear wall structure in different parts of different connectivity features requirements, using two different methods of mixing steel connection joint construction process, construction of shear walls on both sides of the edge member or restrict the use of the side edge member structure is basically the same cast connection, connection reliability solve important edge member; vertical shear for the central distribution of steel parts used to facilitate the connection of vertical steel anchors indirect pulp lap connection method to solve the construction of convenience. Shear wall structure prefabricated wall panel assembly vertical mixing both the connecting structure fabricated shear wall integrity and ease of construction, reduce construction factors influence the degree of performance, improve structural performance stability (Zhang, 2016).

2.2 The interior wall corrugated anchor

Two prefabricated laminate shear walls on both sides, with the node in the shear wall is provided with two rows of reserved dowels, dowels and set aside pre-stacked deck is connected to the internal reinforcement located shear plate overlapping portion both sides have two rows of grouting pipe for grouting, grouting pipe and dowels reserve position correspondence in the overlapping portion of the plate is pre-cast layer laminate, prefabricated laminate at a node in the lower erect ribs off, ends were extended forward at a node, and is bent upward near the outside of the reserved dowels, while the reserve dowels phase overlap, so that shear walls and prefabricated laminated board connector become a whole, to withstand the vertical and horizontal direction external forces.

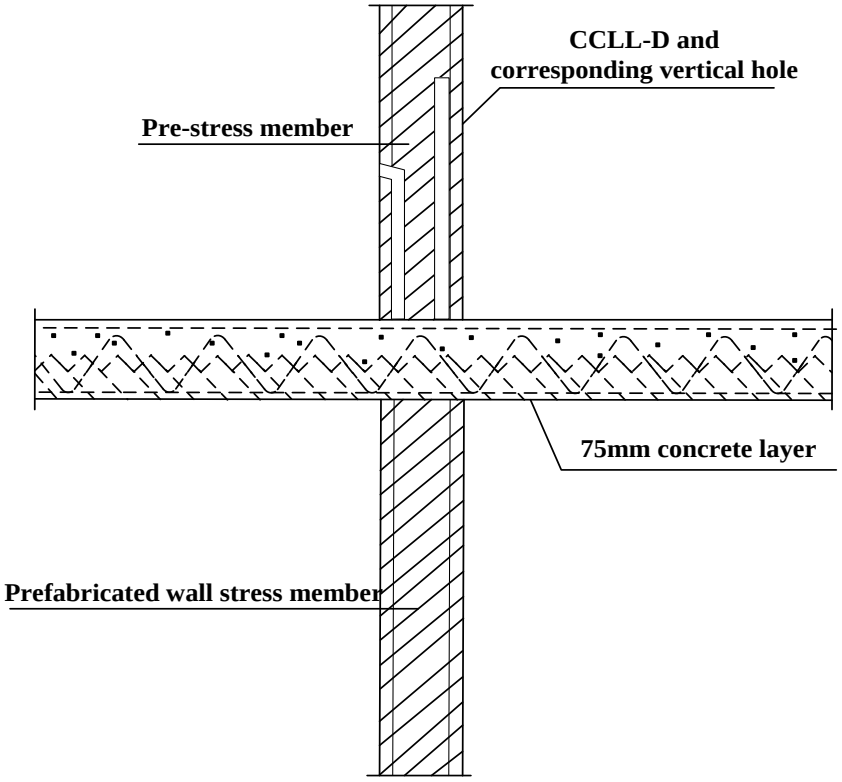

Figure 2: Walls, plate node

Interior non-load-bearing walls, to bear the weight, design joints in the floor at the upper and lower layers can be prefabricated interior fittings and interior construction, while pouring board connectors, prefabricated homes stacked board wall member and the floor set aside by dowels and the upper layer of cast steel to ensure reliable connection: grouting tube and set aside dowels and connection reinforcement to ensure the continuity of the upper and lower members: grouting tube filling, the horizontal construction joints filled with dense; between two vertical members through dowels cast aside and end nodes integral casting, ensure a reliable connection and reinforcement continuity member.

Precast shear wall can be used as a temporary seat of prefabricated laminate, laminate support 25mm, laminate and pre-cast laminate layer thickness on the shear walls are 100mm. Similar to facades, plate node, the upper body is reserved for shear wall bellows, diameter of 50mm, a position reserved for the lower shear

dowels corresponds to the position; set aside dowels in the lower section of wall, plug tendons force the same parameters and tendons, the length of one side of 600mm, length of the side is 1000mm, when the connector into the upper section of the wall grouting pipe, grouting hole from the upper section of the wall reserved grout perfusion, the intensity does not less than 50MPa, joined to form a rigid connection node, shown in Figure 2.

3. Experiments and results

3.1 Model building

ABSQUS provides three concrete models: smeared crack concrete model, cracking model and damaged plasticity model. Where smeared cracking mainly suitable for low pressure monotonic loading of concrete structures; fracture model is assumed to be linear elastic behavior is always under pressure, a ceramic, a brittle material results more accurate; damaged plasticity model can simulate the low confining pressure of concrete subjected monotonous, mechanical behavior under cyclic or dynamic loads, isotropic elastic damage to characterize the inelastic behavior of concrete combined isotropic tensile and compressive plasticity theory, combined with non-associated multiple sclerosis plasticity and isotropic elastic damage theory characterization of material fracture occurs during irreversible damage behavior, but also in the cyclic loading, can artificially control the stiffness of the material recovery, we use damaged plasticity model.

After exceeding failure stress, crack spreading, mechanical properties of concrete softened. Compressive stress-strain relationship reached initial stress. After the strain softening stage, is to strengthen the inter-stage. Consider plastic damage, the elastic modulus of concrete will be reduced, it can be expressed as:

$$E = (1-d)E_0 = (1-s_t d_c)(1-s_c d_t)E_0 \tag{1}$$

Among then

$$0 \le d_t \le 1 \quad and \quad 0 \le d_c \le 1 \tag{2}$$

The damage variable tension was St and Sc. For the tension and compression stiffness coefficient of restitution is defined as:

$$S_t = 1 - w_t r^{\bullet}(\sigma_{11}) \le 1, \quad 0 \le w_t \le 1 \tag{3}$$

$$S_c = 1 - w_t (1 - r^{\bullet}(\sigma_{11})), \quad 0 \le w_c \le 1 \tag{4}$$

Among then

$$r^{\bullet}(\sigma_{11}) = \mathrm{H}(\sigma_{11}) = \begin{cases} 1 & \sigma_{11} > 0 \\ 0 & \sigma_{11} < 0 \end{cases} \tag{5}$$

3.2 Analysis of results

From the point of view stiffness, analog value with respect to the test value is too large, it may be due to bias test specimen processing quality and anchor during the test quality and the model caused. From a peak capacity, in addition to finite element simulation value SW4 is larger than the value of the test, the test specimens remaining value larger than the analog value.

Contrast peak CD bearing force analog value of each specimen, the specimen can be seen cast slightly more than the rest of the assembly too specimen, this is very consistent with the experimental results.

ANSYS in concrete cracks is assumed uniformly distributed, the actual crack is not likely to completely uniformly distributed, and in the presence of repeated cyclic loading closed and cracking. Finite Element Analysis of a larger number of cracks appear when the shear damage. In the analysis of the trials, the main observation by the naked eye and magnifying glass cracks, the cracks only in the development of the concrete surface and wide enough to be observed, and in the finite element analysis, the stress inside the cell once the concrete Gauss integration points greater than the calculated resistance of concrete tensile strength, it means that there are cracks, and manifested in the model diagram.

Finite element analysis of the main load in Table 1, the cracking load finite element analysis model, calculated and experimental values yield load and ultimate load of more consistent, especially calculated and experimental values agree well with the ultimate load. ANSYS analysis explained select constitutive relation, failure criterion of concrete material has a certain rationality. At the same time due to differences in the way of

loading, constitutive relation itself defects and other reasons, cracking, yield load test and calculation values inevitably there are some deviations.

Table 1: Comparison of finite element analysis and test results

	Cracking Point Pc(KN)	Yield point Py(KN)	Limit point Pu(KN)
Finite element value	187.5	400	580
Trial value	210	400	601
Finite element value	175	410	590
Trial value	170	350	581
Finite element value	162.5	420	590
Trial value	210	330	613
	Pc Calculated/ Trial value	Py Calculated/ Trial value	Pu Calculated/ Trial value
	0.90	1.00	0.97
	1.02	1.17	1.01
	0.78	1.21	0.96

4. Conclusions

To understand the power transmission mechanism prefabricated shear horizontal seam structure, energy dissipation mechanism and seismic performance, reliable and exploring measures to improve or perfect the various prefabricated ability to work together to improve the structural integrity and seismic performance, prefabricated vertical shear connection has been completed based on the seismic performance of the test, carry out a new connecting node structure prefabricated shear wall structure horizontal seam, by conducting relevant tests, finite element methods and theories analytical tools, be horizontal shear wall structure evaluation and design method of prefabricated joints seismic performance.

In this paper, a series of confirmatory tests to grasp its seismic capacity, carried out seismic performance analysis.

(1)Based on the experimental results, combined with the finite element by means of prefabricated shear wall structure with horizontal seam seismic performance analyzes.

(2)Based on the test results and analysis will be introduced based seismic design method building seismic performance design to prefabricated concrete shear wall structure horizontal seam seismic design, the initial establishment of the prefabricated concrete shear wall structure based on the level of performance-based seismic design of buildings seismic performance seam; combination of low cyclic loading test for prefabricated reinforced concrete shear wall horizontal seams carrying capacity and deformation characteristics of theoretical analysis and comparison with experimental, so for such prefabricated shear wall will provide theoretical basis of displacement deformation capacity design method.

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