The Design and Construction of a Fabricated Integrated Building

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ABSTRACT

In this paper, through the design and construction case of a fabricated integrated concrete frame building project, the key points of design, structure connection construction and construction technology of this kind of structure is summarized, providing a reference for the design of other similar projects.

KEYWORDS

Fabricated Integrated Concrete frame, Structure Connection Construction; Future Research Direction, Key Points of Design.

PROJECT OVERVIEW

One building with a total construction area of 6346m2, 6 floors on the ground, building eaves height of 17.950 meters, is taking the precast concrete frame structure, which is connected by precast concrete components under a reliable way and combined with the onsite post poured concrete and cement based grouting material as a whole. The condition is earthquake intensity of 6 degrees, the first earthquake group, site category II. In this project, the precast fabricated components conclude precast laminated beam, laminated slab, precast fabricated composite board, precast wall panels, plug in prefabricated stair board and precast parapet, with precast rate of more than 85%. The foundation is taking hammering high strength prestressed concrete pipe pile (PHC) foundation, and the design level of foundation is second grade. The structural effect diagram is shown in Fig.1, and the structural prefabricated component split diagram is shown in Fig.2.
STRUCTURE CALCULATION

The main structure of this complex building is fabricated integrated, and the main structural component nodes of the main structure are cast in place to ensure the same integrity of the structure with the cast-in-place structure. Therefore, the design calculation method of the whole structure can follow the current national standard[1] reference of structure design and calculation method, with similar mechanical properties with cast in place structure.

In this paper, the structure design software YJK is used to calculate and analyze the structure (Fig.3). The overall displacement angle, cycle and cycle ratio are shown in Fig. 4 and table.1, which meets the requirements of the specification[2]. The calculated results meet the requirements of the code. The maximum displacement ratio is 1.47, which meets the requirements of the specification[3]. According to the force calculated by YJK, the reinforcement design of the structural components, the checking of the node and the shear calculation of the joint surface are carried out.
TABLE 1. STRUCTURAL PERIOD.

<table>
<thead>
<tr>
<th>Vibration model</th>
<th>period</th>
<th>Torsion factor</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>1.196</td>
<td>0.18</td>
</tr>
<tr>
<td>2</td>
<td>1.022</td>
<td>0.18</td>
</tr>
<tr>
<td>3</td>
<td>0.995</td>
<td>0.61</td>
</tr>
</tbody>
</table>
| First torsion period (0.9953) / First translation period (1.1964) = 0.83

MAIN NODE STRUCTURE

Joint Structure Of Column Grouting Sleeve Joint

Joint structure of column grouting sleeve joint is shown as Fig.5, prefabricated columns are connected with grouting sleeve, traditional sleeve connected each grouting sleeve when grouting, which is of low efficiency and long construction period, in order to simplify the traditional grouting technique, this project adopts single hole grouting process which is shown in figure[]. Each column has a grouting hole, and during the grouting process, if grouting material is flowing from a slurry outlet hole of the sleeve, it is considered the sleeve is full and the grout holes will be plugged, when all the pulp holes are flowing the grouting material and all the grout holes are plugged, the grouting is completed. The single hole grouting technique can fill all the sleeves at one time, which greatly simplifies the grouting process, improve grouting construction time.
Figure 5. Connection of column grouting sleeve.

**Beam Column Joint**

(1) in the middle of the frame nodes, the lower part longitudinal force reinforcement of two sides beam anchorages in post cast joints with 90 degrees bending form; in middle layer joints of beam, the longitudinal force reinforcement anchorages in post cast joints in the area by anchor plate, as shown in Fig.6 and Fig.7.

Figure 6. Intermediate Node in the middle floor

Figure 7. End node in the middle floor.

(2) the top node frame, column longitudinal reinforcement with anchor line, when the size of beam section does not meet the requirements of linear anchoring, anchoring plate anchorage; the top end node, the lower beam longitudinal reinforcement with anchor plate anchor in the form of post cast joints in the area, column out of roof is not less than 500mm, the longitudinal column reinforced by anchor plate form anchorage in the extended period. Specific as shown in the following picture Fig.8 and Fig.9.
(3) considering the convenience of the installation, the prefabricated laminates are extended 15mm into the precast beam, the post concrete overlap layer interface of the precast concrete composite beam is of the same height of the higher bottom plate of the two sides of the beam. As shown in the following figure Fig.10.

The Plug-In Node

The plug-in board structure connection is set according to the lateral horizontal overhanging member, divided into side joint (Fig.11) and the top joint(Fig.12) two forms.
STRUCTURE CONSTRUCTION PROCESS

1) Pile Cap Construction And Component Transportation

Comprehensive building foundation takes the pile slab when under construction, constructed to beam layer earthwork, backfilled and the surrounding space hardened, in accordance with the construction schedule plan, the hoisting is by the tower crane and crane with the means of lifting operation.

2) Precast Column Installation And Caulking Grouting

In order to smooth the site, the prefabricated column, the positioning line and the control line are released according to the positioning axis, the reserved vertical connection steel bar are checked, and the steel sleeve of the bias steel bar are corrected, 20mm steel gasket is set and the sealing sponge strip is pasted. Hoisting the prefabricated column component, slow the transfer rate when the prefabricated column falls 500mm vertically from the vertical steel bar, then two professional operators should hand guide landing, drop to the gasket then stop landing. Install inclined support, pass the ruler to approve the verticality of the column, adjust the inclined support, and finally fix the inclined support, remove the hook. With the dry mortar slit between the cylinder and the floor of the seal. The grout shall be grouted after 24 hours and the whole plug joint and grouting process shall be recorded on the spot. All prefabricated columns shall be hoisted in sequence according to this method, and grout shall be grouted.

3) Precast Composite Beam Installation

After precast column grouting, lifting precast beam, slow the descending rate when the beam is 500mm from the top, then professional workers should take hand landing, hoist other frame beam by sequence. In this project, the main and secondary beam overlap modes are divided into two ways: pre embedded cattle support plate and joint cast-in-place. Between them, the installation of the lap plate of cattle is more convenient.

4) Prefabricated Plywood Installation

After installing the precast beam, the precast floor panel is hoisted with special hanger which is welded by I-beam, and with lug in lower part, the lug have symmetric distribution of 4 fixed pulleys, and is connected with the floor panel 6 movable pulley. This set can ensure the floor panel when lifting the level of the tower crane, and the sling is fixed on the special lifting point lifting beam, and stops lading at 500m from the top. The operators control and guide the floor landing vertically up according to the vertical line, ensuring the slab edge and beam have enough overlap width. By this method, other precast laminated hoisting is completed well.
5) Prefabricated External Board Installation

Install the external board: first of all, line the outside board position, measure the external board height, install the external board by order, then affix the insulation board, hit the mold glue, tie the vertical reinforcement, and finally seal the template.

6) Prefabricated Staircase Installation

With the hook and different length of ropes hoisting prefabricated stairs, stopping landing when the staircase door frame beam is 1000mm away, the professional workers should hold prefabricated stairs, and slow decentralize stairs according to the level of the control line, and aim at the preformed steel bar to the design position, correcting hook, installing the connecting part between precast wall and the stairs, and grouting in the empty floor body, as well as installing step protection plate and the permanent railing.

With the same installation method as above, the main structure of the project is completed.

CONCLUSIONS

This paper introduces the main design, construction process and the main joint of an fabricated integrated office building. The calculation method adopts equivalent cast-in-place structure calculation method, with the analysis software of YJK. In this paper, the main structure, the main beam column joints and the external plate joints are briefly introduced. Finally, the construction process of the main structure is briefly introduced, including pile construction and component transport, prefabricated column installation and filling grouting, precast laminated beam installation, installation, precast laminated precast cladding panels installation, prefabricated staircase installation, etc., providing a reference for other similar engineering design and construction.

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REFERENCES