

Reinforcement research of a built project due to functional transformation

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Abstract. According to the functional requirements, the construction unit intends to dismantle the 7/B and 8/B columns of the first to second floors of a Renovation of an existing project. The force of the structure has changed after the demolition, and the structure needs to be strengthened. In this paper, 7/AC and 8/AC beams of Negative third floors are reinforced with an enlarged section. After the section is enlarged, the negative moment reinforcement of adjacent beams 7/C-D and 8/C-D do not meet the requirements. The two beams have been enlarged the section at the upper part. Due to the large cross-sectional area of the beam after reinforcement, in order to form a strong column weak beam, the beam lower column 7/A, 8/A, 7/C, 8/C is strengthened by the enlarged section method, and the section is enlarged to make the column line stiffness Greater than the beam line stiffness. The carbon fiber sheet is pasted for reinforced with the beam-slab members in the range of 6-7/A-C and 8-9/A-C. According to the experience calculation, the reinforcement effect is better and meets the requirements of the force.

1. Introduction

With the continuous advancement of society, the construction industry continues to develop, and the demand for building functions varies. Although some of the existing projects have been built, the demand for their functions will change due to various factors. At this time, the structure needs to be functionally modified and the structure will change. The increase or decrease of the components will affect the stress of the overall structure, and some parts will also be insufficiently loaded due to the transformation. At this time, the modified structure needs to be reinforced. Now has an project, Due to functional needs, the construction unit plans to dismantle the 7/B and 8/B columns of first to second floors. The first floor is the exhibition hall, and the rest of the floors are offices. The structure needs to be strengthened after the transformation. Research.



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2. Project Overview

The total construction area of the project is 7080 square meters, and a total of 5 exhibition halls will be built. The structure is a frame structure, and the seismic fortification intensity is 6 degrees. The construction unit is now planning to change the function of the building. The 1-6 axis of the building is 5 layers, the 6-7 axis is two layers, and the right side of the 8 axis is symmetrical with the left side. Due to functional needs, the construction unit plans to dismantle the 1st to 2nd floor 7/B and 8/B columns, the first floor is the exhibition hall, and the remaining floors are offices. After the transformation, the load of the third floor 7/AC and 8/AC beams is 3.5kN/m, and a large screen is added to the beam which weight is 5t. the beam length is 16.2m, and the conversion load is $50/16.2=3.083.5\text{kN/m}$; the floor load is 1.5 kN/m^2 (excluding the board weight), the live load is 2.0kN/m^2 for the office; and the constant load for the roof is 4.0 kN/m^2 (excluding the board weight), the live load is 2.0kN/m^2 .

3. Take reinforcement measures

The reinforcement measures taken for this project are as follows:

(1) After the dismantling, the longitudinal steel bars at the bottom of the 7/AC and 8/AC are discontinuous and the span becomes larger. The beam is reinforced with an enlarged section. After the section is enlarged, the adjacent beams 7/C-D and 8/C-D negative moment reinforcement do not meet the requirements. The two beams are thickened in the upper part for reinforcement.

(2) Because the cross-sectional area of the beam is large, in order to form a strong column weak beam, the 7/A, 8/A, 7/C, 8/C column with lower beam is reinforced by the enlarged section method to make the column line stiffness greater than the beam line stiffness.

(3) Bonding carbon fiber sheets to the beam-slab members in the range of 6-7/A-C and 8-9/A-C.

4. Structural reinforcement check

4.1. Basic review and component reinforcement calculation

Check 7/A, 7/C pile bearing capacity, 7/ A and 7/C piles are elliptical piles, pile reinforcement is 21 B12, concrete strength is C30, and pile cross-sectional area is 1.18m^2 . The compressive bearing capacity of the stressed pile section is:

$$\begin{aligned} N &\leq \varphi_c f_c A_{ps} + 0.9 f_y' A_s' = 0.8 \times 14.3 \times 1.18 \times 10^6 + 0.9 \times 300 \times 2375 \\ &= 14140.45\text{KN} \end{aligned}$$

In the formula:

N -Design value of axial pressure of pile top under basic combination of load effects;

φ_c -Foundation pile forming process factor;

f_c -Concrete axial compressive strength design value;

f_y' -Longitudinal main rib compressive strength design value

A_s' -Longitudinal main rib sectional area;

The standard axial force of the 7/C column bottom is 950.5kN, and the standard value of the axial force of the two columns on the two sides of the elliptical pile is $950.5 \times 2 = 1901\text{ kN}$, then the axial

force design value $N=1901 \times 1.35=2566\text{kN} < 14140.45 \text{ kN}$, the pile bearing capacity meets the requirements. The 7/C column vertical force is greater than 7/A, that is, the 7/A pile bearing capacity also meets the requirements.

4.2. Beam bearing capacity review

The 7/A-C beam is used for bearing capacity review. The section size of the beam is $500 \times 1300\text{mm}$, The reinforcement between the ends of the top of beam is $8\Phi 25$, and the bottom is $10\Phi 25$, the beam concrete strength is C30, and the beam maximum bending moment is $1077\text{kN}\cdot\text{m}$, the maximum negative bending moment is $1072 \text{ kN}\cdot\text{m}$, and the maximum shear force is 424 kN .

Bending capacity calculation(positive bending moment):

$$\alpha_1 f_{c0} b x = f_y A_{s0} + f_y a_s A_s - f'_{y0} A'_{s0}$$

Due to the large size of the reinforcement, the original longitudinal reinforcement is not considered.

$$M \leq a f A (h_0 - x/2) + f_{y0} A_{s0} (h_{01} - x/2) + f'_{y0} A'_{s0} (x/2 - a')$$

$$x = (f_y A_{s0} + f_y a_s A_s - f'_{y0} A'_{s0}) / \alpha_1 f_{c0} b = 44.49\text{mm}$$

Take $a_s = a'_s = 50\text{mm}$

Then $x \leq (2a_s = 100\text{mm})$

Taking the moment of pressed steel bar:

$$M = 0.9 f_y A_s h_0 = 1988 \text{ KN}\cdot\text{m} > 1077 \text{ KN}\cdot\text{m}$$

In the formula:

M —Design value of bending moment after component reinforcement($\text{KN}\cdot\text{m}$);

α_s —New steel bar strength utilization factor, take $\alpha_s=0$;

f_y —New cross-sectional area of tensile reinforcement(N/mm^2);

A_s —New cross-sectional area of tensile reinforcement(mm^2);

h_0 、 h_{01} —Effective height of the section after reinforcement of the component and before reinforcement;

x —Height of concrete compression zone(mm);

f_{y0} 、 f'_{y0} —Design value of tensile and compressive strength of original steel bars(N/mm^2);

A_{s0} 、 A'_{s0} —Cross-sectional area of original tensile reinforcement and compression steel(mm^2);

a' —The distance from the longitudinal compression joint force point to the edge of the concrete compression zone(mm);

α_1 —The ratio of the stress value of the concrete rectangular stress diagram of the compression zone to the design value of the concrete axial compressive strength. When the concrete

strength grade does not exceed C50, take $\alpha_1 = 1.0$. When the concrete strength grade is C80, take

$\alpha_1 = 0.94$. Linear interpolation between them to take;

f_{c0} —Original structural concrete axial compressive strength design value(N/mm²);

b—Rectangular section width(mm);

ξ_b —The relative limit of the nip area after the member is enlarged by the section.

That is, the bending bearing capacity meets the requirements.

Shear capacity calculation:

$$h_w / b = 1300 / 500 = 2.6 \leq 4$$

$$v = 424 \text{ KN} \leq (0.25 \beta_c f_c b h_0 = 0.25 \times 0.80 \times 14.3 \times 500 \times 1250 = 1787 \text{ KN})$$

The section size meets the requirements.

$$v = 424 \text{ KN} \leq \left(0.7 f_t b h_{01} + 0.7 a_c f_t A_c + a_s f_{yv} \frac{A_{sv}}{s} h_0 + f_{yv} \frac{A_{sv0}}{s_0} h_{01} = 793 \text{ KN} \right)$$

In the formula:

V—Shear design value after component reinforcement(KN);

β_c —Concrete strength influence factor;

b—The width of the rectangular section or the web width of the T-shaped, I-shaped section(mm);

h_w —The height of the web of the section; for the rectangular section, take the effective height; for the T-section, take the effective height minus the height of the flange; for the I-section, take the net height of the web.

The shear capacity is satisfactory.

4.3. Column bearing capacity review

The bearing capacity of the 7/C column composite column is taken. The section size of the column after reinforcement is 700×900mm, the axial force of the column is 1242.1kN, the moment of x-axis and y-axis is $M_x=63.9 \text{ kN.m}$, $M_y=15.1 \text{ kN.m}$, and the bearing capacity of the M_x -oriented column is taken.

$$e_1 = e_0 + e_a = 12 + 30 = 42 \text{ mm}$$

$$e = e_1 + h/2 - a = 442 \text{ mm}$$

$$N \leq a_1 f_{cc} b x + 0.9 f_y' A_s' - 0.9 f_y A_s \text{ (Reinforcement reduction calculation).}$$

The result is:

$$x=125 \text{ mm}$$

$$Ne \leq a_1 f_{cc} b x (h_0 - x/2) + 0.9 f_y' A_s' (h_0 - a_s) - 0.9 f_y A_s (h_0 - a_s)$$

$$549 \text{ KN} \cdot \text{m} \leq 985 \text{ KN} \cdot \text{m}$$

After the reinforcement, the bearing capacity of the column meets the requirements.

5. Conclusion and Prospect

(1) The 7/C pile foundation bearing capacity meets the requirements, and the 7/C column vertical force is greater than 7/A, that is, the 7/A pile bearing capacity also meets the requirements.

(2) The 7/A-C beam section size meets the requirements, and the shear capacity meets the requirements.

(3) The column 7/C is taken for calculation. It can be seen from the calculation that the column bearing capacity of the column after reinforcement is satisfactory.

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