Analysis of Typical Old Building Reconstruction and Reinforcement

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Abstract. In recent years, the rapid development of China's economy makes the existing building stock soaring, many of which have the service life of more than 10 years, thus emerging more and more hidden diseases, diseases and other quality problems urgently need to be reinforced. This paper around a multilayer cast-in-situ reinforced concrete frame structure of the old buildings, through the inspection process, the conclusion and the reinforcement scheme of combing the following conclusion: after old buildings reconstruction must be strictly according to the professional testing department of the appraisal report issued to reinforce the transformation processing, transformation of conditions in addition to meet the design requirements, the feasibility of economic cost should also be considered. The old buildings that cannot meet the above two basic conditions should not be changed or reinforced rashly.

1. Current situation and development course of reinforcement and renovation of old buildings

1.1. Current situation of building structure reinforcement
Architecture is the need of human society development as well as human survival. With the acceleration of China's urbanization process, China's 20 years ago large-scale construction has been transformed into the current stage of the repair, renovation and reinforcement of the original buildings, the maintenance and renewal of the existing buildings has become a new industry in the current construction industry development. Huge stock of buildings, a large proportion of the building use fixed number of year is close to or more than 20 years, coupled with the development of enterprises "cost control, cast time limit, high turnover" the development of a disease and the construction, the influence of the improper use of factors, both of the building quality problem increasingly prominent, serious influence the durability of structures, damage the structure of the normal use.

1.2. Development history of building structure reinforcement [1]
In recent decades, the reinforcement and reconstruction techniques of structures have been developed accordingly. From the original only to the general civil residence and the maintenance repair of brick structure, simple processing, then the emergence of the adhesives are JGN structure, the introduction of fiber materials, the domestic various research and calculation method for reinforcement and...
reconstruction of active research and development, as well as the use of new machinery, make the structure reinforcement engineering with wider extension, the development of the building structural renovation.

2. Building inspection

2.1. Project overview
According to original design document: the project location, the structure of two layers of the earth cast-in-situ reinforced concrete frame structure, building the total length and width, each layer is high, the basic form, the design of use fixed number of year, the seismic fortification intensity and the strength grade of main material used, and shows the design load value and local basic wind pressure value, basic snow pressure value of the basic data of this project.

2.2. Test content
In order to understand the safety performance of the building structure, a professional testing enterprise on the overall structure of the house for the following content identification:
   (1) Investigation of the basic situation of structure
   (2) section size detection of stressed members
   (3) compressive strength testing of concrete members
   (4) concrete member reinforcement configuration testing
   (5) Building vertex displacement detection
   (6) Safety identification

2.3. Test Basis
Standardization of reinforcement and transformation technology is a sign of maturity of this technology. In the testing process of this project, in addition to the structural design documents and geological survey reports, there are also the following norms, procedures and standards:
   (1) Technical Standard for Testing Building Structures (GB/T 50344-2004);
   (2) Code for Acceptance of Construction Quality of Concrete Structure Engineering (GB 50204-2015);
   (3) Technical Specification for Testing Compressive Strength of Concrete by Springback Method (JGJ/T 23-2011);
   (4) Load Code for Building Structures (GB 50009-2012);
   (5) Reliability Appraisal Standard for Civil Buildings (GB 50292-2015);

2.4. Test content
Professional testing institutions through the building foundation and superstructure of the site detailed investigation to obtain the following aspects of the test results:
   (1) Axis dimension
   (2) section size, layer height detection
   (3) testing the compressive strength of concrete
   (4) reinforcement configuration testing
   (5) Building tilt detection

3. Safety identification

3.1. Calculation of member bearing capacity [2]
According to the existing state of the structure, PKPM series software (2010 version) is used for modeling and checking. The standard value of the strength of building materials is the inferred value of the measured material strength. The live load, wind load and snow load are calculated according to the current "Code for Load of Building Structure" (GB 50009-2012) according to the use requirements
and local actual conditions. The checking results show that the bearing capacity of 3 columns in the bottom column does not meet the checking requirements (see Table 1). The bearing capacity of both the first and second floor beams is not satisfied (see Table 2). The bearing capacity of three slabs of the first floor roof does not meet the checking requirements (see Table 3); The bearing capacity of the foundation meets the checking requirements, but the checking calculation of the anti-punching shear of four foundations does not meet the requirements (see Table 4).

### Table 1. Beam bearing capacity does not meet the requirements of statistical table

| Elevation Axis location | Calculated value | Measured value | safety margin |
|-------------------------|------------------|----------------|---------------|
|                         | left  | middle | Right | left  | middle | Right | left  | middle | Right |
| 11.80m A-B/3axis | 1200  | 2000   | 1200  | 1257  | 1901   | 1257  | 1.05  | 0.95   | 1.05  |
| A-B/4axis | 2100  | 6500   | 2200  | 2454  | 5890   | 2454  | 1.17  | 0.91   | 1.12  |

### Table 2. Column bearing capacity does not meet the requirements of statistical table

| Elevation Axis number | Calculation of reinforcement (Side B) | Measured reinforcement (Side B) | Degree of safety |
|-----------------------|--------------------------------------|---------------------------------|------------------|
| 5.70m A/3axis | 2800 | 2454 | 0.88 |
| B/7axis | 2500 | 2454 | 0.98 |
| B/8axis | 2600 | 2454 | 0.94 |
| A/3axis | 2600 | 2454 | 0.94 |
| B/3axis | 2600 | 2454 | 0.94 |
| A/8axis | 2500 | 2454 | 0.98 |

### Table 3. Plate bearing capacity does not meet the requirements of statistical table

| Elevation Axis number | X-direction Calculated value | measured value | Degree of safety | Y-direction Calculated value | measured value | Degree of safety |
|-----------------------|------------------------------|----------------|------------------|------------------------------|----------------|------------------|
| 3-3a/A-a2 axis | 1197 | 1187 | 0.99 | 980 | 1187 | 1.21 |
| 7-8/A1-A4 axis | 1070 | 1187 | 1.11 | 1340 | 1221 | 0.91 |
| 7-8/A-A1 axis | 851  | 926  | 1.09 | 1105 | 967  | 0.88 |

### Table 4. Punching and shearing checking calculation of independent foundation

| Axis number | Cutting coefficient | Shear coefficient | Conclusion |
|-------------|---------------------|-------------------|------------|
| A/1axis | 0.99 (28) | 50 (0) | Dissatisfy condition |
| A/7axis | 0.88 (28) | 50 (0) | Dissatisfy condition |
| B/7axis | 0.87 (27) | 50 (0) | Dissatisfy condition |

3.2. Superstructure (component) safety identification rating

3.2.1. Main stress components

According to "civil construction reliability evaluation standard" (GB 50292-2015), article 5.2.1 the safety appraisal of concrete structural components and should be according to the bearing capacity, structure, not suitable for carrying the displacement or deformation, cracks or other damage four check project, respectively named each client component level, and take the minimum level of security as the component level [3]. For this project, the empirical calculation, on-site investigation and testing results are as follows:

1. The independent basis is Du level.
2. The concrete column is Du grade
3. The concrete beam is Du grade
3.2.2. General components
Floor experience calculation, site investigation and testing, generally in line with the current national standards of DU requirements.

3.3. Basic safety identification
According to Article 7.2.1 of "Standard for Reliability Appraisal of Civil Buildings" (GB 50292-2015), the safety appraisal rating of foundation foundation shall be determined according to the evaluation results of foundation deformation or foundation bearing capacity. The buildings built on the slope site should also be determined according to the evaluation results of slope site stability. According to the checking result of bearing capacity, the safety of the foundation of the project is rated as DU. According to the summary statistics, the safety grade of the upper load-bearing structure of this project is DU.

4. Evaluation and conclusion

4.1. Maintenance assessment
According to Article 3.3.4 of "Reliability Appraisal Standard for Civil Buildings" (GB 50292-2015), the repairability level of the building appraisal unit is assessed as CR, that is, it is difficult to repair, the use function needs to be reduced after repair, or the use condition needs to be restricted, or the total cost is more than 70% of the new cost, and the repairability is poor.

4.2. Treatment Conclusions
According to the test results and appraisal conclusions, and comprehensively considering the actual situation on site and the practical feasibility effect of the transformation, the structural designer makes the following analysis [2][4][6]:

1. Because the measured strength of concrete is C20, which is not C30 required by the design, the durability does not meet the concrete strength grade required by the code;
2. In addition to the structural components mentioned in the test results are not satisfied with the situation, due to the use of calculation software simulation calculation, the actual consideration of concrete shortening, steel bar exposure, corrosion and other adverse circumstances of the current conditions;
3. Due to the actual strength of the concrete is low, the design of many planting bars operation strength is low, can not be completed;
4. Too many reinforcement parts, too much investment;
5. The reinforcing and strengthening methods are diverse, and whether the desired effect can be achieved in practice is not controllable.

Conclusion: Based on the above analysis, it is not recommended to transform the existing building into an expected building with many people and important functions.

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