

# Reinforcement Technology and Construction Technology of High Rise Building Structure

Xiaoming Lu, Liujun Fan

School of Civil and Architectural Engineering, Zhengzhou University of Science and Technology, Zhengzhou, Henan, China

## *Abstract:*

The stability of building structure and the importance of reinforcement technology seriously affect the safety of high-rise buildings. In this paper, based on an actual project, the reliability of the original structure before reinforcement is identified and analyzed. According to the results of reliability evaluation, some suggestions on the reinforcement design of the structure are put forward. According to the stress principle of the structure, the appropriate reinforcement form is selected and the reinforcement design is carried out. In this paper, the reinforced concrete nonlinear finite element analysis of the whole process of reinforcement is carried out for a typical frame beam in the project. This paper studies and summarizes the construction technology of structural reinforcement. Practice has proved that the effect of structural transformation is good.

**Keywords:** *Building Structure, Stability, Reinforcement Technology, Nonlinear Finite Element Analysis.*

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## I. INTRODUCTION

At present, the reinforcement and reconstruction projects of existing buildings at home and abroad are increasing day by day, some of them are implemented to meet the change of owners' requirements, and some of them are implemented due to higher seismic requirements [1-3]. However, no matter what the reasons are, the reinforcement and reconstruction technology and construction level of the structure are constantly changing and improving [4]. In order to further understand the related reinforcement technology and its application in practice, this paper analyzes and discusses the reinforcement technology and its related content from multiple perspectives, hoping to provide basis and experience sharing for the next work in the field.

## II. DEMOLITION CONSTRUCTION TECHNOLOGY

### 2.1 Project overview

During the construction, the 1-4 axis of phase I will be taken into consideration as the project of phase II. Due to the functional requirements and structural bearing capacity requirements, local demolition and reconstruction and reinforcement of the 1-4 axis of phase I of Guihe phase I are required. The reconstruction involves about 22000 square meters of the area.

### 2.2 Demolition of concrete structure

#### 1) Scheme comparison and selection

Scheme 1: demolish one floor from bottom to top and restore one floor. The construction period of this construction scheme is very long, and the new floor will be damaged in the process of demolishing the floor, because the strength of concrete has not been improved at this time. The vibration of demolition is unfavorable to the new concrete. At the same time, the reinforcement of the column with larger section will be affected by the original floor of the upper layer, and can not be staggered according to the specification. Because the static distance between the nearest upper and lower layers is very small. At the same time, the space between the upper floor and the new floor is very small, and there is no construction space.

Scheme 2: demolish one floor from top to bottom to restore one floor, the column with enlarged section can not be constructed, and the process is misplaced.

Scheme 3: all four floors are removed and restored from bottom to bottom: the risk is the greatest. Because of the deviation of the central axis of columns between the original floors, the maximum deviation in the empirical data is about 100mm. If all the beams and slabs are removed, there will be no transverse restraint in the range of tens of meters, and the long to fine ratio of the columns is too large, which will cause the instability of the building and collapse.

#### 2) Scheme adopted in the project

##### (1) Demolition principle

The general principle of demolition work is the principle of first up and then down, first non bearing structure and then bearing structure, first plate and beam and then wall and column, and the main steel beam shall be installed before demolition. In the actual operation of the project, the floor is removed from top to bottom, and then the steel beam is removed from bottom to top. After the installation of the main steel beam, the concrete frame beam of the corresponding floor is removed. The demolition sequence is shown in the figure below.

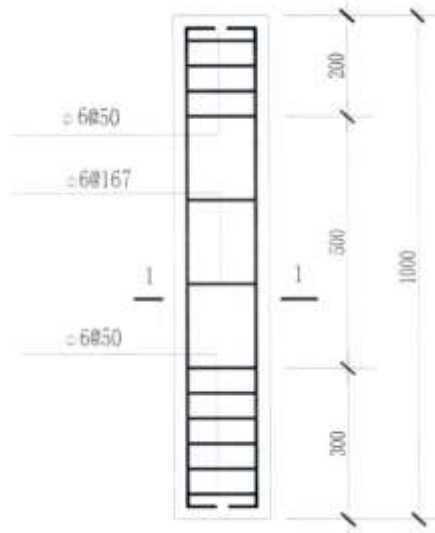


Fig 1: Demolition sequence details

## (2) Demolition method

Except 4 columns of 2-A axis need to be removed, other frame columns need to be retained. At present, the whole construction period is very tight, and shopping malls and hotels are in normal operation to the north of axis 4. On the premise of ensuring the construction quality and construction period, the impact on the normal business of shopping malls and hotels should be minimized. It is proposed to adopt the comprehensive method of vibration free and damage free straight-line cutting and mechanical demolition for the demolition of beams, slabs and columns.

## 2.3 Prestressing tendon tensioning of floor slab

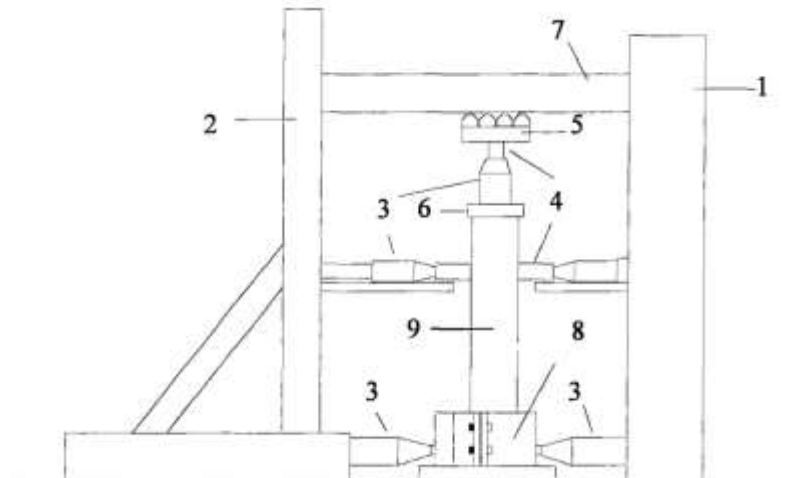


Fig 2: Process flow chart of unbonded prestressed tension Engineering  
 Main construction methods [5-7]:

(1) construction preparation

Safety support and protective measures shall be taken before tensioning, and the live load of this layer shall be removed.

(2) The floor is opened and slotted

Positioning prestressed steel bars and cutting positions of construction slots. According to the design drawings and combined with radar locator, the plane position of prestressed reinforcement is determined, and the tensioning construction slot is arranged at the beam end along the straight line of prestressed reinforcement, which is beneficial to the stable installation of temporary tensioning anchorage.

(3) Install the tensioning tool anchor

First, install a 95mm×95mm×10mm open steel base plate to support the tensioning anchorage and increase the local compression area. Ensure that the base plate contacts with the concrete and is flat and dense, polish it with an angular grinder, assemble the temporary tensioning anchorage and knock on the clamping piece with a hammer to prevent the phenomenon of slipping wire during tensioning.

(4) Release operation

When the site conditions are satisfied, the prestressing tendons are relaxed in batches by the skip BIN method. In order to ensure the safety of the structure, the method of group symmetrical tension and stress recovery should be adopted.

(5) Re tensioning of prestressed tendons

Before tensioning operation, carefully check the installation of working anchorage, check the quality of bearing plate at tensioning end, and conduct tensioning operation only when there is no abnormal phenomenon.

### **III. RESEARCH ON REINFORCEMENT AND RECONSTRUCTION TECHNOLOGY**

#### **3.1 Reinforcement and reconstruction scheme**

According to the reinforcement requirements, the structure is strengthened (including carbon fiber reinforcement, steel plate reinforcement, chemical planting reinforcement and column section enlargement). Structural construction of floor replacement in 1-5 floors, structural construction of connection between new and old buildings in 2-11 floors, structural reconstruction of underground 1-2 floors, new shear wall construction in southeast corner and northeast corner of b1-113 floors [8].

#### **3.2 Reinforcement and transformation methods**

1. Paste carbon fiber to reinforce
2. Steel plate reinforcement
3. Chemical reinforcement planting
4. Column enlarged section

### 3.3 Construction technology of reinforcement and reconstruction

#### 3.3.1 Strengthening with carbon fiber

##### 1) Reinforcement design basis:

- (1) The original design drawings of this project
- (2) Design code for strengthening concrete structure( GB50367-2006)
- (3) Code for acceptance of Construction quality of strengthening building structures (GB50550-2010)
- (4) Technical specification for strengthening concrete structures with carbon fiber reinforced polymer laminate (CECS 146:2003)

##### 2) Construction technology

- (1) The construction should be carried out at the ambient temperature above 5 °C, and the service temperature of carbon fiber adhesive should not be lower than 5 °C, otherwise the heating treatment measures should be adopted.
- (2) Too much humidity may prolong the curing time of carbon fiber adhesive.
- (3) The setting out of the pasting position must be accurate.
- (4) When preparing carbon fiber adhesive, it should be weighed and evenly stirred according to the proportion specified in the instructions. There shall be no oil stain or impurity in the mixing container [9-10]. The mixing amount of carbon fiber adhesive shall be determined according to the actual ambient temperature on site, and the use time shall be strictly controlled.

#### 3.3.2 Reinforce with steel plate

When the structure is reinforced by sticking steel plate or section steel, the following construction technology shall be adopted.

##### (1) The surface of concrete members shall be treated according to the following methods:

For the bonding surface of the original concrete components, a hard brush can be used to dip in a high-efficiency detergent. After brushing off the oil dirt on the surface, wash it with cold water, and then polish the bonding surface to remove the 2-3mm thick surface layer until the new surface is completely exposed, and use oil-free compressed air to blow off the powder particles.

(2) The bonding surface of steel plate or section steel shall be derusted and roughened. If the steel plate or section steel is not rusted or slightly rusted, it can be polished by sand blasting, emery cloth or flat grinding wheel until metallic luster appears. The greater the grinding roughness, the better. The grinding lines should be perpendicular to the stress direction of the steel plate. Afterwards, wipe clean with absorbent cotton and acetone. If the steel plate is seriously rusted, soak it in hydrochloric acid for 20 minutes to make the rust layer fall off, then rinse it with lime water to neutralize acid ions, and finally grind the groove with a flat grinding wheel.

(3) Before the steel plate or section steel is pasted, the reinforced members shall be unloaded. If the lifting method of Jack is adopted for unloading, for beams bearing uniform load,

multi-point (at least two points) shall be used to lift uniformly. For the main beam with secondary beam action, a jack shall be set under each secondary beam. The jacking tonnage shall be subject to the non crack on the top surface.

(4) The binder shall be inspected on site before use, and can be used only after it is qualified. It shall be prepared according to the product operation manual. Attention should be paid to avoid rainwater entering the container during mixing, mixing in the same direction, and there shall be no oil pollution in the container.

(5) After the adhesive is prepared, the trowel is used to smear on the treated concrete surface and steel plate surface at the same time, with the thickness of 1-3mm, thick in the middle and thin at the edge, and then the steel plate is pasted on the predetermined position. If it is vertical paste, in order to prevent flow, can add a layer of dewaxing glass cloth. After bonding the steel plate or section steel, gently tap the steel plate or section steel along the bonding surface with a hand hammer. If there is no cavity sound, it means that the steel plate or section steel has been bonded tightly. Otherwise, the steel plate should be stripped off, glued and pasted again.

(6) After the steel plate or section steel is pasted, it should be clamped immediately with clamp or fixed with support, and properly pressurized to make the glue just extrude from the edge seam of the steel plate.

(7) The binder can be cured at room temperature and maintained above 20 °C. The fixture or support can be removed in 24 hours and can be used under force in 3 days. If the temperature is lower than 15 °C, it should be heated manually, usually by infrared lamp.

(8) After reinforcement, the surface of steel plate or section steel shall be painted with cement mortar for protection. If the surface area of steel plate or section steel is large, in order to facilitate mortar bonding, a layer of lead wire mesh or a layer of pisolite can be bonded.

### 3.3.3 Enlarged section of column

Column reinforcement details is shown in Figure 3.

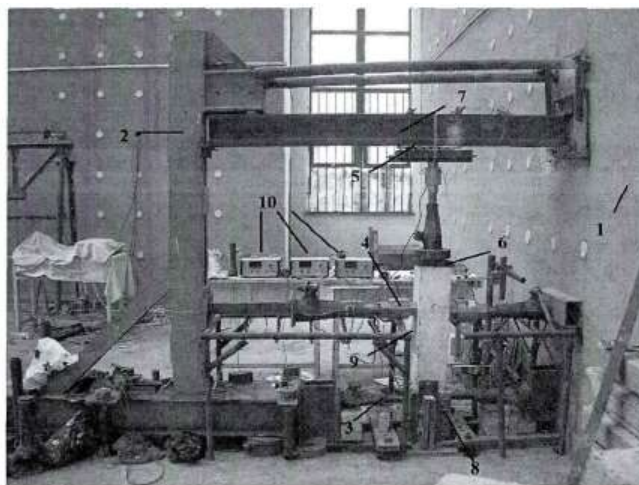


Fig 3: Column reinforcement details

Technological process:

Chiseling of new and old joints - reinforcement processing - planting of main reinforcement - planting of stirrup - reinforcement binding - formwork pouring grouting material - formwork removal and maintenance

Grouting construction technology:

(1) Before grouting, all gravel, dust or other debris shall be removed and the surface of base concrete shall be wetted.

(2) Prepare mixing equipment, grouting equipment, formwork and maintenance items.

(3) When mixing cement-based grouting materials, water shall be added according to the water consumption required by the product. Mechanical mixing should be used. When mixing, 213% water should be added to mix for about 3 minutes, and then the remaining water should be added to mix until it is even. The mixing place should be close to the grouting place.

(4) Pour the evenly mixed grouting material into the formwork and knock the formwork properly.

(5) When the thickness of grouting layer is more than 150 mm, relevant measures should be taken to prevent temperature cracks.

#### **IV. CONCLUSION**

Whether it is civil or industrial building, the service life of the building has a fixed period. But in the service life, it often appears in different periods to meet the different use requirements of people. If the building can not achieve new function, it will be demolished blindly and replaced by the new project at the original site. The result is that it not only consumes a lot of human and financial resources, but also may not produce the economic and social benefits. Even the vicious circle phenomenon of repeated construction has negative and negative effects on the economic development, social progress, environmental protection and sustainable development of the whole region. Therefore, it is necessary to meet the requirements of building use in time and to strengthen and transform the building is the necessary measure to prevent the above phenomena.

At present, with the continuous development and expansion of the reinforcement and reconstruction market, the continuous maturity and improvement of reinforcement technology, and the further standardization and detail of reinforcement technology, the reinforcement industry has gradually changed from the simple reinforcement of components to the functional transformation of large industrial and civil buildings. How to realize the integral reinforcement and reconstruction of large-scale buildings, high-rise buildings and even super high-rise buildings has become a common concern and research hotspot of scholars and other practitioners in the industry.



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