Discussion on Foundation Reinforcement of an Existing Old Building

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Abstract. At present, there are a large number of old buildings in China. Some buildings belong to historical and cultural relics. From the perspective of protecting culture and history，the old buildings need to be reinforced to ensure the structural and functional stability of the old buildings. As the foundation plays an important role in the building, the most important thing for the reinforcement of old buildings is the foundation reinforcement. This paper first expounds the significance of strengthening and transforming existing buildings, and then takes a project in Hefei as an example for analysis. This paper introduces the general situation of the existing buildings, and introduces the foundation reinforcement scheme of this project. Finally, it is expected to provide reference value for related projects.

Keywords: Existing buildings, Foundation reinforcement, Engineering.

1. Introduction

Since the reform and opening up, with the steady improvement of the national economy and the acceleration of the urbanization process, a large number of buildings have sprung up. However, after the prosperity and development of the construction industry, there are still some problems left. Due to the current industry standards, the original old buildings cannot meet the requirements of the current building codes in terms of function and safety [1]. Therefore, in order to meet the needs of the people for a better life, promote the transformation of urban renewal and development and construction methods, and promote high-quality economic development, the existing buildings should be transformed and reinforced.

The significance of strengthening and reconstruction of existing buildings is as follows: (1) New buildings need to use many materials and resources, most of which are nonrenewable materials, such as concrete. Therefore, in order to ensure that existing buildings can be continuously used by people and reduce the waste of resources, the effective life of buildings should be extended, which also meets the requirements of sustainable development. (2) The reinforcement and transformation of existing buildings can effectively reduce urban construction waste, prolong the life of building materials, and ultimately protect the ecological environment. (3) The reinforcement of buildings with strong historical and cultural significance can protect these historical relics, enable the inheritance of Chinese culture and promote the continuous development of cultural undertakings such as tourism.

Taking this project as an example, the significance of the reinforcement project is to revitalize the old buildings, making the reinforced buildings a cultural building with exhibition, historical culture and commemorative significance. It avoids the environmental pollution caused by the reconstruction of buildings, and makes the dilapidated buildings play a new role through reinforcement.

Foundation reinforcement is the top priority of existing building reinforcement, and also the premise to ensure the smooth progress of subsequent construction. It can play a certain value role in ensuring the safety, stability and reliability of building engineering structures [2]. Therefore, in the process of foundation design and construction, reasonable selection and application of reinforcement methods are required to ensure that the safety, stability and durability of the building project can be comprehensively improved [3].

2. Building overview

Most of the buildings built before the 1970s were unreinforced masonry structures [4]. The unreinforced masonry structure (URM) is made of simple masonry blocks and mortar [5]. The wall is built of clay bricks and used as a load-bearing component. It is also called a brick concrete structure house. Masonry structure is a brittle material with low tensile and shear strength and weak structural integrity. Therefore, strengthening the existing masonry structure is the most effective technical means to improve the overall performance of the building.

The building structure was built in the 1970s, with a design life of 50 years. It is located in the building group park, with a land area of 197740.04m^2. The total area of the building group is 291641.55m^2

This paper mainly studies a building in the southern cluster building complex, which has a total building area of 881m^2.After appraisal, the safety grade of the building structure is low and the comprehensive seismic capacity of the building does not meet the seismic requirements.

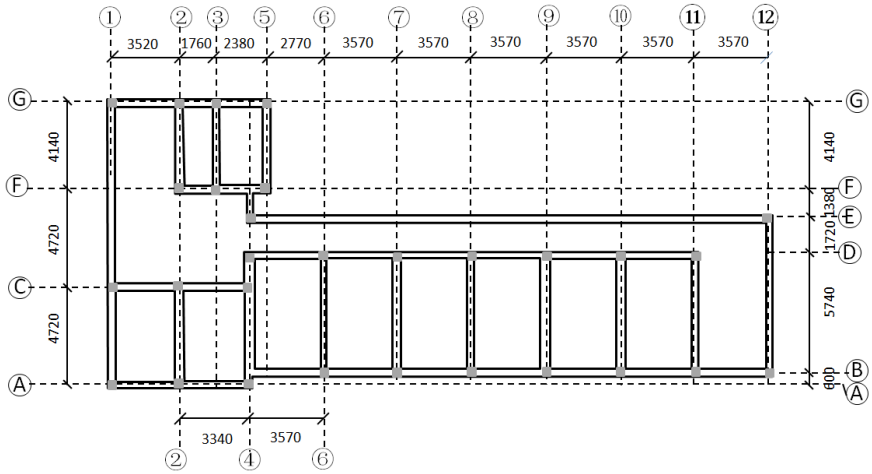

Fig. 1 Plan of the first floor and the second floor

The plan of the building is roughly rectangular, with a size of about 31.6×13.6m. The building is a three story structure, with two stories locally. The bearing system is composed of vertical and horizontal walls. The bearing wall is made of ordinary bricks and mixed mortar, with a thickness of 240mm. The building area of the first floor and the second floor is 291.29m^2, the height of the first floor and the second floor is 3.35m, and the plan is as shown in Fig. 1. The building area of the third floor is 98.9m^2, and the height of the third floor is 3.25m. The total building area of all floors is 681m^2.

The outdoor floor elevation is -0.360m, the indoor floor elevation is ± 0.000m, the second floor height is 3.350m, the cornice bottom elevation is 6.750m, the vault elevation is 7.320m, the third floor height is 6.700m, the roof structure is 9.950m, and the parapet elevation is 10.550m.

3. Foundation reinforcement scheme

3.1. Original basic information

The layout plan of the original foundation of the building is shown in Fig. 2. The foundation of this project is an independent foundation under the column, and the original structural dimensions of the foundation are shown in Fig. 3. The original width and length of the foundation DJ1 are both 1200mm, and the height is 1000mm. There are three steps in total. The dimensions of each step are 350mm, 300mm and 200mm, respectively. The thickness of the protective layer is 40mm, and the concrete strength grade is C30.

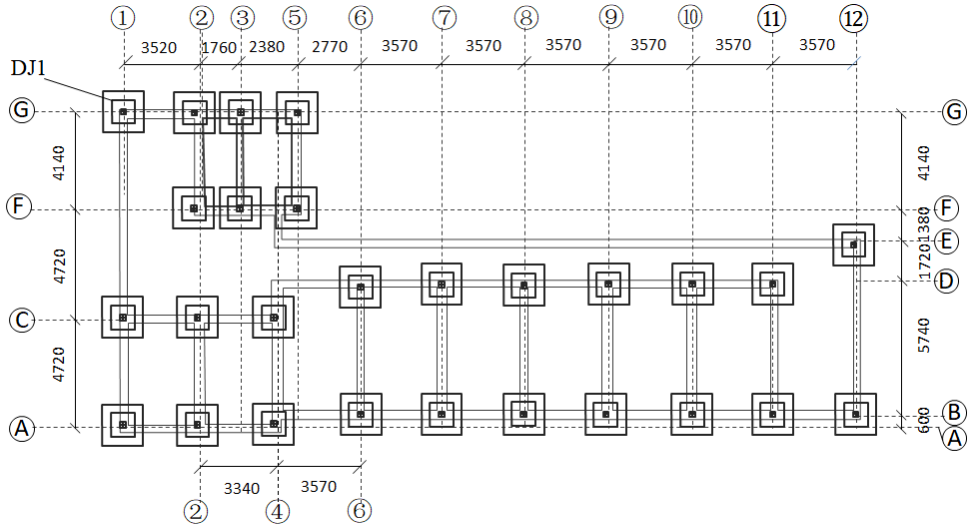

Fig. 2 Foundation Layout Plan

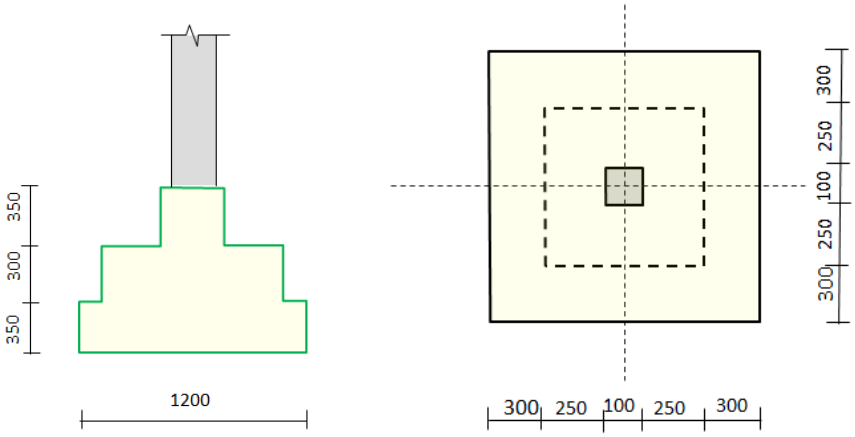

Fig. 3 Detail drawing of independent foundation under column

3.2. Foundation reinforcement scheme

Nowadays, there are many kinds of reinforcement technologies for reinforced concrete structures, such as reinforcement with enlarged section, reinforcement with wrapped steel, reinforcement with bonded steel, carbon fiber reinforcement, replacement concrete reinforcement. Among them, the reinforcement method of increasing section is to add a certain amount of reinforcement on the surface of the original component, and then pour a new layer of concrete to improve the bearing capacity and pressure resistance of the concrete structure [6]. The advantage of this method is that the new and old sections can be closely combined, the construction process is simple, the adaptability is strong, and the design and construction experience are mature. Considering the characteristics and basic application principle of the reinforcement method with enlarged section, it was finally decided to adopt the reinforcement method with enlarged section to strengthen the foundation. At the same time, the chemical planting reinforcement technology was adopted, and the high-strength chemical adhesive was used to bond the reinforcement and concrete, so as to produce high load bearing capacity after curing.

DJ1 foundation shall be reinforced by increasing section reinforcement method. Grout with strength no less than C30 shall be used for pouring. The interface between new and old interfaces strengthened by increasing section shall be roughened, wetted and sprayed with interface agent. The planting reinforcement shall be constructed according to the provisions in《Code for Design of Reinforcement of Concrete Structures》 (GB50367-2013) [7].The new reinforcement is connected with the original structure by chemical planting reinforcement. The planting depth shall be at least 200mm.

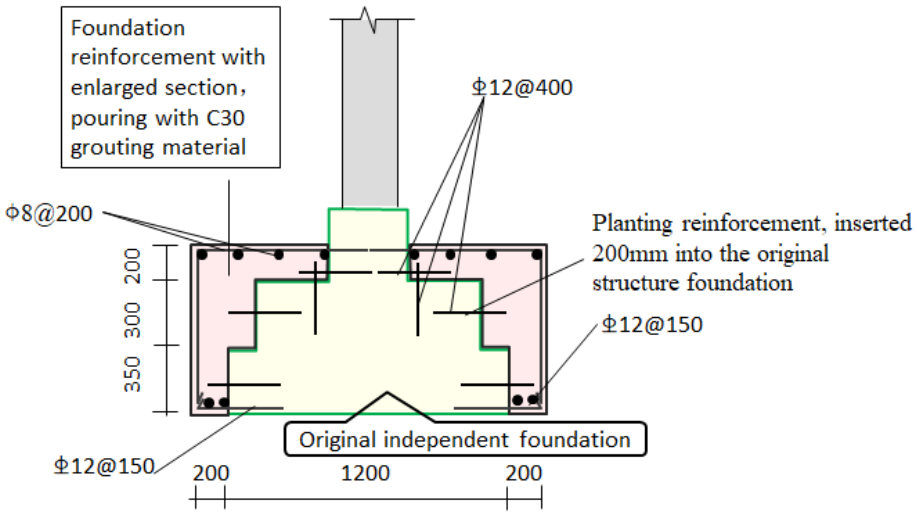

Fig. 4 Reinforcement Details of Reinforcement Foundation

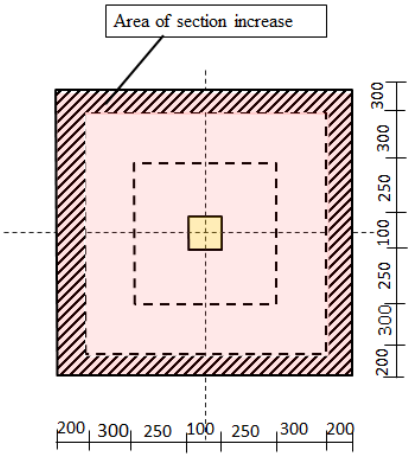

Fig. 5 Reinforced foundation structure

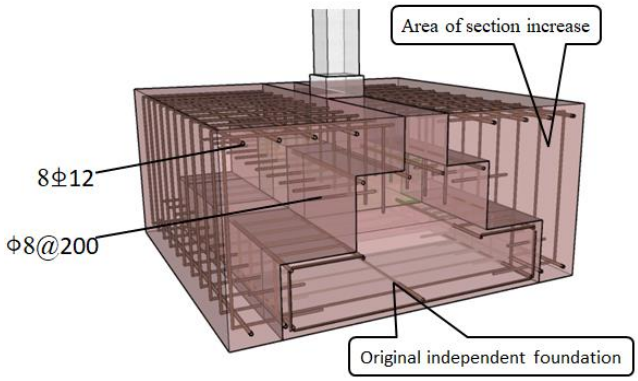

Fig. 6 Sketch of foundation reinforcement

There are 4 longitudinal bars at the lowest step, the model is HRB400, the diameter is 12mm, and the spacing is 150mm. Stirrups with a diameter of 12mm and a spacing of 150mm are used to fix the longitudinal bars, and they are embedded to a certain depth of the original foundation. The dimension of longitudinal bars at the top step is 8mm in diameter and 200mm in spacing. Stirrups with a diameter of 8mm and a spacing of 200mm are used to connect the longitudinal bars and are embedded in the original foundation to a certain depth. The reinforcement details of the reinforced foundation are shown in Fig. 4, and the dimensions of the reinforced foundation structure are shown in Fig. 5. Fig. 6 shows the reinforcement effect of the foundation.

3.3. Implementation of foundation reinforcement

The foundation reinforcement scheme of the building is described above. This section introduces the implementation process of the reinforcement scheme.

(1) Dig the outside drawing of the foundation to the base elevation, so that the original foundation is completely exposed. Roughen the original foundation surface and blow out the ash. The chiseled concrete surface shall be cleaned with a brush, and then be washed and wetted with water [8].

(2) Reinforcement shall be embedded in each step, and the embedded reinforcement shall be filled and fixed with chemical adhesive.

(3) Apply a layer of epoxy resin coating on the original foundation interface. The new and old concrete of the foundation is bonded into a whole through the interface bond and the rear anchor. Form a foundation with enlarged section to improve the bearing capacity of the foundation.

(4) For the widened part of the base, a cushion with the same thickness and material as the original foundation cushion is laid on the foundation.

4. Conclusions

The reinforcement of existing buildings is becoming more and more important, and the foundation reinforcement plays an important role. In view of the characteristics of the foundation structure of this project, the reinforcement method of enlarging the section and the chemical planting reinforcement technology are adopted for reinforcement, which not only considers the theoretical basis of the reinforcement method, but also considers the difficulty of implementation. Through the reinforcement analysis of this project, the experience of similar projects is accumulated, which provides a reference for similar projects in the future.

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