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Review Article

# Structural Reinforcement of Damaged Houses after the Earthquake

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**Abstract:** This article briefly expounds the specific classification of post-earthquake damaged house structures and the importance and significance of strengthening the post-earthquake damaged houses, and then studies how different post-earthquake structures are reinforced and listed several reinforcement methods.

**Keywords:** Damaged house, Reinforcement, Method

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## 1 Introduction

Under the influence of the earthquake, the structure of the house will be damaged to varying degrees. Reconstruction of the house will consume a lot of money and human resources. Reinforcement of the damaged house can save a large portion of funds and energy, and short cycle time does not affect people's use. In addition, the bearing capacity of the reinforced building has been greatly strengthened, which has provided great safety guarantee for people's lives and property in the future earthquake.

## 2 Structural classification of damaged houses after the earthquake

The overall structure of the house will be damaged to varying degrees after being affected by the strong earthquake. The structural damage of the house has two kinds of cracks and deformation in the general direction. After the earthquake, buildings with brick-concrete structures mainly have two kinds of cracks in the wall part and cracks in the building connection. The cracks in the wall part are classified according to the location of the cracks. There are four aspects: the wall stack position, the upper and lower parts of the door and window of the wall, and the four corners; and the crack at the building connection refers to the crack generated at the position where the horizontal and vertical walls are connected in the building.

There are also many types of wall cracks caused by earthquakes, including two types of cracks, shear and bend-shear, and these two types can be divided into different stages according to different damage levels. The main types are as follows: At one stage, the cracks on the wall after the earthquake extended from the middle to both sides. The length of the cracks on the wall was less than half of the total length of the wall, and the two ends of the crack did not completely reach the two ends of the wall. There is still some distance from the wall terminal. In the second stage, the cracks on the wall after the earthquake extended from the middle to both sides and did not fully join the two ends of the wall, nor did the cracks in the structural columns and other places be connected to the cracks. The length of the cracks was greater than half the length of the wall in the horizontal direction. In the third stage, at least one end of the crack on the wall after the earthquake appears to be connected to the cracks in the structural columns and the like, or the crack on the wall after the earthquake has been dislocated, but its severity is still within the repairable range[1]. During the repair process of the damaged house after the earthquake, different reinforcement methods can be formulated according to the specific width of the crack and the degree of damage. Other types of damage can also be set with different indicators according to certain standards, so as to complete the reinforcement of the damaged house structure after the earthquake.

## 3 Significance and importance of structural reinforcement of damaged houses after the earthquake

According to the understanding of the earthquake situation in China, it is known that most of the earthquake-stricken areas are not the ones that do not occur after one earthquake, but as long as the earthquake-stricken areas are mostly earthquake-prone areas, earthquakes will occur one after another. In previous earthquakes, some houses in the same area were strengthened after the earthquake, and some houses were not strengthened after the earthquake. It can be clearly seen after the second earthquake houses that have undergone post-earthquake reinforcements are less affected by the earthquake, and those that have not undergone post-earthquake reinforcements are much more severely damaged than the first time. It can be seen that strengthening the structure of damaged houses after the earthquake can not only reduce the damage to the houses by the earthquake, but also protect people's lives.

In addition, the construction of houses in any area is an important part of local immovable assets. When building a house, it consumes a lot of human and financial resources and various resources. Doing a good job of strengthening the structure of damaged houses after the earthquake is also to be able to extend the life cycle of the house to the maximum extent, maintain social assets and save energy.

## 4 The concrete method of strengthening the damaged house structure after the earthquake

### 4.1 Reinforcement of damaged brick-concrete structure

Generally, in the earthquake-stricken area, the structure of damaged houses is often affected by many factors, which makes it impossible to identify which houses are suitable for reinforcement and which houses are no longer necessary for reinforcement. For example, the structural system of damaged houses cannot be determined if the power transmission route of the damaged house is not clear, the structure lacks integrity, and the connections are relatively weak. In the following, the damaged houses with multi-layer brick-concrete structure are taken as an example to elaborate several commonly used reinforcement methods:

#### 4.1.1 Reduce the number of floors

The structure that can effectively resist earthquakes in brick-concrete houses is brick walls.

However, the brick wall itself has the disadvantages of poor shear resistance and relatively small plastic deformation when subjected to external forces, so it is very easy to be damaged under the influence of earthquakes. In previous earthquakes, we can also find that the higher the number of floors of brick-concrete structure, the greater the degree of damage in the earthquake. Therefore, for such houses in the post-earthquake strengthening of the house structure, the number of floors of the building can be appropriately reduced to reduce its own load. It can also increase the overall seismic resistance of the house structure.

#### 4.1.2 Add plywood wall

Properly increasing the plywood wall in the structural strengthening of damaged houses after the earthquake can greatly increase the load bearing capacity of the building. When adding plywood walls, we can use single-sided and double-sided additions. There are two kinds of plywood walls: reinforced mesh cement mortar plywood walls and reinforced concrete plywood walls[2]. It is particularly important to note that during the plywood wall reinforcement process, care must be taken to ensure that the remaining floor slabs are tightly integrated and that they are to be bonded to the reinforced wall.

#### 4.1.3 Brick door and window openings

After detailed statistics of the damage to the house and the factors that affect the degree of damage to the house, we can see that the number of windows and doors in the house is one of the important factors affecting the damage to the structure of the house. Too many doors and windows of a house structure will reduce the overall structure's seismic resistance, so when the damaged house structure is reinforced after the earthquake, some unnecessary door and window openings can be properly closed with bricks, which can increase the overall seismic resistance of the house structure.

#### 4.1.4 Pressure grouting

Brick-concrete houses are prone to cracks under the influence of earthquakes. According to the types of cracks described above, it can be fully judged whether the damaged house meets the repair standards. If the

repair standards are met, pressure grouting can be used to reinforce the cracks. . Because the overall seismic resistance of the house structure will be greatly reduced after the cracks are generated, the cracks will be filled with cement mortar and other materials to strengthen the seismic performance of the house structure after solidification.

## 4.2 Reinforcement of damaged concrete structure

### 4.2.1 Increasing the cross-section reinforcement method

In the earthquake, the concrete members of many houses will be bent and deformed after being subjected to a large external force. In accordance with the standards for post-earthquake damaged house structural reinforcement, concrete cast-in-place treatment can be performed on curved concrete members, thereby increasing the cross-sectional area of the concrete. After the cross-sectional area is increased, the ability of concrete members to withstand external forces can be greatly improved, and it is not easy to deform and bend, thereby strengthening the damaged house structure[3].

In addition, the actual bending capacity of the concrete structure of the house also has a great relationship with the internal cross-sectional area of the steel bar and the strength of the steel bar. Therefore, in the process of concrete structure reinforcement, the area of the steel bar can be appropriately increased and the steel bar with better strength can be selected. This improves the bending resistance of concrete structure. When strengthening the concrete members by increasing the cross-sectional area, attention must be paid to the fact that the cast-in-situ concrete and the original concrete must be fully adhered, and the original concrete must be cleaned before the concrete is poured. This method of reinforcement is simple in construction and can be reinforced for general concrete structures, but the disadvantage is that the longer construction period will affect the use of the house to a certain extent, and the method of increasing the cross-sectional area will also reduce the original space for house construction.

### 4.2.2 Bonding steel reinforcement method

When reinforcing the concrete structure of a damaged house, steel plates can be pasted on the tensile zone and the compression zone of the concrete structure with a relatively weak bearing capacity or on the cross-sectional surface of the concrete structure. Compared with the above method, this reinforcement method is easy to operate and has a short construction period. It has no great impact on production or people's lives. After the reinforcement treatment is completed, it can be directly put into production and life. However, the reinforcement effect of the steel reinforcement method depends more on the construction skills and the quality of the adhesive.

### 4.2.3 Bonding carbon fiber fabric reinforcement method

This reinforcement method uses a certain construction technique to adhere the carbon fiber material to the position of the tensile zone of the structure to be reinforced, so that it can bear the external force with the original firmware and improve the tensile and pressure resistance of the original structure. This reinforcement method is actually similar to the working principle of the steel bonding method, but because it is light in texture and has high corrosion resistance, it has the advantages of long life and low maintenance costs after reinforcement. The disadvantage is that you need to pay attention to fire treatment. This method is more widely applicable.

### 4.2.4 Wire winding method

This reinforcement method is to increase the bearing capacity of the original component by winding metal wires on the construction surface of the damaged house structure, or to restrain the components that are easily deformed in the lateral direction to reduce the deformation caused by the external force.

### 4.2.5 Steel strand reinforcement method

During the earthquake, many bridges and structures such as beams, slabs and columns of industrial and civil buildings may be damaged due to unreasonable structural design in the early stages of construction, or construction technical problems or it is severely damaged during use, or its bearing capacity is reduced due to large external forces such as earthquakes, and deformation or bending occurs. At this time, a relatively new type of reinforcement technology the stainless steel stranded wire mesh-permeable polymer mortar can be used to reinforce the damaged structure. Compared with the above several reinforcement methods, it can not only greatly improve the bearing capacity of concrete members, but also extend the service life of reinforcement members.

No matter which method is used to reinforce the

damaged house structure, the reinforced house structure is very different from the normal house structure, because after the damaged house structure is reinforced, the reinforcement part is composed of two parts, the old and the new. There are different degrees of stress and strain difference. Therefore, when the damaged house structure is reinforced, the material selection must be similar to that of the original structure of the house. In this way, the new and old parts at the reinforcement site can be coordinated as much as possible when bearing external forces.

## 5 Conclusion

To sum up, there are various methods for the reinforcement of damaged house structures after an earthquake. Comprehensive analysis can be performed according to the different damage levels of different structures to select the most suitable reinforcement method for reinforcement. In addition, the selection of reinforcement materials must also be carried out. Careful consideration is made to optimize the bearing capacity of the reinforced members. Of course, the specific reinforcement construction plan must be determined according to the actual situation in the earthquake zone. You cannot keep the traditional old method to move the hard cover. Instead, you must sum up the experience in the process of strengthening the damaged house structure again and again, and continue to improve the existing methods, and finally make the reinforced house structures more earthquake-resistant and extend the service life of the house.

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