The Analysis on the Seismic Reinforcement Method of Masonry Structures

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Abstract

The brick masonry structures is widely used in the buildings of our country. Due to it's low strength material, poor structural integrity and the disadvantage affect of construction and material selection, it's capability of seismic resistance is poor. This paper analyzed some commonly used reinforcement method of masonry structures and pointed out some suggestions.

Keywords

Masonry Structures; Seismic Strengthening; Measures.

1. Introduction

Masonry structures is a long history and strong viable structure, which in our country is still very widely used in the construction of buildings .About 90% above the wall is masonry, and many of them is brick masonry. But masonry structural have the poor ductility, high stiffness, material tensile, low flexural and shear strength. When in the earthquake, fire, flooding, temperature changes, uneven settlement of Foundation under the action of natural or man-made accidents, destruction of cracks in masonry structure, certain measures need to be taken to reinforce the rear can continue to be used.

2. Characteristics of earthquake damage to masonry structures

For a long time, because of economic conditions limit, the building of our country used masonry structure mostly. In rural area, this structure is widely used. According to China's current building statistics, masonry structure accounted for 80% above, in rural this proportion more higher. Combined with the Wenchuan earthquake disaster area of brick structure damage situation, summed up the following main earthquake damage of brick concrete structure.

2.1 Longitudinal wall failure

Due to the vertical wall of the lateral stiffness, distribution of longitudinal seismic forces is larger. Combined with the vertical walls of the opening rate is high, in the earthquake vulnerable to stress concentration on the wall near the door hole collapse [1]. Near the side of corridor the longitudinal walls need to open both window and door, damage is more serious. As shown in Figure1 [2]. If earthquakes produced in the walls of the main tensile stresses greater than the shear failure strength of the wall, wall shear failure is going to happen and occur through inclined crack. The wall will appear throughout the x-shaped crack when earthquakes repeatedly [3]. These two kinds of cracks often appear in the door of the wall, the wall between the window, the window under the wall and other parts. As shown in Figure 2, 3.

2.2 Cross wall failure

Within the cross wall in brick masonry structure is generally not open holes, and the cross wall around the constrained longitudinal wall and floor is strong, the damage is relatively light. Often appear diagonal cracks and X - shaped cracks in cross wall. Mechanism of cracks is the same of longitudinal wall. As shown Figure 4, figure 5. when using precast slab, because end gable's constraints is weak and the stress is complex, is prone to damage, resulting in severe external flash even collapse.

Figure 1 Longitudinal wall failure

Figure 2 Oblique cracks in the wall of the door

Figure 3 X - shaped cracks in the wall between windows and under the window

Figure 4 diagonal cracks in the cross wall

2.3 Collapse of stairs

Because the brick structure of the staircase is generally at the end, the seismic horizontal wall spacing staircase, sharing of horizontal seismic force is large, and the staircase around the wall did not form a closed structure, the overall effect of the staircase space is extremely easy to cause the staircase wall collapse damaged in the earthquake, see figure 6.

2.4 Floor or roof fall off damage

Because most of the construction unit construction quality of masonry structure is low. It is not in strict accordance with the national standard, prefabricated structural measures standard construction, such as the mutual connection between the precast panels, plate and wall, beam bridge, support length requirements. When the earthquake to the wall, it have large lateral deformation, pole is easy to be damaged in precast slab Rachel or lap site caused prefabricated broken off, see Figure 7.

Figure 5 x- shaped cracks in the cross wall

Figure 6 Collapse of stairs

Figure 7 The collapse of the wall causes the precast slab to fall off

2.5 Collapse and failure of non structural members

If the tailgate, parapet, surface decoration and other non structural members connected with the main structure is not strong, in the earthquake prone to lead off these parts causing casualties, see Figure 8, Figure 9.

Figure 8 the collapse of the tailgate

Figure 9 The collapse of parapet wall

3. Reinforcement technology and methods

The different strengthening methods on masonry bearing have varying degrees of impact force and seismic performance. The form of reinforcement and technical points also be quite different. This chapter purposed to combined with some of the masonry structure projects at present common reinforcement method ,the relevant scientific research, the related literature were collected ,and summarized their advantages and shortcomings contribute to the understanding of masonry reinforcement methods further and further research.

3.1 Outer-wrap reinforced concrete cover

This reinforcement method need removal of the original wall and wall plaster layer in one side or both sides of the layout of the steel mesh firstly. And then the wall is poured or sprayed with a certain thickness of concrete to form a "masonry concrete" composite wall. So as to improve the original seismic bearing capacity, see figure 10. Using this method after the reinforcement of the wall, the level of shear capacity can be increased by about 1.8~3 times. When the seismic bearing capacity of the wall section is larger than the prescribed value, or the composite seismic capacity index of the original structure is relatively small, this method can be used to reinforce [4]. In addition, because the wall larger self weight, it should be set up based on the wall and continuous. Using the reinforcement method effectively enhance the shear and compressive bearing capacity of the original wall and can significantly improve the stiffness and deformation ability. In addition, the reinforced concrete wall thickness and increase the support length of the precast slab can have effectively prevent the earthquake off the precast slab. Construction site can not hand wipe, it use the formwork pouring or sprayed concrete construction generally. This reinforcement method construction process is complicated, concrete and steel cost is higher.

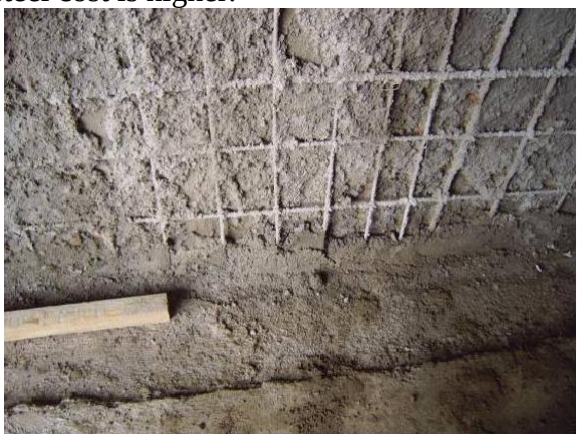

Figure 10 The field practice of outer-wrap reinforced concrete cover

3.2 Coating cement mortar with steel meshes

The reinforcement methods also need to remove the original wall plaster layer and in the wall of one side or both sides of the layout of reinforced cement mortar. And then apply a certain thickness, so as to improve the shear bearing capacity of the original wall, see figure 2.10. Using this method after reinforcement of the wall, the horizontal shear capacity can be increased by 1.04~2.5 times. when there is lack of overall seismic capacity and regulations or housing value difference, you can consider using this method of reinforcement[3]. The reinforcement can also enhance the compressive bearing capacity of the original wall, shear bearing capacity, stiffness and deformation capacity. But the rate of increase than the reinforced concrete wall. In addition, Due to the small thickness of the steel mesh cement mortar surface layer. The construction of cement mortar can be layered with manual preparation. The reinforcement methods construction process is simple. The amount of mortar and reinforcement is small, and the reinforcement cost is low.

Figure 11 The field practice of coating cement mortar with steel meshes

3.3 Binding carbon fiber sheet

Compared with the front two kinds of traditional reinforcement methods binding carbon fiber sheet is gradually being applied to the reinforcement of various buildings. Because of its high efficient, convenient construction method ,light texture and other excellent properties. Nevertheless, reinforced by CFRP sheets have various disadvantages: First, the method also needs to be wet operation, and the cost is higher. The elastic modulus of carbon fiber is relatively low, the effect is reinforced the component is mainly reflected in terms of strength, stiffness has almost no influence; Secondly, epoxy resin with carbon fiber sheet resistance and high temperature resistant performance is poor. So this method is not far for high temperature under the condition of the cattle. When a fire is added between the bearing capacity of the member will be a sharp decline, serious impact on the fire-resistant properties.

3.4 High-strength steel wire & polymer mortar

At both sides of the wall cracks, vertical cracks or crack direction is laid on the surface of high strength steel wire mesh with a crack pressure 20~30 mm thick polymer mortar repair technology. Its for four corners in cracking are not serious, the wall crack width is usually not more than 0.2 mm .It can double the construction. The wall crack repair diagram and field wall reinforcement as shown in Figure 12.

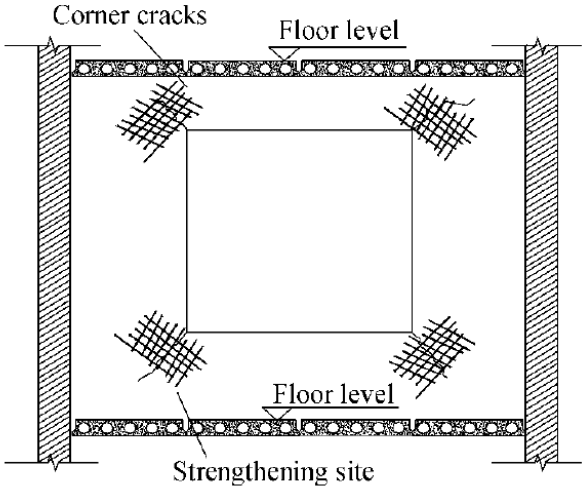

Figure 12 Retrofit on crack wall at corner of window with high-strength steel wire & polymer mortar

4. Conclusion

With the rapid development of economy and society in China, all kinds of destruction or damage to housing also has attracted more and more attention. For masonry buildings, as engineering and technical personnel should be "prevention" as the primary principle, to ensure the quality of building products, can withstand all kinds of damage factors test. But the masonry structure is easy to produce after all such destruction, in this regard, according to the damage mechanism, damage degree and the functions of the house need to adopt appropriate reinforcement method, which makes use of the quality of masonry buildings are protected.

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