

Collapse-resistant Capacity of Masonry Building with Framed-Shear Walled Lower Floor with Different Protection Levels

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SUMMARY:

Multi-story Masonry Building with R. C. Frames on Ground Floor (Framed-Ground Floor Structure for short) which has serious seismic damage and high collapsed rate, is the unreasonable structure system. However, the structure system not be abolished for economic reason. Collapse types of that are divided into collapse of ground floor, collapse of transition layer, global collapse. And seismic damage is also serious for frame column and shear wall. Experiences are obtained from above seismic damage, and the following aspects should be taken into account in the future. 1. The shear wall can be increased to improve stiffness of weak layer. And designer should try to arrange the walls equably. 2. In order to avoid stiffness mutation, stiffness ratio between ground frame and transition layer can be adjusted. 3. Collapse resistant design of Framed-Ground Floor Structures should be emphasized.

Keywords: Framed-Ground Floor Structure, seismic damage, collapse-resistant capacity, weak layer, transition layer

1. GENERAL INSTRUCTIONS

Multi-story Masonry Building with R. C. Frames on Ground Floor (Framed-Ground Floor Structure for short) is the structure which own Multi-story Masonry Building on the top and one or two story frame on the bottom. The material for shear wall of frame can be reinforced concrete, masonry or both the two materials. The large space on the bottom meets with conditions of store, restaurant, bank, meeting room, garage, and many bays on the top can meets with conditions of houses or offices. Moreover, so much advantage such as economy applicable, simple structure, convenient, etc, that Framed-Ground Floor Structure is extensively applied in frontage buildings.

However, seismic damage of Framed-Ground Floor Structure is serious. Collapsed rate is as high as 85% in the Yingxiu town and the old Beichuan town which is damaged seriously in Wenchuan earthquake. Then collapsed rate of frame structure is 63% as a second, and collapsed rate of Multi-story Masonry Building is 48% as a third. Collapse of building under seismic is the main factor to leading casualties and property lose, it often is the limits of life and death. And many Framed-Ground Floor Structures are frontage buildings located in the centre of city. That the high collapsed rate leads to the serious negative social influence.

2. SEISMIC DAMAGE TO FRAMED-GROUND FLOOR STRUCTURES

Characteristic of seismic damage to Framed-Ground Floor Structures combines the characteristic of seismic damage to Frame structure, Multi-story Masonry Building. It is complicated.

2.1. Collapse of ground floor

Compared with frame structure and other structures, seismic damage of Framed-Ground Floor Structures has its inherent characteristics. Firstly, Framed-Ground Floor Structures is a mixed structure system with upper rigid lower flexible, bearing components of that change from R.C. frame structures by bottom to rigid upper Multi-story Masonry structure (Figure.1). The mass and stiffness is not well distributed, the weak layer where seismic damage tends to occur is existed. The shear walls are arranged mostly on one side of the building, the mass and stiffness both are eccentric. Then seismic damage caused by torsion is also serious.



(a) [Y. Feng, etc, 2008]



(b)

Figure 1. Collapse of ground floor

2.2. Collapse of transition layer

Because stiffness suddenly changes, the masonry transition layer, which connects to frame layer, also prone to transition layers collapsed (Figure.2).



(a)



(b)



(c)

Figure 2. Collapse of ground floor

2.3. Global collapse

Moreover, top-heavy^[Y.L. Xu, 2008] is one characteristic of Framed-Ground Floor Structures, great impact load is added to ground frame by the collapsed transition layer, which results in not only collapse of ground frame but also casualties and property lose (Figure.3).



Figure 3. Global collapse

At the same time, characteristic of seismic damage to Framed-Ground Floor Structures combines the characteristic of seismic damage to Frame structure and Multi-story Masonry Building, such as “strong beam and weak column”, “Effect of filler wall” and so on.

3. LOCAL SEISMIC DAMAGE

Local seismic damage of Framed-Ground Floor Structures also is serious, such as seismic damage of frame column and shear wall, seismic damage of Multi-story Masonry wall. Because of early damage of brick wall in frame, great seismic load is added to frame. That will lead serious seismic damage of frame column (Figure.4).



(a)



(b)

Figure 4. Seismic damage of column

Shear wall bears more seismic load for the big stiffness and uneven arrangement of wall, which results in cracking or collapse of wall (Figure.5).



(a)



(b)



(c) [Y. Feng, etc, 2008]



(d) [Y. Feng, etc, 2008]

Figure 5. Seismic damage of shear wall

In addition, Seismic damage is serious at the multi-story masonry wall for the big stiffness of frame (Figure.6).



(a) [Y. Feng, etc, 2008]



(b)

Figure 6. Seismic damage of multi-story masonry wall

4. SUMMARY

Collapse types of Framed-Ground Floor Structures are divided into collapse of ground floor, collapse of transition layer, global collapse. Seismic damage is also serious for frame column and shear wall. The unreasonable structure system is main reason. Then the structure system cannot be prohibited for the economic reasons. Experiences are obtained from above seismic damage, and the following aspects should be taken into account in the future. 1. The shear wall can be increased to improve stiffness of weak layer. And designer should try to arrange the walls equably. 2. In order to avoid stiffness mutation, stiffness ratio between ground frame and transition layer can be adjusted. 3. Collapse resistant design of Framed-Ground Floor Structures should be emphasized.

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