

$$N_f = V_w H_f / l \quad (7.2.11-1)$$

$$V_f = V_w \quad (7.2.11-2)$$

Where: V_w —the shear force design value distributed to the wall; for walls existed on both sides of the column, the value may be taken as the greater one.

N_f —additional axial pressure design value of the frame column.

V_f —additional shear force design value of the frame column.

H_f, l —the story height and span of the frame respectively.

2 The seismic bearing capacity of the wall made with common bricks filled in the frame and the frame columns at the two ends of wall shall be checked according to the following equation:

$$V \leq \frac{1}{\gamma_{REc}} \Sigma (M_{yc}^u + M_{yc}^l) / H_0 + \frac{1}{\gamma_{REw}} \Sigma f_{vE} A_{w0} \quad (7.2.11-3)$$

where: V —the shear force design value of the filled common brick wall and the frame columns at the two ends of wall.

A_{w0} —calculated horizontal sectional area of the brick wall. When wall has no opening, take as 1.25 times of the actual sectional area; when wall has opening, take as the net sectional area, but the sectional area of the wall, which width is less than 1/4 of the opening height, is not considered.

M_{yc}^u, M_{yc}^l —non-seismic bending bearing capacity design values at the upper and lower end of the frame columns in the first story respectively, and it may be determined by the provision in the current national standard "Code for design of concrete structure" GB 50010.

H_0 —calculated height of first story frame column; when there are brick walls on the both sides of the column, take as 2/3 of clear height of the column; in other cases, take as the clear height of the column.

γ_{REc} —seismic adjusting factor for first story frame column bearing capacity, and may be taken as 0.8;

γ_{REw} —seismic adjusting factor for filled common brick wall bearing capacity, and may be taken as 0.9.

7.2.12 The seismic check for composite brick column at external wall of multi-story buildings with inner-frames shall be done according to the provision in Clause 9.3.9 of this code.

7.3 Details of seismic design for multi-story clay brick buildings

7.3.1 The cast in-situ reinforcement concrete tie-columns (hereinafter referred to as tie-column) for multi-story clay brick and perforated brick buildings shall be installed in accordance with the following requirements:

1 The location installed of tie-column shall comply with the requirements in Table 7.3.1 in generally.

2 For multi-story gallery-type or one-sided corridor buildings, the tie-columns shall be installed in accordance with the Table 7.3.1, but the building assumed with one more story, and the longitudinal walls on the both sides of the one-sided corridor shall be regarded as exterior walls.

3 For buildings with rather less transversal walls such as schools and hospitals, the tie-columns shall be installed in accordance with the Table 7.3.1, but the building assumed with one more stories. When such buildings adopt the gallery-type or one-sided corridor, that shall also comply with provision in Point 2 of this clause; but the following building assumed with two more stories: does not exceed 4 stories for Intensity 6, or 3 stories for Intensity 7, or 2 stories for Intensity 8.

Table 7.3.1 Requirements for arrangement of tie-columns for brick buildings

Number of stories in building				Location of installation	
Int. 6	Int. 7	Int. 8	Int. 9		
4,5	3,4	2,3		Four corners of the exterior wall; Intersections of the transversal wall in the slit-level portion and the exterior longitudinal wall; Both sides of bigger openings; Intersections of interior wall and exterior longitudinal walls at large rooms	Four corners of the staircase and elevator shaft for Intensity 7 and 8; intersections of each 15m or the unit transversal wall and exterior longitudinal wall
6,7	5	4	2		Intersections of every other transversal wall (axis) and exterior wall; intersections of gable and interior walls; four corners of staircase and elevator shaft for Intensity 7 to 9
8	6,7	5,6	3,4		Intersections of interior wall and exterior wall, smaller piers of the interior wall, four corners of the staircase and elevator shaft of Intensity 7~9; Intersections of interior longitudinal and transversal wall for Intensity 9

7.3.2 The tie-columns of the multi-story common brick and perforated brick buildings shall comply with the following requirements:

1 The minimum crosssection for the tie-column may adopt 240mm × 180mm, the longitudinal bars should adopt 4φ12; spacing of the stirrups shall not be greater than 250mm, besides, in the upper and lower ends of the tie-column, the spacing of stirrups shall be reduced accordingly. When exceeding 6 stories for Intensity 7, exceeding 5 stories for Intensity 8, and for Intensity 9, the longitudinal bars of the tie-column shall adopt 4φ14, and the spacing of stirrups shall not exceed 200mm. For the tie-columns in the corners of the building, cross section and stirrups shall be increased accordingly.

2 The connection of the tie-column and the adjacent walls shall be built into horse-toothed joints, the 2φ6 tie bars shall be arranged in spacing each 500mm along the height of the wall, the length extending into the wall at each side should not be less than 1 m.

3 At the connection of the tie-column and the ring-beam, the longitudinal bars of the tie-column shall be through the ring-beam to ensure the continuation of longitudinal bars in the tie-column.

4 The tie-columns may not establish individual footing, but they shall extend to 500mm into the underground level, or shall be connected with the foundation ring-beam, whose buried depth less than 500mm underground.

5 When the building height and the number of stories are close to the limit values of Table 7.1.2, the spacing of tie-columns within the longitudinal and transversal walls shall also comply with the following requirements:

- 1) For the transversal wall, the spacing of tie-columns should not be greater than 2 times of the story height, and this spacing of tie-columns in lower 1/3 of stories should be reduced accordingly;
- 2) For the longitudinal walls, when the bays of building are greater than 3.9m, the exterior longitudinal walls shall adopt strengthening measures; the spacing of tie-columns of the interior longitudinal wall should not be greater than 4.2m.

7.3.3 The cast-in-situ reinforced concrete ring-beam of multi-story common brick and perforated brick buildings shall be installed in accordance with the following requirements:

1 For the buildings with precast reinforced concrete or timber floors and roof, ring-beams shall be installed as follows:

When the buildings assigned to bearing transversal wall system, ring-beams shall be installed according to the requirements in Table 7.3.3; when assigned to bearing longitudinal wall system, ring-beams shall be installed at each story and their spacing on the transversal wall shall be reduced accordingly.

2 Only the building with cast-in-situ or assembly-monolithic reinforcement concrete floors and roof that have reliable connection with the walls, the ring-beams shall be permitted not installed. But the strengthened reinforcements of in-situ slabs shall be arranged along the wall perimeters and shall be reliably connected with corresponding tie-columns.

Table 7.3.3 Requirements for installation of cast-in-situ reinforcement concrete ring-beam in brick buildings

Type of wall	Intensity		
	6,7	8	9
Exterior walls and interior longitudinal wall	At roof level, each floor level	At roof level, each floor level	At roof level, each floor level
Interior transversal wall	Ditto; the spacing at roof shall not be greater than 7m; spacing at the floor shall not be greater than 15m; corresponding location of the tie-column	Ditto; along all transversal wall at roof and the spacing shall not be greater than 7m; the spacing at floor shall not be greater than 7m; corresponding location of the tie-column	Ditto; all transversal walls at roof and each floor

7.3.4 The details of cast-in-situ reinforced concrete ring-beam in multi-story common and perforated brick buildings shall comply with the following requirements:

1 The ring-beam shall be enclosed; at the location of opening, the ring-beam shall be spliced with two limbs along the upper and lower of opening. The ring-beams should be installed in the same level of the precast slabs or immediate next to the bottom of the slab.

2 For no transversal wall exists within of ring-beam spacing required by Table 7.3.3, the reinforcements in the floor girder or the joint between precast slabs shall be used for the replacement of ring-beam.

3 The cross-sectional height of the ring-beam shall not be less than 120mm, and the reinforcements shall comply with the requirements in Table 7.3.4. The ring-beams added according to the requirements of point 3 of Clause 3.3.4 of this code, the cross-sectional height shall not be less than 180mm, and the reinforcement bar shall not be less than 4φ12.

**Table 7.3.4 Requirements for reinforcement arrangement
in ring-beam of brick buildings**

Reinforcement	Intensity		
	6,7	8	9
Min. longitudinal bar	4φ10	4φ12	4φ14
Max. stirrup spacing (mm)	250	200	150

7.3.5 Roof and floors of multi-story common brick and perforated brick buildings shall comply with the following requirements:

1 The length for cast in-situ reinforced concrete roof or floor slabs extending to the transversal and longitudinal walls shall not be less than 120mm.

2 For precast reinforcement concrete floor or roof slab and the ring-beam is not installed at the same level of the slab, the length for the slab end extending into the exterior wall shall not be less than 120mm; into interior wall, than 100mm; and in to beam, than 80mm.

3 For the span of the precast slab is greater than 4.8m and is parallel to the exterior wall, the side of the precast slab next to the exterior wall shall be tied with the exterior wall or ring-beam.

4 The precast slabs of the large room at the end of the building, which assigned to the roof for Intensity 8 or to the floors and roof for Intensity 9, shall be tied with one another, as well as with the beam, wall or ring-beam, when the ring-beam is installed at the bottom of the slab.

7.3.6 The reinforced concrete girders or trusses of the roof or floor system shall be reliably connected with the wall, column (including tie-column) or ring-beam. The connection of the girder and the brick column shall not weaken the cross section of the brick column. For the independent brick columns, the top of each story shall have reliable connection in two

directions.

7.3.7 For the rooms with length greater than 7.2m of Intensity 7 or for Intensity 8 and 9, in the corners of exterior wall and intersection of exterior and inner wall, the tie bars of 2 ϕ 6 shall be installed in each 500mm along the height of the wall. Besides, the tie bars should be extended into the walls on each side with length not less than 1 m.

7.3.8 The staircase shall comply with the following requirements:

1 For the transversal wall and exterior wall of the staircase at top story for Intensity 8 and 9, 2 ϕ 6 reinforcement bars shall be installed overall length of wall and installed in each 500mm along the height of the wall. For Intensity 9, a 60mm thick reinforced concrete strip or a reinforced brick course shall be installed at the landing platform or middle level of the story in other stories of the staircase. For reinforced brick course, the strength grade of mortar shall not be less than M7.5, and the longitudinal reinforcement bars shall not be less than 2 ϕ 10.

2 For Intensity 8 and 9, the supporting length of the girder, which is at the staircase or the salient angle of the interior wall for the vestibule, shall not be less than 500mm, and the girder shall be connected with the ring-beam.

3 The precast waist slabs shall be reliably connected with the beam of the landing platform; the stairs with the cantilevered steps tread from wall or the steps riser interposed the walls shall not be adopted, and the plain brick railing shall not be adopted.

4 For staircase or elevator shaft exceeding the roof level, the tie-column shall extend to the wall top and shall connect with the ring-beam of the wall top. And its intersection of the interior and exterior walls, 2 ϕ 6 tie-bars shall be installed in each 500mm along the height of the wall; more over, the length for each side to extend into the wall shall not be less than 1 m.

7.3.9 The trusses of pitch roof shall be reliably connected with the ring-beam of the top story of building; the purlines and the roof slabs shall be connected with the walls or trusses. The tiles of eaves course at the entrance and exit of the building shall be anchored to the roof members. For Intensity 8 and 9, the stepwise piers at the top of longitudinal interior wall of the top story should be built up to support the gables.

7.3.10 The plain brick lintels shall not be adopted at the door or window openings. The supporting length of lintel shall not be less than 240mm from Intensity 6 through Intensity 8, and shall not be less than 360mm for Intensity 9.

7.3.11 The precast balcony slabs shall be reliably connected with the ring-beam and the cast-in-situ strip of the precast floor slab.

7.3.12 The post-built non-bearing partition wall shall comply with relevant provision of Section 13.3 in this code.

7.3.13 The foundation (included the pile capping) of the same structural unit should adopt foundation of the same type. The bottom of foundation shall be buried at the same lev-

el; otherwise, added foundation ring-beams shall be installed, and foundation shall be stepped on a slope 1:2.

7.3.14 For the total height and number of stories of multi-story common brick and perforated brick living buildings exceed the limit values listed in Table 7.1.2, the strengthening measures shall comply with following provisions:

- 1 The size of the largest bay in the building shall not be greater than 6.6m.
- 2 Within the same structural unit, the number of staggered-axis transversal wall should not exceed 1/3 of the total number of walls; more over, successive staggered-axis walls should not exceed two. The added tie-columns shall be installed at fall of intersection of the staggered-axis walls and longitudinal walls, and the floors and roof shall adopt in-situ reinforced concrete slabs.

3 The width of opening in the transversal wall and the interior longitudinal walls should not be greater than 1.5m; the width of opening in the exterior longitudinal wall should not exceed 2.1m or 50% of the bay dimension. More over, the locations of these opening on the interior and exterior walls shall not affect the integral connections between the interior and/or exterior longitudinal walls and transversal walls.

4 The in-situ strengthening reinforcement concrete ring-beam shall be installed for each transversal and longitudinal wall in the floors and roof. The cross-sectional height of the ring-beam should not be less than 150mm, the upper and lower longitudinal reinforcement bars shall not be less than 3 ϕ 10, the stirrup diameter shall not be less than ϕ 6, and the spacing of stirrup shall not be greater than 300mm.

5 In the intersections of all transversal and longitudinal walls as well as the middle of the transversal walls, the added tie-columns shall be installed in accordance with following requirements:

The column spacing within the transversal wall should not be greater than the story height, the spacing of column within the longitudinal walls should not be greater than 4.2m;

The minimum cross section of tie-columns should not be less than 240mm \times 240mm; the reinforcements should comply with the requirements in Table 7.3.14.

Table 7.3.14 Requirements for longitudinal bars and stirrups in the added tie-column

Location	Longitudinal bars			Stirrup		
	Max. steel ratio (%)	Min. steel ratio (%)	Min. diameter(mm)	Scope of densified zone (mm)	Spacing in densified zone (mm)	Min. diameter(mm)
Corner column	1.8	0.8	14	Full height	100	6
Side column	1.8	0.8	14	Upper end 700	100	6
Middle column	1.4	0.6	12	Lower end 500		

6 The floors and roof of the same structural unit should be installed at the same level.

7 At the windowsill level of the top and first story of the building, the cast-in-situ reinforced concrete horizontal strip should be installed along overall length of the transversal walls and longitudinal walls. The cross-sectional height of this strip shall not be less than 60mm, the width shall not be less than 240mm, and the longitudinal bars shall not be less than 3 ϕ 6.

7.4 Details of seismic design for multi-story small-block buildings

7.4.1 The reinforced concrete core columns (hereinafter refer to core-column) for small-block buildings shall be installed in accordance with the requirements of Table 7.4.1. For buildings with rather less transversal walls such as hospital and school, core-columns shall be installed in accordance with the Table 7.4.1, but the building assumed with one more stories.

Table 7.4.1 Requirements for core-columns installed in small-block buildings

Number of stories			Location of core-columns	Number of core-columns (filled holes)
Int. 6	Int. 7	Int. 8		
4, 5	3, 4	2, 3	Corner of exterior wall, four corners of staircase intersection of interior and exterior walls in large rooms, intersections of each 15m or the unit transversal wall and exterior longitudinal wall	Corners of the exterior wall, 3 holes shall be filled; intersection of interior and exterior walls, 4 holes
6	5	4	Corner of exterior wall, four corners of staircase intersection of interior and exterior walls in large rooms, intersection of the interior wall and the gable, intersection of other bay transversal wall (axis) and exterior longitudinal wall	
7	6	5	Corner of exterior wall, four corners of staircase, intersection of all interior and exterior walls; for Intensity 8, intersection of interior longitudinal wall and transversal wall (axis), both sides of bigger openings	Corners of the exterior wall, 5 holes shall be filled; intersection of interior and exterior walls, 4 holes; intersection of interior walls, 4 or 5 holes; both sides of opening, 1 holes
	7	6	Ditto; The spacing of the transversal wall core-column shall not be greater than 2m	Corners of the exterior wall, 7 holes shall be filled; intersection of interior and exterior walls, 5 holes; intersection of interior walls, 4 or 5 holes; both sides of opening, 1 hole

Note: In locations such as the corners of the exterior wall, intersection of the interior and exterior wall, and corners of staircase, it shall be permitted adopted tie-columns to replace corresponding core-columns.