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General Code for Masonry Structures

砌体结构通用规范

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1 General Rules

1.0.1 In order to ensure the quality and safety of masonry structure engineering, implement the policies of energy saving, land saving and promotion of new masonry materials, protect the ecological environment, ensure the safety of life, property and personal health of the people, and improve the sustainable development level of masonry structure engineering, this Code is formulated.

1.0.2 Masonry structure engineering must implement this Code.

1.0.3 Whether the technical methods and measures adopted in the project construction meet the requirements of this Code shall be judged by the relevant responsible parties. Among them, innovative technical methods and measures shall be demonstrated and meet the performance requirements in this Code.

2 Basic Provisions

2.0.1 Masonry strength shall be tested according to the masonry standard test method; and the construction quality control level of the test shall be clarified; and the average value, variation coefficient and standard value of masonry strength shall be determined by mathematical statistical analysis methods.

2.0.2 The standard value of masonry strength shall be determined according to the 0.05 percentile value of its probability distribution.

2.0.3 The variation coefficient of masonry strength shall be adopted according to Table 2.0.3. For the variation coefficient of new masonry materials, when the calculated value is less than the value listed in Table 2.0.3, the value in the table shall be taken; when the calculated value is greater than the value listed in Table 2.0.3, the actual calculated value shall be taken.

2.0.4 The design value of masonry strength shall be calculated and determined by dividing the standard value of masonry strength by the partial coefficient of material properties of masonry structures; and the partial factor for property of material of masonry structures shall be determined according to the construction quality control level. When the construction quality control level is Level-A, Level-B, and Level-C-, the partial factory for property of material shall take 1.5, 1.6 and 1.8, respectively.

3 Materials

3.1 General rules

3.1.1 Materials for masonry structural shall be selected reasonably based on their load-bearing performance, energy-saving and environmental protection performance, and use environment conditions.

3.1.2 The materials selected for masonry structures shall meet the following requirements:

- 1 The used materials shall have the product exit-factory qualification certificate and the product performance type inspection report;
- 2 The main properties of blocks, cement, steel bars, admixtures, ready-mixed mortar and ready-mixed concrete shall be inspected to prove that the quality is qualified and meets the design requirements;
- 3 The matching masonry mortar shall be selected according to the type and performance of the block materials.

3.1.3 Masonry structures shall not use non-autoclaved silicate bricks, non-autoclaved silicate blocks and non-autoclaved aerated concrete products.

3.1.4 Non-sintered wall materials shall not be used in parts that are above 200°C for a long time or in rapid heat and rapid cooling, as well as in parts with acidic medium.

3.1.5 The steel bars in the masonry structures shall use hot-rolled steel bars or waste heat treated steel bars.

3.2 Bulk materials

3.2.1 In the masonry structure, blocks made of waste bricks and tiles, concrete blocks, muck and other wastes as the main materials shall be promoted and applied.

3.2.2 The selected block materials shall meet the requirements of compressive strength grade and variation coefficient; and the porous bricks and autoclaved ordinary bricks used for load-bearing walls shall still meet the requirements of flexural indicators.

3.2.3 The selected non-sintered porous blocks shall meet the requirements of minimum wall thickness and minimum rib thickness; and the selection of load-bearing porous bricks and small blocks shall meet the upper limit requirements of porosity.

3.2.4 For load-bearing masonry in environmental category of Class-1 and Class-2, the minimum strength grade of the used block materials shall meet the requirements in Table 3.2.4. For reinforced block masonry seismic walls, the strength grade of ordinary and lightweight aggregate concrete blocks in Class-1 and Class-2 environments stipulated in Table 3.2.4 is

3.2.9 Lightweight aggregate concrete small hollow blocks or autoclaved aerated concrete blocks shall not be used for infill walls in the following positions or environments:

- 1 The wall below the moisture-proof layer of the building (structure);
- 2 Long-term water immersion or chemical erosion environment;
- 3 The part where the surface temperature of the masonry is higher than 80°C;
- 4 Walls that have been in an environment with vibration sources for a long time.

3.3 Mortar and perforated concrete

3.3.1 The minimum strength grade of masonry mortar shall meet the following requirements:

- 1 The sintered ordinary brick and sintered porous brick masonry with a design service life greater than or equal to 25 years shall be M5; while the sintered ordinary brick and sintered porous brick masonry with a design service life of less than 25 years shall be M2.5;
- 2 The autoclaved aerated concrete block masonry shall be Ma5; while the autoclaved lime-sand ordinary brick and autoclaved fly ash ordinary brick masonry shall be Ms5;
- 3 Concrete ordinary bricks and concrete porous brick masonry shall be Mb5;
- 4 Concrete block and gangue concrete block masonry shall be Mb7.5;
- 5 Reinforced block masonry shall be Mb10;
- 6 The rubble stone and rubble masonry shall be M5.

3.3.2 The perforated concrete strength grade of the concrete block masonry shall be no lower than Cb20; and shall be no lower than 1.5 times the strength grade of the block.

3.3.3 When designing masonry with frost resistance requirements, the mortar shall be subjected to freeze-thaw test, and its frost resistance performance shall be no lower than that of wall blocks.

3.3.4 The masonry with reinforced bars shall not use mortar mixed with chlorine salt and sulfate admixtures.

3.3.5 The material selection of reinforced block masonry shall meet the following requirements:

- 1 The perforated concrete shall have shrinkage resistance;
- 2 For reinforced block masonry buildings with a safety grade of Class I or a design service life greater than 50 years, the minimum strength grade of mortar and perforated concrete shall be increased by at least one grade in accordance with the relevant provisions of this

value of the compressive strength of non-perforated masonry.

4 Design

4.1 General

4.1.1 The masonry structure shall be designed according to the limit state of bearing capacity; and structural measures shall be taken according to the characteristics of the masonry structure to meet the requirements of the limit state of normal service and durability.

4.1.2 The masonry structural members shall, according to their stress, calculate the bearing capacity such as axial compression, eccentric compression, local compression, bending and shearing, etc.; and the members shall be ensured to have sufficient strength to meet safety requirements.

4.1.3 Various wall and column members of masonry structure shall be checked for height-thickness ratio to ensure member stability.

4.1.4 For unreinforced masonry compression members, the axial force eccentricity e calculated according to the design value of internal force shall be no greater than $0.6y$; y is the distance from the center of gravity of the section to the edge of the section in the eccentric direction where the axial force is located.

4.1.5 The corner of the wall and the junction of the longitudinal and horizontal walls shall be provided with horizontal tie reinforcement or welded reinforcement mesh.

4.1.6 Reinforced concrete floors and roof panels shall meet the following requirements:

- 1** The length of the cast-in-place reinforced concrete floor or roof slab extending into the longitudinal and transverse walls shall be no less than 120mm;
- 2** The supporting length of the prefabricated reinforced concrete slab on the concrete beam or ring beam shall be no less than 80mm. When the slab is not placed directly on the ring beam, the supporting length on the inner wall shall be no less than 100mm; and the supporting length on the outer wall shall be no less than 120mm;
- 3** The steel bar at the end of the prefabricated reinforced concrete slab shall be bound to the longitudinal reinforcement arranged along the wall or ring beam at the support; and the concrete with a strength grade of no less than C25 shall be used to form a slab strip;
- 4** When the prefabricated reinforced concrete slab is docked with the cast-in-place slab, the steel bars at the end of the prefabricated slab shall be reliably connected to the cast-in-place slab;

5 When the span of the prefabricated reinforced concrete slab is greater than 4.8m and parallel to the outer wall, the side of the prefabricated slab close to the outer wall shall be tied to the wall or ring beam;

6 Reinforced concrete prefabricated slabs shall be tied to each other and to beams, walls or ring beams.

4.1.7 Brick chimney blocks shall be made of sintered ordinary bricks, and the height shall be no greater than 60m. Brick chimneys shall not be used for Class- III and IV sites with seismic fortification intensity of 8 degrees, and for seismic fortification intensity of 9 degrees.

4.2 Multi-story and single-story masonry structures

4.2.1 The single-story masonry structure bearing the crane load shall adopt reinforced masonry structure.

4.2.2 For the load-bearing structure of the hall roof of a single-story open house, brick columns shall not be used in the following cases:

- 1 There is a cantilever platform in the hall;
- 2 For intensity of 6 degrees, the span of the hall is greater than 15m or the height of the column top is greater than 8m;
- 3 For intensity of 7 degrees (0.1g), the span of the hall is greater than 12m or the height of the column top is greater than 6m;
- 4 Halls with intensity of 7 degrees (0.15g), 8 degrees, and 9 degrees.

4.2.3 Unreinforced masonry members shall not be used for load-bearing wall beams in multi-story masonry structure buildings to support. The wall beam design shall include the structural requirements of the total height of the wall, span, height-span ratio of the wall and joist, opening size and opening position.

4.2.4 For civil buildings with multi-story masonry structure, when the number of stories is 3 or 4, a ring beam shall be set at the ground floor and cornice elevation, respectively. When the number of stories exceeds 4, in addition to setting a ring beam at the ground floor and cornice elevations, respectively; at least all longitudinal and transverse walls shall be provided with partitions. For multi-story masonry industrial buildings, ring beams shall be set on each story. For a multi-story masonry structure building with wall beams, ring beams shall be set at the joist beams, the top surface of the wall beams and the cornice elevation.

4.2.5 For empty single-story buildings such as factory buildings, warehouses, and canteens, ring beams shall be set according to the following provisions:

- 4 When masonry seismic walls are adopted, core columns or concrete structural columns shall be arranged on both sides of the opening; when the wall length is greater than 4m, core columns or concrete structural columns shall be arranged in the middle of the wall.

4.3.2 The frame columns at the bottom of a bottom frame-seismic wall masonry structure building shall meet the following requirements:

- 1 The section size of the frame column shall be no less than 400mm×400mm; and the diameter of the cylinder shall be no less than 450mm.
- 2 The axial compression ratio of the frame column shall be no greater than 0.85 in area with intensity of 6 degrees, no greater than 0.75 in area with intensity of 7 degrees, and no greater than 0.65 in area with intensity of 8 degrees.
- 3 For the minimum total reinforcement ratio of the longitudinal reinforcement of the frame column, when the strength standard value of the reinforcement is lower than 400MPa, it shall be no less than 0.9% when the central column is in the areas with intensity of 6 degrees and 7 degrees; and shall be no less than 1.1% when in area with intensity of 8 degrees. It shall be no less than 1.0% when angle columns, side columns, and end columns of concrete seismic wall are in areas with intensity of 6 degrees and 7 degrees; and shall be no less than 1.2% when in area with intensity of 8 degrees.
- 4 The stirrup diameter of the frame column shall be no less than 8mm in the areas with intensity of 6 degrees and 7 degrees; and shall be less than 10mm in area with intensity of 8 degrees. And the stirrup shall be densely packed at the full height; and the stirrup spacing shall be no greater than 100mm.
- 5 The combined bending moment design value of the uppermost end and the lowermost end of the frame column shall be multiplied by the augmentation coefficient; and the augmentation coefficient of the frame column shall respectively take 1.5, 1.25 and 1.15 in the areas with intensity of 8 degrees, 7 degrees and 6 degrees.

4.3.3 The structure of the concrete joist at the lower part of the wall of a building with a bottom frame-seismic wall masonry structure shall meet the following requirements:

- 1 The section width of the joist shall be no less than 300mm, the section height shall be no less than 1/10 of the span, and shall be no greater than 1/6 of the span. When the wall has an opening near the beam end, the section height of the beam shall be no less than the 1/8 of the span.
- 2 The diameter of joist stirrups shall be no less than 8mm, and the spacing shall be no greater than 200mm. In the range with the beam end 1.5 times of the beam height and no less than 1/5 of the clear span; and in the range with the opening section of the upper wall, and a beam height on the two sides of the opening, and no less than 500mm, the stirrup spacing shall be no greater than 100mm.

- 3 The joists shall be provided with full-length ribs no less than $2\phi 14$ along the beam height, and the spacing shall be no greater than 200mm.
- 4 The longitudinal stress reinforcement and waist reinforcement of the joist shall be anchored in the frame column according to the requirements of the tension reinforcement; and the anchorage length of the longitudinal reinforcement on the upper part of the support in the column shall meet the relevant requirements of the concrete frame support beam.

4.3.4 The floor slab structure of the building with bottom frame-seismic wall masonry structure shall meet the following requirements:

- 1 The floor slab of the transition floor shall adopt cast-in-place concrete slabs, the slab thickness shall be no less than 120mm; and double-layer two-way reinforcement shall be adopted. When the size of the opening is greater than 800mm, side beams shall be arranged around the opening.
- 2 For other stories, when assembly type concrete slabs are used, cast-in-place ring beams shall be installed. When cast-in-place concrete slabs are used, no additional ring beams are allowed. However, the slab shall be reinforced along the perimeter of the seismic wall, and should be reliably connected with the adjacent structural columns.

4.4 Reinforced block masonry seismic wall structure

4.4.1 Reinforced block masonry seismic walls shall be filled with perforated concrete.

4.4.2 The horizontal steel bars of the reinforced block masonry seismic wall shall be arranged in the tie beams; and two steel bars shall be arranged in the same story; and the diameter of the steel bars shall be no less than 8mm, and the net distance of the steel bars shall be no less than 60mm. The vertical steel bars shall be arranged in the hole of the block; in the case of a wall thickness of 190mm, one steel bar shall be arranged in the same hole; and the diameter of the steel bar shall be no less than 10mm.

4.4.3 The reinforcement structure of reinforced block masonry seismic walls shall meet the following requirements:

- 1 Vertical continuous steel bars shall be arranged at the corners and ends of the wall, and both sides of the holes; and the diameter of the steel bars shall be no less than 12mm;
- 2 Horizontal steel bars no less than $2\phi 10$ shall be arranged at the bottom and top of the opening; and the length extending into the wall shall be no less than $40d$ and 600mm;
- 3 Cast-in-place reinforced concrete ring beams shall be installed at all longitudinal and horizontal walls of slabs and roofs. The width and height of the ring beams shall be equal to the wall thickness and block height. The main reinforcement of the ring beams shall be no less than $4\phi 10$. The concrete intensity grade of the ring beam shall be no lower

composition of masonry mortar is changed, its mix ratio shall be re-determined.

5.1.6 For cement, ready-mixed mortar and other special mortars used in masonry mortar, the impact of their storage period on the strength of the material shall be considered.

5.1.7 When mixing mortar on site, each component material shall be measured by mass. After the masonry mortar is mixed, other binders, aggregates, and mixtures shall not be arbitrarily mixed during use.

5.1.8 Lime plaster, carbide plaster, sand, mortar, blocks, etc. used in winter construction shall be prevented from freezing.

5.1.9 The joints between masonry and structural columns and the joints between masonry seismic walls and frame columns shall adopt the construction sequence of building walls first and then pouring columns; and tie reinforcement shall be arranged as required. The joints between masonry and construction column shall be made of horse teeth croucher.

5.1.10 The small blocks used for load-bearing walls shall be complete, free from damage and cracks.

5.1.11 When small blocks are used for masonry, the bottom surface of the small blocks during production shall be turned upside down on the wall. When straight if is reserved for the construction opening, the small block holes built up and down the straight if shall be filled with concrete.

5.1.12 The core column concrete of the masonry structure shall be poured in sections and compacted by vibrating. The compactness of concrete pouring of the core column shall be tested, and the test results shall meet the design requirements.

5.1.13 The drainage hole of the masonry retaining wall shall meet the drainage requirements.

5.1.14 The construction of the connection structure of the infill wall shall meet the design requirements.

5.2 Test of masonry structures

5.2.1 For newly-built masonry structures, when one of the following situations occurs, the strength of the masonry mortar, the strength of the blocks or the compressive and shear strength of the masonry shall be tested:

- 1 Mortar test blocks lack representativeness or insufficient quantity;
- 2 The inspection result of the strength of the mortar test block does not meet the design requirements;
- 3 Doubts or disputes about the test results of blocks or mortar test blocks;

4 If there is doubt or dispute about the construction quality, further analysis of the strength of mortar, block or masonry is required;

5 In the event of an engineering accident, further analysis of the cause of the accident is required.

5.2.2 Masonry structure test shall determine the test objects and test quantity according to the characteristics of test items and test purpose; and the sampling site shall be representative.

5.2.3 When selecting the on-site inspection method for newly developed masonry structures, the following requirements shall be met:

1 The test scatter diagram on which the strength test formula is based, its abscissa shall include no less than 5 groups of data points with differences;

2 The correlation coefficient (or correlation index) of the strength test curve shall be no less than 0.85;

3 The upper and lower limits of the applicable range of the strength test curve shall not be extrapolated on the basis of test data;

4 Reproducibility and repeatability tests shall be carried out;

5 Application experience of project test point shall be possessed.

5.3 Acceptance

5.3.1 The masonry structure quality acceptance data of the unit project shall meet the requirements for overall project acceptance. When part of the masonry structure quality acceptance data of the unit project is missing, the corresponding physical inspection or sampling test shall be carried out.

5.3.2 The project construction quality of masonry structures shall meet the design requirements; and the acceptance of construction quality shall include the following contents:

1 Evaluation of strength and stability of cement;

2 Evaluation of strength of blocks, mortar and concrete;

3 The type, specification, quantity and location of the steel bars;

4 Mortar fullness of masonry horizontal mortar joints and vertical mortar joints;

5 Masonry quality of masonry corners, junctions and horse teeth croucher of structural columns;

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