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Technical Specification for Concrete Structures of Tall Building

高层建筑混凝土结构技术规程

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2 Terms and Symbols

2.1 Terms

2.1.1 Tall building, high-rise building

It refers to the residential building of 10 stories and above or with building height greater than 28m, or the other tall civil building with building height greater than 24m.

2.1.2 Building height

It refers to the height from the outdoor ground to the major roof of building, excluding the height of elevator machine room, water tank and frame that protrude out the roof.

2.1.3 Frame structure

It refers to the structure, composed of beams and columns as the primary member, bearing the vertical and horizontal actions.

2.1.4 Shearwall structure

It refers to the structure, composed of shearwall, bearing the vertical and horizontal actions.

2.1.5 Frame-shearwall structure

It refers to the structure, jointly bearing the vertical and horizontal actions by frame and shearwall.

2.1.6 Slab-column shearwall structure

It refers to the structure, composed of beamless floor slab and column, jointly bearing the vertical and horizontal actions by slab-column frame and shear wall.

2.1.7 Tube structure

It refers to the building structure, mainly composed of the vertical tube, bearing the vertical and horizontal actions. Tubes in the tube structures are divided into the thin-wall tubes enclosed by shearwalls and frame tubes enclosed by thick-column frames or wall frames.

2.1.8 Frame-corewall structure

It refers to the tube structure composed of core tube and peripheral spare-column frame.

2.1.9 Tube in tube structure

It refers to the tube structure composed of core tube and peripheral frame tube.

2.1.10 Mixed structure, hybrid structure

It refers to the building structure, composed of steel frame (frame tube), section steel concrete frame (frame tube), steel pipe concrete frame (frame tube) and reinforced concrete core tube, jointly bearing the horizontal and vertical actions.

2.1.11 Structural transfer member

3 Basic Requirement of Structural Design

3.1 General Requirement

3.1.1 Seismic precautionary intensity of tall buildings must be determined according to the documents (drawings) approved and issued as the limits of authority specified by the state. Typically, the basic seismic intensity determined according to Seismic Ground Motion Parameter Zonation Map of China shall be adopted as the seismic precautionary intensity.

3.1.2 As for the tall concrete buildings adopting seismic design, the seismic precautionary category shall be determined according to the requirements of the current national standard "Standard for Classification of Seismic Protection of Building Constructions" GB 50223.

Note: Category A, Category B and Category C buildings in this specification are short for buildings of particular fortification category, major fortification category and standard fortification category respectively specified in "Standard for Classification of Seismic Protection of Building Constructions" GB 50223.

3.1.3 Concrete structures of tall building may adopt such structural systems as frame, shearwall, frame-shearwall, slab-column shearwall and tube structure.

3.1.4 Tall buildings shall not adopt severely-irregular structural system and they shall meet the following requirements:

1 They shall be possessed of necessary bearing capacity, rigidity and ductility;

2 The whole structure shall be prevented from losing the abilities to bear gravity load, wind load and seismic action due to the failure of partial structure or members;

3 Effective strengthening measures shall be taken for potential weak positions.

3.1.5 Structural system of tall buildings should also meet the following requirements:

1 Vertical and horizontal layout of structure should enable the structure to have reasonable rigidity and bearing capacity distribution, and avoid forming weak positions due to the partial mutation of rigidity and bearing capacity or structural torsion effect;

2 The structural system should have several defense lines in the seismic design.

3.1.6 Measures should be taken for concrete structures of tall building to reduce the adverse effect of non-load effects such as concrete shrinkage, creep, temperature change, and foundation differential settlement. Various curtain walls for buildings should be adopted for the outer walls of tall building whose building height is not less than 150m.

3.1.7 Non-structural members of tall building such as filler wall and partition wall should adopt various light materials, shall reliably connect with the major structure and shall meet the requirements for bearing capacity, stability and deformation.

3.2 Materials

3.2.1 Concrete structures of tall building should adopt high-strength and high-performance concrete and high-strength reinforcement; where the members have larger internal force or higher seismic

performance requirements, section steel concrete and steel pipe concrete members should be adopted.

3.2.2 The strength grade of concrete for various structures shall not be less than C20 and shall meet the following requirements:

1 During the seismic design, concrete strength grade of Seismic Grade I frame beam, column and their nodes shall not be less than C30;

2 Concrete strength grade of tube structure should not be less than C30;

3 Concrete strength grade of basement floor as the build-in position of superstructure should not be less than C30;

4 Concrete strength grade of floor slab in transfer story, transfer beam, transfer column, box-type transfer structure and transfer thick slab shall not be less than C30;

5 Concrete strength grade of pre-stressed concrete structure should not be less than C40 and shall not be less than C30;

6 Concrete strength grades of section steel concrete beam and column should not be less than C30;

7 Concrete strength grade of cast-in-place non-prestressed concrete should not be greater than C40;

8 During the seismic design, concrete strength grade of frame column, should not be greater than C60 in Intensity 9, should not be greater than C70 in Intensity 8; concrete strength grade of shearwall should not be greater than C60.

3.2.3 Stressed reinforcement and its performance of concrete structures of tall building shall meet the relevant requirements of the current national standard "Code for Design of Concrete Structures" GB 50010. As for the frame and diagonal bracing member designed according to Grade I, II and III seismic grade, their longitudinal stressed reinforcement shall also meet the following requirements:

1 The ratio of the measured value of tensile strength to that of yield strength of reinforcements shall not be less than 1.25;

2 The ratio of the measured value of yield strength to standard value of yield strength of reinforcements shall not be greater than 1.30;

3 The measured value of the overall elongation under the maximum tension of reinforcements shall not be less than 9%.

3.2.4 During the seismic design, steels in the composite structure shall meet the following requirements:

1 The ratio of the measured value of yield strength and measured value of tensile strength of steels shall not be greater than 0.85;

2 The steels shall have obvious yield steps and their elongation rate shall not be less than 20%;

3 The steels shall have good weldability and qualified impact ductility.

3.2.5 Section steel of section steel concrete vertical member and steel pipe of steel pipe concrete in the composite structure should adopt Q345 and Q235 steel, or may adopt Q390 and Q420 steel or other steels that meet the structural performance requirements; section steel beam should adopt Q235

5 Structural Analysis

5.1 General Requirement

5.1.1 Load and seismic action of tall building structure shall be calculated according to the relevant requirements of Chapter 4 of this specification.

5.1.2 The computational analysis for the tall buildings of complex structure and composite structure shall not only meet the requirements of this chapter, but also meet the relevant requirements of Chapter 10 and Chapter 11 of this specification.

5.1.3 Deformation and internal force of tall building structure may be calculated by the elastic method. As for such members as frame beam and connection beam, the internal force redistribution caused by plastic deformation may be considered.

5.1.4 Analysis model of tall building structure shall be determined according to the structural actual conditions. The analysis models selected shall be able to accurately reflect the actual stress conditions of each member in the structure.

In the analysis for the tall building structures, such calculation models may be adopted as space cooperation of plane structure, space frame structure, space frame-thin wall frame structure, space frame-wall board element and finite element of other combination.

5.1.5 During the internal force and displacement calculation for the tall buildings, it may be assumed that the floor slab has infinite rigidity in its own plane, and corresponding measures shall be taken during the design to ensure the integral rigidity in the slab plane.

Where the floor slab may produce obvious in-plane deformation, the in-plane deformation influence of floor slab shall be considered in the calculation, or the calculation results shall be adjusted properly for the floor slab adopting in-plane infinite rigidity assumption calculation method.

5.1.6 Where the computational analysis is carried out for the tall building structure according to the spacial integral work, the following deformation shall be considered:

1 Bending, shearing and torsional deformation of beam, axial deformation if necessary;

2 Bending, shearing, axial deformation and torsional deformation of column;

3 Bending, shearing, axial deformation and torsional deformation of wall.

5.1.7 Gravity load, wind load and (or) seismic action effect analysis shall be carried out for the tall building structures according to the actual conditions; load effect and action effect shall be calculated according to the requirements of Section 5.6 of this specification.

5.1.8 During the internal force calculation for the tall building structure, where the live load of floor is greater than $4kN/m^2$, structural internal force increase caused by the adverse layout for live load of floor shall be considered; where the adverse layout for live load of floor is not considered in the integral calculation, calculated bending moment of floor beam shall be increased properly.

5.1.9 During the gravity load action effect analysis for the tall building structure, proper calculation models should be adopted in consideration of the influence during the construction process for the