NATIONAL STANDARD
OF THE PEOPLE'S REPUBLIC OF CHINA

中华人民共和国国家标准

Code for Design of Concrete Structures

混凝土结构设计规范

GB 50010—2002

（英文版）

BEIJING 2002

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NOTICE

The code is written in Chinese and English. The Chinese text shall be taken as the ruling one in the event of any inconsistency between the Chinese text and the English text.

Notice of Promulgation for the National Standard "Code for Design of Concrete Structures"

Document JB [2002] No.47

According to the requirements of, "Notice of Printing and Distributing for the 1997 Preparation and Revision Plan of Engineering Construction Standards, Document JB [1997] NO.108-the Ministry of Construction", the "Code for Design of Concrete Structures" has been revised by the Ministry of Construction together with the relevant departments, after extensive consultation by relevant departments, hence the new code has been approved as a national standard with a serial number of GB 50010—2002, which shall come into force upon April 1, 2002. Herein, clauses 3.1.8, 3.2.1, 4.1.3, 4.1.4, 4.2.2, 4.2.3, 6.1.1, 9.2.1, 9.5.1, 10.9.3, 10.9.8, 11.1.2, 11.1.4, 11.3.1, 11.3.6, 11.4.12 and 11.7.11 are mandatory clauses, which must be enforced strictly. The former "Code for Design of Concrete Structures", GBJ 10—89 is superseded by the new code at December 31, 2002.

The Ministry of Construction is in charge of management and explanation of the mandatory clauses in the code, the China Academy of Building Research is responsible for the explanation of specific technical items and the Research Institute of Standards and Norms, the Ministry of Construction has entrusted the China Architectural & Building Press to take on publishing and distributing works of this code.

Ministry of Construction of the People's Republic of China

February 20, 2002

Preface

According to the requirements of Document JB[1997] No. 108-the Ministry of Construction, the former code was revised by the China Academy of Building Research together with the relevant institutions of higher learning and scientific research, design, enterprises etc.

In the period of revision, the code revision group launched various studies on specific topics, carried out wide-ranging investigative analyses, summarized practical domestic experiences for design of concrete structures, coordinating with relevant standards and made necessary comparison with advanced international standards for reference. On the basis of above metioned measures, various ways were used by the code revision group to solicit comments from the organizations concerned in the country, in addition, some trial designs were carried on by the revision group, in the meantime, the major issues in the code were elaborated and amended revised repeatedly, and finally, the new version of code was decided after examination.

The contents for main stipulations of the present code consist of: Basic design stipulations of concrete structures, Materials, Structural analyses, Calculations of ultimate limit states and checking calculations, Detailing requirements of serviceability limit states, Earthquake-resistant design of structural members and Relevant appendixes.

The main stipulation of the present code may be, if needed, revised in the future, the concerned information and contents of local revised clauses will be published on the Magazine of *Engineering Construction Standardization*.

Clauses marked with boldface type in the code are mandatory ones and must be enforced strictly.

In order to enhance the quality of the code, all relevant units are kindly requested to sum up and accumulate their experiences from actual practices during the process of implementing the code, and the relevant opinions and suggestions should be sent to the Managing Group of Code for Design of Concrete Structures, China Academy of Building Research, No. 30, Bei San Huan Dong Lu, Beijing, China(Postcode: 100013; E-mail: code_ibs_cabr@263.net.cn).

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Contents

1 General Principles

1.0.1 The code was published in order to enforce national technical and economic policies for the design of concrete structures, and to ensure structures to be economical, reasonable, reliable, applicable, with high quality and using advanced technology.

1.0.2 The code is applicable to the design of reinforced concrete, prestressed concrete and plain concrete load-bearing structures used in industrial and civil buildings, as well as normally constructed structures, but it is not applicable to the design of lightweight aggregate concrete structures, or structures using special concrete.

1.0.3 In design of concrete structures, besides complying with the stipulations in the code, the designers shall also conform to the stipulations in relevant current mandatory national standards.

2 Terms, Symbols

2.1 Terms

2.1.1 Concrete structures-The structures are mainly made by concrete, including plain concrete structure, reinforced concrete structure, and prestressed concrete structure etc.

2.1.2 Plain concrete structure-The structure is made of the concrete without the steel reinforcements or not providing with the stressed steel reinforcements.

2.1.3 Reinforced concrete structure-The structure is made of the concrete and providing with the stressed ordinary steel reinforcements, steel reinforcement meshs or steel reinforcement skeletons.

2.1.4 Prestressed concrete structure-The structure is made of the concrete and providing with the stressed prestressing reinforcements, which will be through stretching or by other methods to establish prestress.

2.1.5 Pre-tensioned prestressed concrete structure-The concrete structure of which the concrete will be casted, after the stressed prestressing reinforcements have been stretched on stretching bed, then through the transmission of bond force between tendons and concrete to establish prestress.

2.1.6 Post-tensioned prestressed concrete structure-The concrete structure of which the strength of concrete should be first reached the required stipulated requirements, then stretching the stressed prestressing reinforcements and anchoring on the structure to establish prestress.

2.1.7 Cast-in-situ concrete structure-The concrete structure of which the formwork of concrete is installed in-situ and cast-in-situ the concrete integrally.

2.1.8 Prefabricated concrete structure-The concrete structure of which the structure is assembled by precasted concrete components or parts through the method of welding or bolting connection etc.

2.1.9 Assembled monolithic concrete structure-The monolithic concrete structure is assembled by precasted concrete components or parts, through the connections of steel reinforcements, connecting parts or applied prestressing force, and finally cast-in-situ the concrete.

2.1.10 Frame structure-The load-bearing system structure is composed by girders and columns connecting them with rigid joint or hinged joint.

2.1.11 Structural (shear) wall structure-The structure is composed by structural wall (shear wall) to sustain the vertical and horizontal actions.

2.1.12 Frame-structural (shear) wall structure-The structure of which the vertical and horizontal actions are jointly sustained by frame and structural wall (shear wall).

2.1.13 Deep flexural member-It denotes the flexural member with span-depth ratio less than 5.

2.1.14 Deep beam -It denotes the single-span beam with span-depth ratio not greater than 2 and the multi-span beam with span-depth ratio not greater than 2.5.

2.1.15 Ordinary steel bar -A general call for various non-prestressed steel reinforcements which are used in concrete structural members.

2.1.16 Prestressing steel reinforcements-A general call for steel bars, steel wires, and strands which are used in the prestressed concrete structural members.

2.1.17 Degree of reliability-It refers to the measurement for the probability of which the ability of a structure fulfils the expected functions within stipulated time-limit and stipulated conditions.

2.1.18 Safety class-The classes of structures and structural members which are classified according to the degree of severity for the destructive consequences.

2.1.19 Design working life -The design stipulation for the time-limit of working period of structures or structural members, which can serve for the expected purposes, have no need of heavy repairs.

2.1.20 Load-effect-The reactivity of the structures and structural members are induced by loads, such as internal forces, deformations and cracks etc.

2.1.21 Combination of load-effects-In the limit states design, it is the stipulated combination for design values of various load effects occurred simultaneously, to ensure the reliability of the structures.

2.1.22 Fundamental combination-It refers to the combination of permanent loads and variable loads in the calculation of ultimate limit states.

2.1.23 Characteristic combination- In the checking calculation of serviceability limit states, that the characteristic values and combination values of variable loads are used as the representative values of variable loads in combination.

2.1.24 Quasi-permanent combination-In the checking calculation of serviceability limit states, that the quasi-permanent values of variable loads are used as the representative values of the variable loads in combination.

2.2 Symbols

2.2.1 Material properties

E_c——modulus of elasticity of concrete;

E_c^f——modulus of fatigue deformation of concrete;

E_s——modulus of elasticity of steel reinforcements;

C20——strength grade of concrete with characteristic value of cube strength is $20N/mm^2$;

f'_{cu}——compressive strength of 150mm side length concrete cube during period of construction;

$f_{cu,k}$——characteristic value of compressive strength of 150mm side length concrete cube;

f_{ck}、f_c——characteristic value, design value of axial compressive strength of concrete respectively;

f_{tk}、f_t——characteristic value, design value of axial tensile strength of concrete respectively;

f'_{ck}、f'_{tk}——characteristic values of axial compressive strength, axial tensile strength of concrete during period of construction respectively;

f_{yk}、f_{ptk}——characteristic values of strength of ordinary steel reinforcements, prestressed steel reinforcements respectively;

f_y、f'_y——design values of tensile strength, compressive strength of ordinary steel reinforcements respectively;

f_{py}、f'_{py}——design values of tensile strength, compressive strength of prestressed steel reinforcements respectively;

2.2.2 Actions, action-effects and load-bearing capacity

N——design value of axial force;

N_k、N_q——values of axial forces calculated in accordance with the characteristic combination, quasi-permanent combination of load-effects respectively;

N_p——resultant of forces of prestressed reinforcements and nonprestressed reinforcements in post-tensioned member;

N_{p0}——resultant of forces of prestressed reinforcements and non-prestressed reinforcements, when normal prestress in concrete is equal to zero;

N_{u0}——design value of sectional axial compressive or axial tensile load-bearing capacity of member;

N_{ux}、N_{uy}——design values of eccentric compressive or eccentric tensile load-bearing capacity due to axial forces acting on the X-axis, Y-axis respectively;

M——design value of bending moment;

M_k、M_q——bending moment values calculated in accordance with the characteristic combination, the quasi-permanent combination of load- effects respectively;

M_u——design value of normal section flexural load-bearing capacity of member;

M_{cr}——cracking bending moment value for normal section of flexural member;

T——design value of torsional moment;

V——design value of shearing force;

V_{cs}——design value of shearing load-bearing capacity of concrete and stirrup in inclined section of member;

F_l——design value of local load or concentrated reaction;

σ_{ck}、σ_{cq}——normal stress of concrete at the extreme fiber of section for crack-resistance checking calculation, under the characteristic combination, the quasi-permanent combination of load- effects respectively;

σ_{pc}——normal stress in concrete due to prestressing force;

σ_{tp}、σ_{cp}——principal tensile stress, principal compressive stress in concrete respectively;

$\sigma^f_{c,max}$、$\sigma^f_{c,min}$——maximum stress, minimum stress of concrete on extreme fiber of section in tension zone or compression zone of concrete used for fatigue checking calculation respectively;

σ_s、σ_p——stress in longitudinal ordinary steel reinforcements, stress in prestressed steel reinforcements in calculating load-bearing capacity of normal section respectively;

σ_{sk}——stress or equivalent stress in longitudinal tensile steel reinforcement calculated in accordance with the characteristic combination of load-effects;

σ_{con}——stretching controlled stress for presstressed steel reinforcement;

σ_{p0}——stress in prestressed steel reinforcement, at the resultant of forces point of prestressed steel reinforcements where normal stress in concrete equals to zero;

σ_{pe}——effective prestress of prestressed steel reinforcement;

σ_l、σ'_l——values for loss of prestress in prestressed steel reinforcements on tension zone, compression zone at corresponding stages respectively;

τ——shearing stress of concrete;

w_{max}——maximum crack width calculated in accordance with the characteristic combination of load-effects and in consideration of the influences for effects of long-term actions;

2.2.3 Geometric parameters

a、a'——distance from point for resultant of forces of longitudinal tensile steel reinforcements, point for resultant of forces of longitudinal compressive steel reinforcements respectively to near extrem fiber of section;

a_s、a'_s——distance from point for resultant of forces of longitudinal nonprestressed tensile steel reinforcements, point for resultant of forces of longitudinal nonprestressed compressive steel reinforcements respectively to near extrem fiber of section;

a_p、a'_p——distances from point for resultant of forces of longitudinal prestressed steel reinforcements in tension zone, point for resultant of forces of longitudinal prestressed steel reinforcements in compression zone respectively to near extreme fiber of section.

b——width of rectangular section, web width of T-shaped, I-shaped section;

b_f、b'_f——flange widths in tension zone, in compression zone respectively of T-shaped or I-shaped section;

d——diameter of circular section or diameter of steel reinforcements;

c——thickness of concrete cover;

e、e'——distances from acting point of axial force to point for resultant of forces of longitudinal tensile steel reinforcements, of longitudinal compressive steel reinforcements respectively;

e_0——eccentricity of axial force with respect to centroid of section;

e_a——additional eccentricity;

e_i——initial eccentricity;

h——depth of section;

h_0——effective depth of section;

h_f、h'_f——flange depth in tension zone, flange depth in compression zone of T-shaped or I-shaped sections respectively;

i——radius of gyration of section;

r_c——radius of curvature;

l_a——anchorage length of longitudinal tensile steel reinforcement;

l_0——calculated span of beam, slab or calculated length of column;

s——spacing of transverse steel reinforcements, spacing of spiral steel reinforcements or spacing of stirrups in direction along axis of member;

x——depth of concrete compression zone;

y_0、y_n——distances from centroid of transformed section, centroid of net section to calculated extreme fiber respectively;

z——distance between point for resultant of forces for longitudinal tensile reinforcements and point for resultant of forces for concrete compression zone;

A——sectional area of member;

A_0——transformed sectional area of member;

A_n——net sectional area of member;

A_s、A'_s——sectional area of longitudinal nonprestressed steel reinforcement in tension zone, in compression zone respectively;

A_p、A'_p——sectional area of longitudinal prestressed steel reinforcements in tension zone, in compression zone respectively;

A_{sv1}、A_{st1}——sectional area of single limb stirrup in the shearing calculation, in the torsional calculation respectively;

A_{stl}——sectional area of total torsional longitudinal nonprestressed steel reinforcements used for the torsional calculation;

A_{sv}、A_{sh}——total sectional area for limbs of vertical and horizontal stirrups or for distributing steel reinforcements in a same cross section of member respectively;

A_{sb}、A_{pb}——sectional area of nonprestressed bent-up steel reinforcements, prestressed bent-up steel reinforcements in a same bent-up plane respectively;

A_l——local compression area of concrete;

A_{cor}——core area of concrete within the range of inner surface of fabric reinforcement, spiral steel or stirrup;

B——section rigidity of flexural members;

W——elastic section modulus of extreme tension fiber of section;

W_0——elastic section modulus of extreme tension fiber of transformed section;

W_n——elastic section modulus of extreme tension fiber of net section;

W_t——plastic section modulus of torsional section;

I——moment of inertia of section;

I_0——moment of inertia of transformed section;

I_n——moment of inertia of net section;

2.2.4 Calculation coefficients and miscellaneous

α_1——ratio of the stress value in the rectangular stress diagram for compression zone of concrete to the design value for axial compressive strength of concrete;

α_E——ratio of the elastic modulus of steel reinforcements to the elastic modulus of concrete;

β_c——influence coefficient of concrete strength;

β_1——ratio of depth of compression zone to depth of neutral axis (distance from neutral axis to the extreme fiber of compression zone) in rectangular stress diagram;

β_l——raising coefficient of concrete strength for local compression;

γ——plastic influence coefficient of section modulus for section of concrete members;

η——enhancement coefficient for eccentricity of axial force considering the influence of second-order bending moment for eccentric compression members;

λ——ratio of shear span to depth for calculated section;

μ——friction factor;

ρ——ratio of reinforcement for longitudinal tensile steel reinforcement;

ρ_{sv}、ρ_{sh}——ratios of reinforcement for the vertical stirrup, horizontal stirrup or the vertical distributing steel reinforcement, horizontal distributing steel reinforcement respectively;

ρ_v——ratio of volumetric reinforcement for indirect steel reinforcement or stirrup;

φ——stability coefficient for axial compression member;

θ——influence coefficient for the effects of long-term actions on enlarging of deflection;

ψ——non-uniformity coefficient for the strain of longitudinal tensile steel reinforcements between cracks.

3 Fundamental Design Stipulations

3.1 General Stipulations

3.1.1 The code adopts the probability-based limit states design method, the degree of reliability of structural members is measured by the reliability index, and the design is carried out by adopting the design expressions of partial safety factors.

3.1.2 When a structure or part of a structure exceeding a particular state, that a certain functional requirement in design stipulations will be dissatisfied, hence this particular state is called the limit states of above mentioned function.

The limit states are classified as two categories as follows:

1 Ultimate limit states: A structure or a structural member reaches the maximum load-bearing capacity, and appears the fatigue failure or undue deformation unsuitable for loading continuously;

2 Serviceability limit states: A structure or a structural member reaches a certain stipulated limit value of serviceability or durability.

3.1.3 In accordance with requirements of ultimate and serviceability limit states, the structural members shall be calculated and checking calculated on the basis of the following stipulations:

1 Load-bearing capacity and stability: All structural members shall be calculated in accordance with load-bearing capacity (including instability); in certain cases, structural overturning, floating and sliding shall also be checking calculated;

In addition, the earthquake-resistant capacity of structural members shall still be checking calculated for structures in areas subject to seismic activity;

2 Fatigue: The fatigue strength of structural members, which directly support heavy-duty cranes, shall be checking calculated; depending on actual application and design experiences, the members, which directly support cranes used for installation or maintenance, may be exempted from checking calculation on the fatigue strength of members;

3 Deformation: Deformation checking calculation shall be carried on structural members, where the deformation values need be controlled during service;

4 Crack-resistance and crack width: The checking calculation for tensile stress of concrete shall be carried on the stuatural members, where crack is not allowed during service; in cases where crack is permitted during service, the crack width of members shall be checking calculated; in addition, the checking calculation for tensile stress of longitudinal steel reinforcement in the superposed flexural members shall also be carried out.

3.1.4 The design values of loads shall be used when calculating the load-bearing capacity(including instability), and in checking calculation of structural overturning, floating and sliding; the corresponding representative values of loads shall be used for all checking calculations such as fatigue, deformation, crack-resistance and crack width; when calculating the load-bearing capacity, and checking cal-