NATIONAL STANDARD
OF THE PEOPLE'S REPUBLIC OF CHINA
中华人民共和国国家标准

Load Code for the Design of Building Structures

建筑结构荷载规范

GB 50009—2001

（英文版）

Beijing 2002

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Notice of Promulgation for the National Standard"Load Code for the Design of Building Structures"

Document JB [2002] No.10

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)-Ministry of Construction", that the"Load Code for the Design of Building Structures"has been revised by Ministry of Construction together with the relevant departments, after a joint examination of relevant departments, hence the new code has been approved as a national standard with a serial number of GB50009—2001, and it shall come into force upon March 1,2002. Herein, clauses 1.0.5, 3.1.2, 3.2.3, 3.2.5, 4.1.1, 4.1.2, 4.3.1 , 4.5.1, 4.5.2, 6.1.1, 6.1.2, 7.1.1 and 7.1.2 are mandatory clauses, which must be enforced strictly. The original"Load Code for the Design of Building Structures"GBJ 9—87 shall be abolished after 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 will be responsible for the explanation of specific technical contents and the Research Institute of Standards and Norms – Ministry of Construction will organize the China Architecture & Building Press to take on publishing and distributing works of this code.

Ministry of Construction of the People's Republic of China

January 10, 2002

Preface

According to the requirements of Document JB[1997] No.108-Ministry of Construction, "Notice of Printing and Distributing for the '1997 Preparation and Revision Plan of Engineering Construction Standards'" that the "Load Code for the Design of Building Structures" GBJ 9—87, which was approved by 1987 the State Capital Construction Commission of the People's Republic of China, has been revised by the China Academy of Building Research together with the relevant units.

In the period of revision, the code revision group carried out various studies on specific topics, summarized the recent domestic design experience and referred to the concerned contents of abroad codes and international standards, meanwhile, the various ways were used by the code revision group to solicit widespread comments from nation-wide relevant units, the code was born out through repeated revisions and finally, the new version of code was decided after examination.

The code includes 7 chapters and 7 appendices, the main revised contents in present code are as follows:

1. Based on the revised combination rule in the revised edition of "Unified Standard for Reliability Design of Building Structures", and cast away the old ideas for "combination of wind load"; the combinations, which are controlled by the permanent load effects, have been added into the fundamental combinations of loads; in the serviceability limit states design, two types of combinations including the characteristic combination and the frequent combination are given in the combinations of short term effects, in the mean time, the coefficients for frequent values for variable loads are increased; the respective coefficients of combinations values are given in the all combination values of variable loads.

2. Partial edjusted and supplemented to live loads on floors.

3. For uniform live loads on roofs, the live load on unmanned roof is adjusted and the stipulations for the loads of roof garden, helicopter parking apron are added.

4. The character of service for crane is changed to the working grade of crane.

5. Wind pressure and snow pressure have been considered anew respectively by their statistical data, according to the new observation records from nation-wide meteorological observatory, meanwhile, the mean recurrence interval for the reference values of wind load, snow load have been changed from a 30-year mean recurrence interval to a 50-year mean recurrence interval; the values of snow pressure and wind pressure from the main meteorological stations throughout the country, during a 10-year, a 50-year and a 100-year mean recurrence intervals respectively are given in the appendix of the code.

6. A category of terrain roughness is added.

7. The adjustment coefficients considsring the topographic conditions have been given to the exposure factors of wind pressure for the buildings in mountain area.

8. A special stipulation for the wind load on the fencing structure is given.

9. The consideration for the influences of interference with each other between buildings in a ar-

chitectural complex has been put forward.

10. The requirement for checking calculation of crosswind direction wind excitation is added for the flexible structures.

The present code may be in need of local revised in the future, that the concerned information and contents of local revised clauses will be published on the magazine of "*Engineering Construction Standardization*".

Clauses marked with boldface letters in the code are mandatory clauses and must be enforced strictly.

In order to enhance the quality of code, all relevant units are kindly requested to sum up and accumulate their experiences in actual practices during the process for implementing this code, that the relevant opinions and advices, which may be available for reference to next revision, can be posted to the China Academy of Building Research (Postcode: 100013; No.30, Bei San Huan Dong Lu, Beijing, China).

Chief Editorial Unit: China Academy of Brälding Research

Participating Units: Tongji University, China Architecture Design and Research Group, China International Engineering Institute for Light Industry, China Institute of Building Standard Design and Research, Beijing Institute of Architectural Design and China Academy of Meteorological Sciences.

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Reviser (English edition of code):

Chen Dingwai Professor, China Academy of Building Research, Oct., 2004, Beijing, China

Table of Contents

1 General Principles

1.0.1 The code was drawn up to suit the needs for design of building structures, and to conform with the requirements for the safety, serviceability and the economy, rationality of building structures.

1.0.2 The code is applicable to the structural design of building engineering.

1.0.3 The code was drawn up in accordance with the principles stipulated in the "Unified Standard for Reliability Design of Building Structures" (GB 50068—2001).

1.0.4 Actions, wbich are dealt with the design of building structures, include direct actions (loads) and iodirect actions (such as the actions may be caused by deformation of subsoil, shrinkage of concrete, distortion due to welding, variation of temperature, earthquake and etc.). Only the stipulations of concerned loads were dealt with the code.

1.0.5 A 50-year design reference period was adopted by the code.

1.0.6 Actions or loads, which are dealt with the design of building structures, besides they shall be implemented in accordance with the code, the stipulations of other current national standards shall still be conformed.

2 Terms and Symbols

2.1 Terms

2.1.1 Permanent load

In the service period of structure, the value of load is not varied with the time, or the variation of load, which is compared with the mean value, can be neglected, or the variation of load is in one sense and can attain some limiting value.

2.1.2 Variable load

In the service period of structure, the value of load is varied with time, or the variation of load, which is compared with the mean value, can not be neglected.

2.1.3 Accidental load

In the service period of structure, the load is not occured definitely, once it is occured, that the load is with a significant value and its continuous time is very short.

2.1.4 Representative values of a load

Measuring values of a load are adopted for the checking calculations of the limit states in design, such as, the characteristic value, the combination value, the frequent value and the quasi- permanent value.

2.1.5 Design reference period

The time parameter is selected for determing the representative values of the variable load.

2.1.6 Characteristic value

The fundamental representative value of a load, which denotes the characteristic value for the statistical distribution of the maximum load in the design reference period (such as, mean-value, mode, mid-value or certain fractile) .

2.1.7 Combination value

For the values of variable loads after combination, that their transcendental probability for the load effects in the design reference period can be tended toward indentical with the corresponding probability for the load effect of the appearance of single load alone; or the values of variable loads after combination, that the structure should has the unified stipulated reliability index.

2.1.8 Frequent value

For the value of variable load in the design reference period, that the transcendental total time is in small ratio of stipulated time, or the transcendental frequency is the stipulated frequency.

2.1.9 Quasi-permanent value

For the value of variable load in the design reference period, that the transcendental total time is about one-half of the design reference period.

2.1.10 Design value of a load

The design value of a load is the product of representative value of load and partial safety coeffi-

cient of load.

2.1.11 Load effect

The response of structure or structural member, such as internal force, deformation, crack and etc., is caused by load.

2.1.12 Combination of loads

When in the limit states design, the stipulations are used for the simultaneous occurrence of the design values of different loads to guarantee the reliability of structures.

2.1.13 Fundamental combination

When in the calculation of ultimate limit states, the combination of permanent loads and variable loads belongs to the fundamental combination.

2.1.14 Accidental combination

When in the calculation of ultimate limit states, the combination of permanent loads, variable loads and an accidental load belongs to accidental combination.

2.1.15 Characteristic combination

When in the calcutation of serviceability limit states, the characteristic values or the combination values are adopted as the representative values of loads for combination.

2.1.16 Frequent combination

When in the calculation of serviceability limit states, for the variable loads that their frequent values or quasi-permanent values are adopted as the representative values of loads for combination.

2.1.17 Quasi-permanent combination

When in the calculation of serviceability limit states, for the variable loads that their quasi-permanent values are adopted as the representative values for combination.

2.1.18 Equivalent uniform load

When in the design of structures, the actual loads are not distributed in succession, that they are commonly substituted by the uniform load; the equivalent uniform load denotes its load effects, which is snstained by structure, can keep identical with the actual load effects.

2.1.19 Tributary area

Tributary area is edopted for the calculation of beam, column members, it denotes the loading area for the flooring, which shall be divided by the zero line of shearing force in floor slab, it can be simplified appropriately in the actual application.

2.1.20 Dynamic coefficient

The coefficient is adopted for the structure or the structural member sustaining dynamic load, which is designed according to the static design, the value of coefficient is the ratio of the maximum dynamic force effects and the corresponding static force effects of the structure or the structural member.

2.1.21 Reference snow pressure

The reference pressure of snow load, its maximum value with a 50-year mean recurrence interval, can be commonly determined according to the observational data of the self-weight of snow cover on the open, plane terrain in locality through the probability statistics.

2.1.22 Reference wind pressure

The reference pressure of wind load, its maximum value of wind velocity with a 50-year mean recurrence interval, can be commonly determined according to the observational data of the 10 min mean wind velocity at the 10m height from the open, plane terrain in locality, through the probability statistics, meanwhile, considering the relative air density, hence, the reference wind pressure can be determined according to the equation (D.2.2-4).

2.1.23 Terrain roughness

The description of the grade for distribution conditions of the irregular obstacles on the terrain within the scope of 2km, where the wind blowed over before reaching the structural objects.

2.2 Symbols

G_k——characteristic value of permanent load;

Q_k——characteristic value of variable load;

S_{Gk}——characteristic value of permanent load effects;

S_{Qk}——characteristic value of variable load effects;

S——design value for combination of load effects;

R——design value for resistance of structural member;

S_A——along wind direction wind load effects;

S_C——cross wind direction wind load effects;

T——natural peried of vibration for structure;

H——top height of structure;

B——width of windward side for structure;

Re——Reynolds number;

St——Strouhal number;

s_k——characteristic value of snow load;

s_0——reference snow pressure;

w_k——characteristic value of wind load;

w_0——reference wind pressure;

v_{cr}——critical wind velocity for cross wind direction resonance;

α——gradient angle;

β_z——dynamic wind effect factor at z beight;

β_{gz}——gust factor;

γ_0——importance factor of structure;

γ_G——partial safety factor for permanent load;

γ_Q——partial safety factor for variable load;

ψ_c——combination value coefficient of variable loads;

ψ_f——frequent value coefficient of variable load;

ψ_q——quasi-permanent value coefficient of variable load;

μ_r——roofing snow cover distribution factor;

μ_z——exposure factor for wind pressure;

μ_s——shape factor for wind load;

η——terrain, geomorphic adjustment coefficient of wind load;

ξ——maginification factor for wind fluctuation;

ν——wind fluctuation factor;

φ_z——vibration mode factor of structure;

ζ——damp ratio of structure.

3 Classification of Loads and Combination of Load Effects

3.1 Classification of Loads and Representative Values of Loads

3.1.1 Loads on structures can be classified into the following three types:

1 Permanent loads, such as, self-weight of structure, earth pressure and prestressing force etc.

2 Variable loads, such as, live load on floors, live load on roofs, ash load, crane load, wind load, snow load etc.

3 Accidental loads, such as explosive force, collision force and etc.

Note: self-weight denotes the load produced by the weight of the material itself (gravity force).

3.1.2 Different representative values shall be adopted for different loads in the design of building structures.

The characteristic value shall be adopted as the representative value of permanent load.

The characteristic value, combination value, frequent value or quasi-permanent value shall be adopted as the representative value of variable load in accordance with the requirements of design.

The representative value of accidental load shall be determined in accordance with the distinguish features of service for building structures.

3.1.3 The characteristic value of permanent load: For the self-weight of structures can be determined by calculations for the design dimensions of structural members and the unit weight of materials. For various materials and structural members which have considerable variances in self-weight (such as thermal insulation materials fabricated on the site, thin-walled concrete members and etc.), the upper or lower characteristic value of self-weight shall be taken according to unfavorable situations for the structures.

Note: The unit weight for commonly used materials and structural members can be referred to the Appendix A of the Code.

3.1.4 The characteristic value of variable load shall be adopted in accordance with the stipulations in the relevant chapter of the Code.

3.1.5 When in the ultimate limit states design or in the serviceability limit states design according to the characteristic combination, that, the characteristic value or the combination value shall be adopted as the representative value of the variable load, in accordance with the stipulations of combination.

The combination value of variable loads shall be the characteristic values of variable loads multiplied by the coefficients for combination value of loads.

3.1.6 When in the serviceability limit states design according to the frequent combination, that, the frequent value, the quasi-permanent value shall be adopted as the representative value of the variable load; for the design according to the quasi-permanent combination, that, the quasi-permanent value

shall be adopted as the representative value of the variable load.

The frequent value of the variable load shall be the characteristic value of variable load multiplied by the coefficient for frequent value of loed.

The quasi-permanent value of the variable load shall be the characteristic value of variable load multiplied by the coefficient for quasi-permanent value of load.

3.2 Combination of Loads

3.2.1 When design of building structures, the loads, which are possible occurrence simultaneously on structures during the service process of structures, shall be based on, hence, the combination of loads (effects) for the ultimate limit states and for the serviceability limit states shall be carried out respectively, and the most unfavourable combination of effects shall be taken in the each design.

3.2.2 For the ultimate limit states, the combination of loads (effects) shall be carried out in accordance with the fundamental combination or the accidental combination of loads effects, and the following design expression shall be adopted in the design.

$$\gamma_0 S \leqslant R \tag{3.2.2}$$

Where γ_0——importance factor of structures;

S——design value of combination of loads effects;

R——design value of the resistance of structural members, determined in accordance with the stipulations in relevant codes for the design of huilding structures.

3.2.3 For the fundamental combination, the design value S of the combination of loads effects shall be determined by the most unfavourable value taking from the following combination values:

1) The combination is controlled by the variable load effects:

$$S = \gamma_G S_{Gk} + \gamma_{Q1} S_{Q1k} + \sum_{i=2}^{n} \gamma_{Qi} \psi_{ci} S_{Qik} \tag{3.2.3-1}$$

Where γ_G——partial safety factor of permanent load, shall be adopted in accordance with the Clause 3.2.5;

γ_{Qi}——partial safety factor for the variable load of number i, herein, the γ_{Q1}, which shall be adopted in accordance with the Clause 3.2.5, is the partial safety factor of variable load Q_1;

S_{Gk}——the load effects value is calculated in accordance with the characteristic value of permanent load G_k;

S_{Qik}——load effects values are calculated in accordance with the characteristic values of variable load Q_{ik}, herein, the S_{Q1k} denotes the controlling one among all variable load effects;

ψ_{ci}——coefficients of combination values of the variable loads Q_i shall be adopted in accordance with the stipulations of the Clauses in the Chapters of the Code respectively;

n——number of the variable loads participated in the combinations.

2) **The combination is controlled by the permanent load effects:**

$$S = \gamma_G S_{Gk} + \sum_{i=1}^{n} \gamma_{Qi} \psi_{ci} S_{Qik} \qquad (3.2.3\text{-}2)$$

Note: 1 **The design values in the fundamental combination are suitable only for loads and load effects in the linear condition.**

2 **When the S_{Q1k} can not be clearly judged, taking each variable load effect as S_{Q1k} in turn, then the most unfavourable combination of load effect can be selected.**

3 **When the vertical permanent load effect is considered as the controlling combination, hence, only the vertical variable load is limited to participate in the combination.**

3.2.4 For ordinary bent and frame structures, the simplified rule may be adopted for the fundamental combination, and it shall be determined in accordance with the following combination values, taking the most unfavourable value:

1) The combination is controlled by the variable load effects:

$$S = \gamma_G S_{Gk} + \gamma_{Q1} S_{Q1k}$$

$$S = \gamma_G S_{Gk} + 0.9 \sum_{i=1}^{n} \gamma_{Qi} S_{Qik} \qquad (3.2.4)$$

2) The combination is controlled by the permanent load effects, it is still adopted in accordance with formula (3.2.3-2).

3.2.5 Partial safety factors for fundamental combination shall be adopted as follows:

1 partial safety factor for permanent load:

1) When the effect of permanent load is unfavourable to structures

—for the combination is controlled by the variable load effects, that the 1.2 shall be taken;

—for the combination is controlled by the permanent load effects, that the 1.35 shall be taken;

2) When the effect of permanent load is favourable to structures

—under ordinary condition that the 1.0 shall be taken;

—for the checking calculation for the overturning, sliding or floating of structure, that the 0.9 shall be taken.

2 partial safety factor for variable load:

—under ordinary condition that the 1.4 shall be taken;

—the characteristic value of variable load is greater than 4 kN/m^2 for floor structure of industrial building, that the 1.3 shall be taken.

Note: **For the special conditions, it can be determined in accordance with the stipulations for the relevant design codes of building structures.**

3.2.6 The design values for accidental combination, combination of load effects, may be determined according to the following stipulations: The representative value of accidental load is not multiplied by the partial safety factor; the proper representative values for other loads, which may occur simultaneously with the accidental load, may be adopted according to observation materials and engineering experiences. Formulas calculating the design value of load effects under different cases can be stipulated

separately by the relevant codes.

3.2.7 For the serviceability limit states, the characteristic combination, the frequent combination or the quasi-permanent combination of loads shall be adopted in accordance with the different requirements of design, and the design shall be carried on according to the design expressions as follows:

$$S \leqslant C \tag{3.2.7}$$

Where C——The stipulated limiting values, which denote the structures or the structural members reaching the requirements of normal service, such as the limiting values of deformation, crack, amplitude of vibration, acceleration, stress and etc., shall be adopted according to the stipulations in the different relevant design codes of building structures.

3.2.8 The design values S for the characteristic combination, the combination of load effects shall be adopted in accordance with the following formula:

$$S = S_{Gk} + S_{Q1k} + \sum_{i=2}^{n} \psi_{ci} S_{Qik} \tag{3.2.8}$$

Note: The design values in the combination are suitable for the loads and load effects in the linear condition.

3.2.9 The design values S for the frequent combination, the combination of load effects shall be adopted in accordance with the following formula:

$$S = S_{Gk} + \psi_{f1} S_{Q1k} + \sum_{i=2}^{n} \psi_{qi} S_{Qik} \tag{3.2.9}$$

Where ψ_{f1}——coefficient for frequent value of variable load Q_1, shall be adopted according to the stipulations in the different Chapters of the Code;

ψ_{qi}——coefficient for quasi-permanent value of variable load Q_i, shall be adopted according to the stipulations in the different Chapters of the Code.

Note: The design values in the combination are suitable for the loads and load effects in the linear condition.

3.2.10 The design values S for the quasi-permanent combination, the combination of load effects shall be adopted in accordance with the following formula:

$$S = S_{Gk} + \sum_{i=1}^{n} \psi_{qi} S_{Qik} \tag{3.2.10}$$

Note: The design values in the combination are suitable for the loads and load effects in the linear condition.