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

Code for Seismic Design of Buildings

建筑抗震设计规范

GB 50011—2001

（英文版）

Beijing 2001

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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 Seismic Design of Buildings"

Document JB[2001]No. 156

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 "Code for Seismic Design of Buildings" 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 GB50011—2001, and it shall come into force upon January 1, 2002. Herein, clauses 1.0.2, 1.0.4, 3.1.1, 3.1.3, 3.3.1, 3.3.2, 3.4.1, 3.5.2, 3.7.1, 3.8.1, 3.9.1, 3.9.2, 4.1.6, 4.1.9, 4.2.2, 4.3.2, 4.4.5, 5.1.1, 5.1.3, 5.1.4, 5.1.6, 5.2.5, 5.4.1, 5.4.2, 6.1.2, 6.3.3, 6.3.8, 6.4.3, 7.1.2, 7.1.5, 7.1.8, 7.2.4, 7.2.7, 7.3.1, 7.3.3, 7.3.5, 7.4.1, 7.4.4, 7.5.3, 7.5.4, 8.1.3, 8.3.1, 8.3.6, 8.4.2, 8.5.1, 10.1.3, 10.2.5, 10.3.3, 12.1.2, 12.1.5, 12.2.1 and 12.2.9 are compulsory provisions, which must be enforced strictly. The former "Code for Seismic Design of Buildings" GBJ 11—89 and the "Proclamation on Partial Revision for National Standards of Engineering Construction" (No. 1) 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

July 20, 2001

PREFACE

The present code is the revised version of the former "Code for seismic design of buildings" GBJ 11—89. The revision is undertaken by China Academy of Building Research (CABR) together with other institutions related to design, reconnaissance, research, and universities in accordance with the Document JB [1997] No. 108 issued by the Ministry of Construction.

During the process of revision, the editorial team carried out studies on specific topics and some laboratory tests concerned. Experiences and lessons, learned from damages induced by strong earthquake having occurred in recent years home and abroad, are summarized, achievements of research in earthquake engineering are involved, the economic condition and construction practices in China are taken into account, comments from all aspects of design, reconnaissance, research, education and municipal authorities are widely collected nation wide. Through a multi-round discussion, revision, substantiation, and with pilot designs as well, the final version has been completed and reviewed by an expert panel.

The newly updated version consists of 13 chapters and 11 appendixes. The major contents of the revision can be clarified by follows: the seismic fortification classification for buildings has been adjusted; the seismic design is required to be based on the design basic acceleration of the ground motion; the near-field and far-field earthquakes employed by the previous code have been replaced by the design earthquake groups; provisions related to the site classification, liquefaction identification, seismic influence coefficient and torsion effect calculation have been modified; requirements for the conception design of irregular building structures, the seismic analysis of structures, the limit of inter-story seismic shear force and deformation have been added; the seismic measures of masonry and concrete structures, and masonry buildings with bottom R.C. frames have been improved; more contents related to active fracture, pile foundation, R.C. tube structure, steel structure, reinforced hollow block masonry structure, and non-structural components, as well as the provisions for base isolation and energy dissipation have been involved. In the meantime, the new code has abrogated some provisions dealing with inner-frame house and medium-sized block masonry structure, chimney and water tower, etc.

The new code could be partly modified in the future. The relevant information and details of clauses will be published on the magazine of "Engineering Construction Standardization".

Clauses marked with boldface type in this code are compulsory provisions and must be enforced strictly.

The Institute of Earthquake Engineering of CABR is responsible for the interpretation of this code. Hopefully, in the process of its enforcement, all institutions may sum up and

accumulate their experiences in practice. Any comment and advice is welcome to submit to the Code Panel by the address: IEE, CABR, No. 30, Bei San Huan Dong Road, Beijing 100013. (e-mail: ieecabr @ public3. bta. net. cn).

Chief Editorial Unit: China Academy of Building Research (CABR)

Participating units: Institute of Engineering Mechanics (IEM) of China Seismology Bureau; China Institute of Building Technology Research; Institute of Building Research of Ministry of Metallurgical Industry; Institute of Architecture Design of the Ministry of Construction; Institute of Project Planning and Research of the Ministry of Machinery Industry; China Institute of International Engineering Design of Light Industry; Institute of Architecture Design of Beijing; Institute of Architecture Design of Shanghai; Institute of Building Design of Mid-southern China; Institute of Building Design and Research of Northwestern China; Institute of Building Design and Research of Xinjiang Autonomous Region; Institute of Building Design and Research of Guangdong Province; Design Institute of Yunnan Province; Institute of Building Design and Research of Liaoning Province; Institute of Architecture Design of Shenzhen; Geological Reconnaissance Institute of Beijing; Institute of Building Design and Research of Shenzhen University; Qinghua University; Tongji University; Harbin Building University; Science and Technology University of Mid China; Chongqing Building University; Yunnan Polytechnic University; Construction College of Southern China (West campus)

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Chapter 1 General

1.0.1 This code is prepared for the purpose of carrying out " The Law of Construction of People's Republic of China" and "The Law of Earthquake-prevention and Disaster Mitigation of People's Republic of China", and carrying out the policy of giving priority to the prevention of earthquake disasters. So that, when the buildings are made earthquake-fortification, the damages to buildings, loss of life and economic losses will be mitigated.

The seismic fortification objective of buildings, which designed and detailed in accordance with the requirements of this code, as follows:

When the place is subjected to frequently earthquake influence which intensity is lower than the local fortification intensity, the buildings will not be damaged or only slightly damaged, with continued service without repair.

When the place is subjected to local fortification intensity earthquake influence, the buildings will be damaged, with continued service after ordinary repair or without repair.

When the place is subjected to rarely earthquake influence which intensity is expected to higher than the local fortification intensity, the buildings will not collapse nor suffer damage that would endanger human lives.

1.0.2 Every building, which is situated on zones of fortification intensity 6 or above, must be designed to resist the effects of earthquake motions.

1.0.3 The design of seismic ordinary buildings and seismically isolated structures, which are situated on the zone of fortification intensity 6 to 9, shall be in accordance with this code.

When buildings are situated on zone where the fortification intensity is greater than 9, and/or industry buildings with specific professional requirements, the corresponding design of these buildings shall be in accordance with special provisions.

Note: The "fortification intensity" hereinafter usually referred as "intensity". For example, fortification intensity 6,7,8 and 9 is referred as intensity 6,7,8 and 9 respectively.

1.0.4 Fortification intensity of a region must be determined by documents (or maps) published by the authorized central government agency.

1.0.5 Normally, the local fortification intensity may be adopted the seismic basic intensity as provided in "the China Seismic Ground Motion Parameter Zonation Map" (or the intensity values corresponding to the design basic seismic acceleration in this code). If cities where a seismic fortification zonation has been drawn up, the approval fortification intensity or design ground motion parameters may be adopted.

1.0.6 Seismic design based on this code shall also be coordinated with provisions specified in other current compulsory design codes concerned.

Chapter 2 Definitions and notations

2.1 Definitions

2.1.1 Seismic Fortification Intensity

The seismic intensity approved by State authority, which is used as the basis for the seismic fortification of buildings in a certain region.

2.1.2 Seismic Fortification Criterion

The rule for judging the seismic fortification requirements, which depends on the seismic fortification intensity and importance of the building's using functions.

2.1.3 Earthquake Action

The structural dynamic action due to earthquake, including horizontal seismic action and vertical seismic action.

2.1.4 Design Parameters of Ground Motion

The seismic acceleration time-history curve, the response spectrum of acceleration, and the peak value acceleration used in seismic design.

2.1.5 Design Basic Acceleration of Ground Motion

The design value of seismic acceleration, that exceeding probability is 10% during the 50-years reference period.

2.1.6 Design Characteristic Period of Ground Motion

The period value corresponding to the starting point of reduced section of seismic influence coefficient curve, which describes the earthquake magnitude, the distance of epicenter and the site-classes etc.

2.1.7 Site

An area of a building group, usually it has similar characteristic in response spectrum. Its scope approximately equivalent to a factory area, a living quarter, a village or a plain area no less than $1.0km^2$.

2.1.8 Seismic Concept Design of Buildings

The process of making the general arrangement for the architectures and structures and of determining details, that based on the design fundamental principles and the ideas obtained from past experiences in earthquake disaster prevention and the constructional project.

2.1.9 Seismic Fortification Measures

The seismic design contents except seismic action calculation and member resistance calculation, and details of seismic design included.

2.1.10 Details of Seismic Design

All of detailed requirements, which are determined according to seismic concept design of buildings and no calculation is necessary.

2.2 Main Notations

2.2.1 Actions and effects

F_{Ek}, F_{Evk}——characteristic value of total horizontal and vertical seismic action of structure respectively.

G_E, G_{eq}——representative value of gravity load of structure (or member) and the total equivalent gravity load of a structure in earthquake respectively.

w_k——characteristic value of wind load.

S_E——seismic effect (bending moment, axial force, shear, stress and deformation).

S——base combination of seismic effect and other load effects.

S_k——effect corresponding to characteristic value of action or load.

M——bending moment.

N——axial force.

V——shear.

p——compression on bottom of foundation.

u——lateral displacement.

θ——rotation of story draft.

2.2.2 Resistance and Material Properties

K——stiffness of structure (or member).

R——resistant capacity of structural member.

f, f_k, f_E——design value, characteristic value and seismic design value of material strength (bearing capacity of subsoil included) respectively.

$[\theta]$——allowable rotation of story draft.

2.2.3 Geometric Parameters

A——cross-sectional area of structural member.

A_s——cross-sectional area of reinforcement.

B——total width of structure.

H——total height of structure, or column height.

L——total length of structure (or structural unit).

a——distance.

a_s, a'_s——distance from near extreme fiber of section to the point for resultant of force of all longitudinal reinforcement in tension and compression respectively.

b——width of cross section of member.

d——depth or thickness of soil, or diameter of reinforcement.

h——height of story, or height of cross section of member i.e. depth of member.

l——length or span of member.

t——thickness of seismic structural-wall or slab.

2.2.4 Coefficients of Calculation

α——horizontal seismic influence coefficient.

α_{max}——maximum value of horizontal seismic influence coefficient.

α_{vmax}——maximum value of vertical seismic influence coefficient.

$\gamma_G, \gamma_E, \gamma_w$——partial factor of gravity, earthquake and wind load respectively.

γ_{RE}——seismic adjusting factor for bearing capacity of member.

ζ——calculation factor.

η——amplification factor or adjusting factor of seismic effect (inner force or deformation).

λ——slenderness ratio of member, or proportional factor.

ξ_y——yield strength coefficient of structure (or members).

ρ——reinforcement ratio or ratio.

φ——stability factor of compressive member.

ψ——combination value coefficient, or effect factor.

2.2.5 Others

T——natural period of structure.

N——penetration resistance (in blow number).

I_{lE}——liquefaction index of subsoil under earthquake.

X_{ji}——mode coordinate of displacement (relative displacement of mass i-th of mode j-th in the x direction).

Y_{ji}——mode coordinate of displacement (relative displacement of mass i-th of mode j-th in the y direction).

n——total number, such as number of stories, masses, reinforcement bars, spans etc.

v_{se}——equivalent shear-wave velocity of soil.

Φ_{ji}——mode coordinate of rotation (relative rotation of mass i-th of mode j-th around the z axial direction).

Chapter 3 Basic requirements of seismic design

3.1 Classifications of seismic fortification and corresponding criterion

3.1.1 Every building shall be classified, according to the importance of their using functions, as a seismic fortification category A, B, C or D defined as follows:

Category A buildings are those, major buildings or the failure of which would result in severe secondary disaster.

Category B buildings are those which the continual function is necessary during earthquake or could be restored quickly after earthquake.

Category C buildings are those not assigned to either category A, B or D buildings.

Category D buildings are those less important buildings.

3.1.2 Each building shall be assigned to a fortification category in accordance with the current national standard "Standard for seismic fortification classification of buildings" GB 50223.

3.1.3 Fortification categories are used in this code to determine fortification criterion as follows:

1 For buildings assigned to category A, the earthquake action of which shall be higher than that of the local fortification intensity, that values shall be determined based on the site seismic safety appraisal results. When the fortification intensity is 6～8, the seismic measures shall be one grade higher than that of the local fortification intensity; However, the seismic measures shall be appropriately higher than that of fortification intensity 9, where zones belong to fortification intensity 9.

2 For buildings assigned to category B, the earthquake action of which shall be adopted as local fortification intensity. Normally When the fortification intensity is 6～8, the seismic measures shall be one grade higher than that of the local fortification intensity; However, the seismic measures shall be appropriately higher than that of fortification intensity 9, where zones belong to fortification intensity 9. And the seismic measures for foundation shall comply with relevant provisions.

For smaller buildings assigned to category B, only when their structural system changed into that with higher seismic capability, it is permitted to take seismic measures as that of local fortification intensity.

3 For buildings assigned to category C, the earthquake action and seismic measures shall be take as that of local fortification intensity.

4 For buildings assigned to category D, the earthquake action shall be take as that of local fortification intensity, and the seismic measures shall be appropriately lower than

that of local fortification intensity. However, seismic measures cannot be lowered where zones belong to fortification intensity 6.

3.1.4 If the buildings assigned to fortification category B, C and D are situated on zone where the fortification intensity is 6, except as specified in this code, earthquake action is permitted not to be calculated.

3.2 Seismic influences

3.2.1 The seismic influence for the buildings situated region shall be described by using the design basic acceleration of ground motion and design characteristic period of ground motion, or by using the design ground motion parameters as indicated in Clause 1.0.5 of this code.

3.2.2 The corresponding relationship between the fortification intensity and the design basic acceleration of ground motion as indicated in Table 3.2.2. Where the design basic acceleration of ground motion is 0.15g and 0.30g, except as specified in this code, the seismic design of buildings shall be adopted as that of fortification intensity 7 and 8 respectively.

Table 3.2.2 Relationship between the intensity and design basic acceleration of ground motion

Fortification intensity	6	7	8	9
Design basic acceleration of ground motion	0.05g	0.10 (0.15)g	0.20 (0.30)g	0.40g

Note: g is the gravitational acceleration.

3.2.3 The design characteristic period of ground motion shall be determined according to the design earthquake groups and Site-classes of location of each building. For Site-class Ⅱ, the design characteristic period of ground motion for 1 st, 2 nd, and 3 rd design earthquake group shall be taken as 0.35s, 0.40s and 0.45s respectively.

Note: The "design characteristic period of ground motion", hereinafter reference as "characteristic period".

3.2.4 The values of fortification intensity, design basic acceleration of ground motion and design earthquake groups for main cities and towns in China may be indicated in Appendix A of this code.

3.3 Site and subsoil

3.3.1 When selecting a construction place, a comprehensive assessment classified as favorable plat, unfavorable plat or hazardous plat to seismic fortification shall be made, according to seismicity of the region, and the geotechnical and geological data of site dependent to necessities of project. The favorable plats to seismic fortification shall be selected, while unfavorable plats shall be avoided except appropriate seismic measures have been taken. The buildings assigned to Fortification Category A, B and C. shall not be construct-

ed on the hazardous plats.

3.3.2 Only the construction field belong to Site-class Ⅰ, the seismic designed details is permitted taken as follows:

For building assigned to Fortification Category A or B, seismic detail requirements could be taken as that for local fortification intensity.

For building assigned to Fortification Category C, seismic detail requirements could be taken as that for intensity of one grade lowers than local fortification intensity, but shall not be reduced for local fortification intensity 6.

3.3.3 When design basic acceleration of ground motion is 0.15g and 0.30g, while construction field assigned to Site-class Ⅲ or Ⅳ, except as specified in this code, the seismic designed details should be taken as that of fortification intensity 8 (0.20g) and 9 (0.40g) respectively.

3.3.4 Design requirement of subsoil and foundation shall be as follows:

1 Foundation of same structural unit should not be posited on subsoil with entirely different characteristics.

2 Foundation of same structural unit should not consist of partly natural subbase and partly pile foundation.

3 For base-soil with layers consisted of soft clay, liquefied soil, recently back-filled soil, or soil with extremely non-uniform distribution, differential settlement and/or other harmful impact under earthquake shall be calculated in design and corresponding measures shall be taken.

3.4 Regularity of architectural design and structural design

3.4.1 The architectural design shall be made in accordance with the requirements of seismic concept design of buildings, a seriously irregular design scheme of building shall not be adopted.

3.4.2 The plan arrangement of architecture and lateral-force-resisting members should be regular and symmetrical, and shall have good integrity. The configuration and elevation of building should be regular, the lateral stiffness of structure should be changed equably, and the cross-sectional dimensions and its material strength of vertical lateral-force-resisting members should be reduced along whole structure from lower part to upper part gradually, to avoid sudden change in stiffness and bearing capacity of lateral-force-resisting system of the structure.

Buildings having one or more of the features listed in Table 3.4.2-1 shall be designated as having plan structural irregularity, buildings having one or more of features listed in Table 3.4.2-2 shall be designated as having vertical structural irregularity. Their design shall comply with the requirements in Clause 3.4.3 of this code.