UDC

NATIONAL STANDARD
OF THE PEOPLE'S REPUBLIC OF CHINA

P

GB 50011-2010

Code for Seismic Design of Buildings

建筑抗震设计规范

Issued on: May 31,2010

Implemented on: December 1,2010

Jointly Issued by Ministry of Housing and Urban-Rural Development of the People's Republic of China
General Administration of Quality Supervision, Inspection and Quarantine of the People's Republic of China

NATIONAL STANDARD
OF THE PEOPLE'S REPUBLIC OF CHINA

Code for Seismic Design of Buildings

GB 50011 – 2010

Chief Development Department: Ministry of Housing and Urban-Rural Development of the People's Republic of China
Approval Department: Ministry of Housing and Urban-Rural Development of the People's Republic of China
Implementation Date: December 1, 2010

China Architecture & Building Press

Beijing 2014

图书在版编目(CIP)数据

建筑抗震设计规范 GB 50011－2010：英文/中华人民共和国住房和城乡建设部组织编译. —北京：中国建筑工业出版社，2014.9
（工程建设标准英文版）
ISBN 978-7-112-16967-2

Ⅰ.①建… Ⅱ.①中… Ⅲ.①建筑结构-防震设计-建筑规范-中国-英文 Ⅳ.①TU352.104-65

中国版本图书馆 CIP 数据核字(2014)第 124922 号

Chinese edition first published in the People's Republic of China in 2010
English edition first published in the People's Republic of China in 2014
by China Architecture & Building Press
No. 9, Sanlihe Road
Beijing, 100037
www. cabp. com. cn

Printed in China by BeiJing YanLinJiZhao printing CO., LTD

ISBN 978-7-112-16967-2(25755)

Announcement of Ministry of Housing and Urban-Rural Development of the People's Republic of China

No. 609

Announcement on Publishing the National Standard *Code for Seismic Design of Buildings*

The standard *Code for Seismic Design of Buildings* has been approved as a national standard with the serial number of GB 50011 - 2010 and shall be implemented on December 1, 2010. Therein, Articles 1.0.2, 1.0.4, 3.1.1, 3.3.1, 3.3.2, 3.4.1, 3.5.2, 3.7.1, 3.7.4, 3.9.1, 3.9.2, 3.9.4, 3.9.6, 4.1.6, 4.1.8, 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, 5.4.3, 6.1.2, 6.3.3, 6.3.7, 6.4.3, 7.1.2, 7.1.5, 7.1.8, 7.2.4, 7.2.6, 7.3.1, 7.3.3, 7.3.5, 7.3.6, 7.3.8, 7.4.1, 7.4.4, 7.5.7, 7.5.8, 8.1.3, 8.3.1, 8.3.6, 8.4.1, 8.5.1, 10.1.3, 10.1.12, 10.1.15, 12.1.5, 12.2.1 and 12.2.9 are compulsory ones and must be enforced strictly. The former standard GB 50011 - 2001 *Code for Seismic Design of Buildings* shall be abolished simultaneously.

Authorized by the Research Institute of Standard and Norms of the Ministry, this code is published and distributed by China Architecture & Building Press.

Ministry of Housing and Urban-Rural Development of the People's Republic of China

May 31, 2010

Foreword

According to the requirements of Document Jian Biao [2006] No. 77—*Notice on Printing and Distributing the Development and Revision Plan of Engineering Construction Standards and Codes in* 2006 (*Batch 1*) issued by the former Ministry of Construction (MOC), this code was revised from GB 50011 - 2001 *Code for Seismic Design of Buildings* by China Academy of Building Research (CABR) together with other design, survey, research and education institutions concerned.

During the process of revision, the editorial team summarized the experiences in building seismic damages during Wenchuan Earthquake in 2008; adjusted the seismic precautionary intensities of the relevant disaster areas; added some compulsory provisions on the sites in mountainous areas, the arrangements of the infilled wall in frame structure, the requirements for staircase of masonry structure and the construction requirements of seismic structure; and raised the requirements for the details of the precast floor slab and for the reinforced elongation. Hereafter, the editorial team carried out studies on specific topics and some tests concerned, investigated and summarized the experiences and lessons from the strong earthquakes occurred in recent years home and abroad (including Wenchuan Earthquake), adopted the new research achievements of earthquake engineering, took the economic condition and construction practices in China into account, widely collected the comments from the relevant design, survey, research and education institutions as well as seismic administration authorities nationwide. 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. This newly-revised version comprises 14 Chapters and 12 Appendixes. Besides remaining those provisions partially revised in 2008, the main revisions at this edition are:

1. supplementing the provisions on the seismic measures for areas with the seismic precaution Intensity 7(0.15g) and Intensity 8 (0.30g);

2. adjusting the Design Earthquake Groups of Main Cities in China in accordance with GB18306 - 2001 *Seismic Ground Motion Parameter Zonation Map of China*;

3. improving the soil liquefaction discriminating equation;

4. adjusting the damping modification parameter of design response spectrum;

5. modifying the damping ratio and the seismic adjusting factor for load-bearing capacity of steel structure;

6. modifying the calculation methods of the horizontal seismic-reduced factor of seismically isolated structure;

7. supplementing the calculation method for horizontal and vertical earthquake action of large-span buildings;

8. raising the seismic design requirements for concrete frame structure buildings and for masonry buildings with RC frames on ground floors;

9. proposing the classification method for the seismic grades of steel structure buildings, and

adjusting the provisions on seismic measures, correspondingly;

10. improving the seismic measures for multi-story masonry buildings, concrete wall buildings and reinforced masonry buildings;

11. expending the application scope of seismically isolated and energy-dissipated buildings;

12. adding the principles on performance-based seismic design of for buildings as well as the seismic design provisions for large-span buildings, subterranean buildings, frame-bent structure factories, buildings with composite steel brace and concrete frame structures, and buildings with composite steel frame and concrete core tube structures;

13. canceling the contents related to multi-story masonry buildings with inner frames.

The provisions printed in bold type are compulsory ones and must be enforced strictly.

The Ministry of Housing and Urban-Rural Development of the People's Republic of China is in charge of the administration of this code and the explanation of the compulsory provisions hereof. China Academy of Building Research (CABR) is responsible for the explanation of specific technical contents. All relevant organizations are kindly requested to sum up and accumulate your experiences in actual practices during the process of implementing this code. The relevant opinions and advice, whenever necessary, can be posted or passed on to the Management Group of the National Standard *Code for Seismic Design of Buildings* of the China Academy of Building Research (Address: No. 30, Beisanhuan East Road, Beijing City, 100013, China; E-mail: GB50011-cabr@163. com).

Chief Development Organization:

China Academy of Building Research (CABR).

Participating Development Organizations:

Institute of Engineering Mechanics (IEM) of China Earthquake Administration, China Architecture Design & Research Group, China Institute of Building Standard Design & Research, Beijing Institute of Architectural Design, China Electronics Engineering Design Institute, China Southwest Architectural Design and Research Institute, China Northwest Architectural Design and Research Institute, China Northeast Architecture Design and Research Institute, East China Architectural Design and Research Institute, Central-South Architectural Design Institute, the Architectural Design and Research Institute of Guangdong Province, Shanghai Institute of Architecture Design and Research, Institute of Building Design and Research of Xinjiang Uygur Autonomous Region, Yunnan Province Design Institute, Sichuan Architectural Design Institute, Shenzhen General Institute of Architectural Design and Research, Beijing Geotechnical Institute, Shanghai Tunnel Engineering and Rail Transit Design and Research Institute, China Construction (Shenzhen) Design international, Architecture Design General Institute of China Metallurgical Group Corporation, China National Machinery Industry Corporation, China IPPR International Engineering Corporation, Tsinghua University, Tongji University, Harbin Institute of Technology, Zhejiang University, Chongqing University, Yunnan University, Guangzhou University, Dalian University of Technology and Beijing University of Technology

Chief Drafting Staffs:

Huang Shimin, Wang Yayong

(The following is according to the Chinese phonetic alphabetically)

Ding Jiemin Fang Taisheng, Deng Hua, Ye Liaoyuan, Feng Yuan, Lu Xilin, Liu Qiongxiang, Li Liang, Li Hui, Li Lei, Li Xiaojun, Li Yaming, Li Yingmin, Li Guoqiang, Yang Linde, Su Jingyu, Xiao Wei, Wu Mingshun, Xin Hongbo, Zhang Ruilong, Chen Jiong, Chen Fusheng, Ou Jinping, Yu Yinquan, Yi Fangmin, Luo Kaihai, Zhou Zhenghua, Zhou Bingzhang, Zhou Fulin, Zhou Xiyuan, Ke Changhua, Lou Yu, Jiang Wenwei, Yuan Jinxi, Qian Jihong, Qian Jiaru, Xu Jian, Xu Yongji, Tang Caoming, Rong Baisheng, Cao Wenhong, Fu Shengcong, Zhang Yiping, Ge Xueli, Dong Jincheng, Cheng Caiyuan, Fu Xueyi, Zeng Demin, Dou Nanhua, Cai Yiyan, Xue Yantao, Xue Huili and Dai Guoying

Chief Examiners:

Xu Peifu, Wu Xuemin, Liu Zhigang

(The following is according to the Chinese phonetic alphabetically)

Liu Shutun, Li Li, Li Xuelan, Chen Guoyi, Hou Zhongliang, Mo Yong, Gu Baohe, Gao Mengtan, Huang Xiaokun and Cheng Maokun

Contents

1 General

1.0.1 This code is equationted with a view to implementing the relevant laws and regulations on construction engineering and protecting against and mitigating earthquake disasters, carrying out the policy of "prevention first", as well as alleviating the seismic damage of buildings, avoiding casualties and reducing economic loss through seismic precautionary of buildings.

The basic seismic precautionary objectives of buildings which designed and constructed in accordance with this code, are as follows:

1) under the frequent earthquakeground motion with an intensity being less than the local Seismic Precautionary Intensity, the buildings with major structure undamaged or requiring no repair may continue to serve;

2) under the earthquake ground motion with an intensity being equivalent to the local Seismic Precautionary Intensity, the buildings with possible damage may continue to serve with common repair; or

3) under the rare earthquakeground motion with an intensity being larger than the local Seismic Precautionary Intensity, the buildings shall not collapse or shall be free from such severe damage that may endanger human lives.

If the buildings with special requirements in functions or other aspects are carried out with the seismic performance-based design, more concrete and higher seismic precautionary objectives shall be established.

1.0.2 All the buildings situated on zones of Seismic Precautionary Intensity 6 or above must be carried out with seismic design.

1.0.3 This code is applicable to the seismic design and the isolation and energy-dissipation design of the buildings suited on zones of Seismic Precautionary Intensity 6, 7, 8 and 9. And the seismic performance-based design of buildings may be implemented in accordance with the basic methods specified in this code.

As for the buildings suited on zones where the Seismic Precautionary Intensity is above Intensity 9 and the industrial buildings for special purpose, their seismic design shall be carried out according to the relevant special provisions.

Note: For the purposes of this code, "Seismic Precautionary Intensity 6, 7, 8 and 9" hereinafter is referred to "Intensity 6, 7, 8 and 9".

1.0.4 The Seismic Precautionary Intensity must be determined in accordance with the documents (drawings) examined, approved and issued by the authorities appointed by the State.

1.0.5 Generally, the seismic precautionary intensity of buildings shall be adopted with the basic seismic intensity (the intensity values corresponding to the design basic acceleration of ground motion value in this code) determined according to the *Seismic Ground Motion Parameter Zonation Map of China*.

1.0.6 In addition to the requirements of this code, the seismic design of buildings also shall comply with the requirements specified in the relevant current standards of the State.

2 Terms and Symbols

2.1 Terms

2.1.1 Seismic precautionary intensity

The seismicintensity approved by the authority appointed by the State, which is used as the basis for the seismic precaution of buildings in a certain region. Generally, it is taken as the seismic Intensity with a 10% probability of exceedance in 50 years.

2.1.2 Seismic precautionary criterion

The rule for judging the seismic precautionary requirements, which is dependent on the Seismic Precautionary Intensity or the design parameters of ground motion and the precautionary category of buildings.

2.1.3 Seismic ground motion parameter zonation map

The map in which the whole county is divided into regions with different seismic precautionary requirements according to the ground motion parameter (that is the degree of earthquake ground motion intensity indicated by acceleration).

2.1.4 Earthquake action

The dynamicresponse of structure caused by earthquake ground motion, including horizontal and vertical earthquake action.

2.1.5 Design parameters of earthquake ground motion

Theparameters of earthquake ground motion used in seismic design, including the acceleration (velocity or displacement) time history of the earthquake ground motion , the acceleration response spectrum and the peak value of ground acceleration

2.1.6 Design basic acceleration of earthquake ground motion

The design value of seismic accelerationwith a 10% probability of exceedance in the 50-years design reference period.

2.1.7 Design characteristic period of earthquake ground motion

The period value corresponding to the starting point of the descendingsection of the seismic influence coefficient curve used for seismic design, that is dependent on the earthquake magnitude, epicentral distance, site class and etc. For convenience, it is named as "characteristic period" for short.

2.1.8 Site

Locations of the project colonies, being with similar characteristics of responsespectra. The scope of site is equivalent to plant area, residential area and natural village or the plane area no less than 1.0km^2.

2.1.9 Seismic concept design of buildings

The process of making the general arrangement for the buildings and structures and of determining details, based on the fundamental design principles and concepts obtained from the past experiences in earthquake disasters and projects.

2.1.10 Seismic measures

The seismic design contents except earthquake action calculation andmember resistance calculation, including the details of seismic design.

2.1.11 Details of seismic design

All the detailed requirementsthat must be taken for the structural and nonstructural components according to seismic concept design principles and require no calculation generally.

2.2 Symbols

2.2.1 Actions and effects

F_{Ek}, F_{Evk}——Standard values of total horizontal and vertical earthquake actions of structure respectively;

G_E, G_{eq}——Representative value of gravity load of structure (or component) and the total equivalent representative value of gravity load of a structure ,respectively;

w_K——Standard value of wind load;

S_E——Seismic effect (bending moment, axial force, shear, stress and deformation);

S——Fundamental combination values of the effects of earthquake action and other loads;

S_k——Effect of the standard value of action or load;

M——Bending moment;

N——Axial force;

V——Shear;

p——Pressure on bottom of foundation;

u——Lateral displacement;

θ——Story drift.

2.2.2 Material properties and resistance

K——Stiffness of structure (member);

R——Resistantcapacity of structural component;

f, f_k, f_E——Design value, standard value and seismic design value of various material strength (including the bearing capacity of soil) , respectively;

$[\theta]$——Allowable story drift.

2.2.3 Geometric parameters

A——Cross-sectional area of member;

A_s——Cross-sectional area of reinforcement;

B——Total width of structure;

H——Total height of structure, or the column height;

L——Total length of structure (unit);

a——Distance;

a_s, a'_s——Minimal distance from the force point of the longitudinal tensile and compressive reinforcements to the margin of section, respectively;

b——Sectional width of member;

d——Depth or thickness of soil layer, or the diameter of reinforcement;

h——Depth of cross-section of member;

l——Length or span of member;

t——Thickness of wall or floor 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;

γ_G, γ_E, γ_W——Partial factor of action;

γ_{RE}——seismic adjusting factor for load-bearing capacity;

ζ——Calculation coefficient;

η——Enhancement or adjustment coefficient of earthquake action effect (internal force or deformation);

λ——Slenderness ratio of member, or the proportionality coefficient;

ξ_y——Yield strength coefficient of structure (member);

ρ——Reinforcement ratio or ratio;

$\varnothing$——Stability coefficient of compressive member;

ψ——Combination value coefficient or the influence coefficient.

2.2.5 Others

T——Natural vibration period of structure;

N——Penetration resistance (in blow number);

I_{lE}——Liquefaction index of soil under earthquake;

X_{ji}——The coordinate of modal displacement (relative displacement of the i^{th} mass point of the j^{th} mode in x direction);

Y_{ji}——The coordinate of modal displacement (relative displacement of the i^{th} mass point of the j^{th} mode in y direction);

n——Total number, such as number of storeys, masses, reinforcements and spans, etc.;

υ_{se}——Equivalent shear wave velocity of soil layer;

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

3 Basic Requirements of Seismic Design

3.1 Category and Criterion for Seismic Precaution of Buildings

3.1.1 The seismic precautionary category and the seismic precautionary criterion of buildings shall be determined in accordance with the current national standard GB 50223 *Standard for Classification of Seismic Protection of Building Constructions*.

3.1.2 Unless otherwise specified in this code, Categories B, C and D buildings with seismic precautionary intensity 6 may not be carried out the calculation of earthquake action.

3.2 Earthquake Ground Motion

3.2.1 The earthquake ground motion of the zones in which buildings are suited shall be represented by design basic acceleration and characteristic period of earthquake ground motion corresponding to the seismic precautionary intensity.

3.2.2 The corresponding relationship between the seismic precautionary intensity and the design basic acceleration of ground motion shall be in accordance with those specified in Table 3.2.2. Unless otherwise stated in this code, the buildings in such zones where the design basic acceleration of ground motion is 0.15g and 0.30g shall be carried out with seismic design respectively according to the requirements of seismic precautionary intensity 7 and 8.

Table3.2.2 Corresponding Relationship Between Seismic Precautionary Intensity and Design Basic Acceleration of Ground Motion

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

Note: g is the gravity acceleration.

3.2.3 The characteristic period of earthquake ground motion shall be determined according to the design earthquake groups and the site class of the building site. The design earthquakes in this code are totally divided into three groups, and their characteristic periods shall be adopted according to the relevant provisions in Chapter 5 of this code.

3.2.4 The seismic precautionary intensity, design basic acceleration of ground motion and design earthquake groups of the central areas in the main cities in China may be adopted according to Appendix A of this code.

3.3 Site and Soil

3.3.1 During the selection of a building site, a comprehensive assessment to the region shall be made according to the project demand and the relevant information on the seismicity, engineering geology and seismogeology of the region, and the assessment result such as the favorable, common, unfavorable or hazardous section shall be given simultaneously. At the unfavorable section, the building site shall be avoided to locate or be treated with some effective measures if unable to avoid. In the hazardous sections, the buildings assigned to Category A or B must not be constructed and the

buildings assigned to Category C shall not be constructed.

3.3.2 If the building site is of Class I, it shall be permitted to adopt details of seismic design according to the requirements of local seismic precautionary intensity for the buildings assigned to Category A and B, and to the requirements of the reduced Intensity that shall be taken as one grade less than the local seismic precautionary intensity, but not less than Intensity 6, for the buildings assigned to Category C.

3.3.3 If the building site is of Class Ⅲ or Ⅳ, in the areas where the design basic acceleration of ground motion is 0.15g and 0.30g, unless otherwise stated in this code, buildings should be adopted with details of seismic design according to the requirements of the seismic precautionary intensity 8 (0.20g) and 9 (0.40g), respectively.

3.3.4 The design of base and foundation shall meet the following requirements:

1 Foundation of one same structural unit should not be built on the soils with entirely different features.

2 One same structural unit should not be adopted with natural subsoil and pile foundation partially. If different types of foundations are adopted or the buried depth of foundation is different obviously, corresponding measures shall be taken at the relevant positions of foundation and superstructure according to the differential settlement of these two parts of foundations under earthquake.

3 To the subsoils consisted of soft clay, liquefied soil, newly filled soil or extremely non-uniform soil, the corresponding measures shall be taken according to the non-uniform settlement and other adverse impacts of foundation under earthquake.

3.3.5 The site and foundation of buildings in mountainous areas shall comply with the following requirements:

1 For the buildings in mountainous areas, the slop stability evaluation and prevention and treatment scheme suggestions shall be made during geotechnical investigation, and the slope project meeting the requirements of seismic precaution shall be set up in accordance with the geologic and orographic conditions, usage function requirements and local conditions.

2 The slope design shall meet the requirements of the current national standard GB 50330 *Technical Code for Building Slope Engineering*; and the relevant friction angle shall be corrected according to the precautionary intensity during the slope stability evaluation.

3 The building foundation near to slope shall be carried out with seismic stability design. An adequate distance with proper measures that shall be determined according to the precautionary intensity, shall be left at the edge of the soil or severely weathered rock slope and building foundation to avoid the foundation failure under earthquake.

3.4 Regularity of Building Configuration and Structural Assembly

3.4.1 The building design shall specify the regularity of building configuration according to the requirements of seismic concept design. For irregular buildings, strengthening measures shall be taken as required; for especially irregular buildings, special strengthening measures shall be taken through special study and demonstration; severely irregular buildings shall not be built.

Note: The building configuration refers to the variations in the plane, elevation and vertical section of a building.

3.4.2 The building design shall attach great importance to influences of the regularity of its

plane, vertical plane and vertical section on the seismic performance and economical rationality, and the regular building configuration should be as a matter of priority. And at the same time, the arrangement of the lateral-force-resisting components should be regular and symmetrical in plan with respect to two orthogonal axes, the lateral stiffness of the lateral-force-resisting system should vary uniformly along the vertical direction, the sectional dimension and material strength of the vertical lateral-force-resisting components should be reduced gradually from bottom to top to avoid the sudden changes of lateral stiffness and load-bearing capacity.

The seismic design of irregular building shall comply with those specified in Article3. 4. 4 of this code.

3. 4. 3 The horizontal and vertical irregular classification for the building configuration and its structural assembly shall be carried out according to the following requirements:

1 The concrete structure building, steel structure building or steel-concrete structure building, having one of horizontal irregularity types listed in Table 3. 4. 3-1 or one of vertical irregularity types listed in Table 3. 4. 3-2 or other similar irregular types, shall be designated as irregular building.

Table3. 4. 3-1 Horizontal structural Irregularities

Type of irregularity	Description and reference index
Torsional irregularity	Under the action of specified horizontal force, the maximum elastic story displacement or story drift, computed including accidental torsion, at one end of structure transverse to an axis is more than 1. 2 times the average of the story displacement or story drift at two ends of the structure
Reentrant corner irregularity	Both projections of the structure beyond a re-entrant corner greater than 30% of the plan dimension of the structure in the given direction
Diaphragm discontinuity irregularity	Diaphragms with abrupt discontinuities or variations in stiffness, including those having cutout or open areas greater than 30% of the gross enclosed diaphragm area, or effective width less than 50% of total width of diaphragm, orwith floors staggered greatly in the vertical direction

Table3. 4. 3-2 Vertical structural Irregularities

Type of irregularity	Description and reference index
Stiffness-soft Story irregularity	The lateral stiffness in the story is less than 70% of that in the story above or less than 80% of the average stiffness of the three storeys above; or the horizontal dimension of the story is less than 75% that of next story lower except the top storey or the small buildings outside roof
In-plan discontinuity in vertical lateral-force-resisting component irregularity	The internal force of vertical lateral-force-resisting components (columns, seismic walls and seismic bracing) is transmitted downward through horizontal transmission components (beam and truss)
Discontinuity in lateral strength-weak story irregularity	The story lateral strength of lateral-force-resisting structure is less than 80% of that in the story above

2 The horizontal and vertical irregular classification for masonry buildings, single-storey factory buildings, single-storey spacious buildings, large-span roof buildings or subterranean buildings shall meet those specified in the related chapters of this code.

3 A building, with several irregularity types or one certain irregularity type exceeding the