RESEARCH OF SOME ISSUES ABOUT THE EARTHQUAKE ENGINEERING DESIGN

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ABSTRACT :
Has discussed certain questions in the project seismic design, including: The related seismic motion parameter's value should unify in the Chinese seismic motion parameter regionalization map; Take the architectural engineering condition design general rule (test) as a basic rule; Absorb the experience of the domestic and foreign macroseism earthquake damage; Revises the seismic design standard comprehensively match with the work, imperative; Structural design standard of China is somewhat low; Earthquake function computation also has great disparity with the international rules; Earthquake resistance reliability question urgently needed solution; The computation of the ground attached subsidence, the ground seismic design, the ground distortion control design, ground seismic design questions and degree of security are in further studying; The elastic-plasticity time interval analysis of structure, the earthquake resistance reliability analysis, the earthquake resistance optimization analysis's method and the software application, the condition has, needs widely to promote the application; The seismic design standard and project management advocate marketability, mainly participation by the academic body, avoids the administrative intervention, in order to enhance seismic design quality.

KEYWORDS:
Engineering， earthquake ， resistance design，some issues， research

1. INTRODUCTION

The earthquake has caused serious losses to the humanity. There are lots countries suffer the serious earthquake disaster all over the world.
Chile: in 1939 the Kangsaipuxiweng city encountered the ruination, more than 40,000 people died. Also had 7.8 magnitude of earthquakes in May 21, 1960. On May 22 blue collected wonderfully has earthquake of 8.5 magnitude. The earthquake has swallowed the coastal houses on south central Chile. And the Pacific regional ocean waves with speed of 640 kilometer per hour swept the Pacific Ocean from the Chilean coast. The wave in the height of 4 meter reached Japan where is 17000 kilometer away from Chile 22 hours later. The wave brought heavy damage to Honshu and Hokkaido's harbor, and the wharf construction of Japan.
USA: There are approximately 1300 people died in the history. Economic loss is approximately 4,000,000,000 US dollars. San Francisco has an earthquake of 8.3 magnitude in 1906. The fire caused by the earthquake burnt down 521 blocks and 28,000 buildings. The Alaska earthquake of 8.4 magnitude in 1964, lead to approximately 300,000,000 US dollars lost, and the landslide are serious.
Japan: 8.2 magnitude of earthquake on east at the end of 1923, the depth of earthquake origin was just 10 kilometers. Casualty is 200,000. South the Japanese Bing Ku County has 7.2 magnitude of earthquake on January 17, 1995. The depth of origin is 10.2 kilometers. 5420 people died 27,000 people injured. The refugee number reaches 300,000. The economic loss reached approximately 99,600,000,000 US dollars. The fire in Kobe was serious. The fire last 15 hours, and there were 170 times of fire caused by the earthquake.
Turkey: The Turkish west had 7.4 magnitude of earthquakes on August 17, 1999. 15,000 people were dead.

27,000 ones injured. More than 50 ten thousand person were homeless. Direct economic losses reached approximately 20,000,000,000 US dollars.

Indonesia: on December 26, 2004, the northwest of Indonesian Sumatra island where entered the sea, had 8.9 magnitude of earthquakes, and initiated the huge Tsunami. The tsunami affected southeast Asia and south Asian, the casualty is nearly 300,000.

China: in 1556 the Shanxi Hua County has 8.0 magnitude of big earthquakes, almost 830,000 people died;

The Ningxia Haiyuan had big earthquakes in 8.5 magnitude, in 1920. Approximately 200,000 people died; The earthquake causes big landslide of the Loess Highlands, and formed the imprisoned lake latter.

Tangshan has 7.8 magnitude of earthquakes, on July 28, 1976. The casualties is more than 420,000 people, The economic loss is more than 10,000,000,000 Yuan. The reason of the serious disaster are as following: the earthquake occur in the urban heartland; the depth of origin only was 11 kilometers; the location of the earthquake damage is serious; and earthquake resistance ability of buildings is low; the earthquake occur in dawn when most of the citizens were in sound sleep. Liu Huixian as director's editorial committee has published a Tangshan big earthquake damage book, which is 4 volumes, comprehensivly summary the experiences and lessons of Tangshan big earthquake damage, which is extremely profound .

Taiwan Nantou County has 7.3 magnitude of earthquakes, on September 21, 1999.The entire island of Taiwan has the intensely feeling. 2470 people died, injured 11,300 people, direct economic losses is approximately 11,800,000,000 US dollars.

The Sichuan Wenchuan has 8.0 magnitude of earthquakes, on May 12, 2008. More than 69,000 people died, more than 18,000 people were missed, more than 360,000 people injured. The collapse, serious damage houses were 4,500,000 households. And there are more than 1000 ten thousand people homeless. The disaster area are almost 100,000 square kilometers. The direct economic losses surpass 1,000,000,000,000 Yuan, It is predicted that the estimate total investment of reconstruction is more than 1,200,000,000,000 Yuan. The primary reasons of Sichuan Wenchuan 8.0 magnitude of earthquake areas following. The magnitude is big. The last time is long. The seismic region population are many. The earthquake resistance standard of the building is low. The geological disaster is serious, such as the road, railway communication blocked, the imprisoned lake brought the flood harm.

The earthquake damage of China are the most serious one in history. The distracted should not be forget by the common people.

The frequently natural disasters have brought serious loses in recent years. Indonesia, Japan, Taiwan, the southwest of Asian suffered the damaged by the serious earthquakes. The governments in different countries, the engineering society and institute of academic pay more and more attention to the research of earthquake.

The main feature of earthquake resists in China is:

- The seismic activities distribute broad. The region resists earthquake is approximately 70% of the domain. The center of earthquake origin is shallow in most of the area.
- The overwhelming majority earthquake intensity is big in 10~30KM.
- The world has macroseism more than 1500 times, in recent centuries. More than 1/4 happened in China, and the magnitude above 7 is 1/10. But the power release is the 20~30% of the total earthquakes all over the world.
- Any big or media-sized cities are locate in the earthquake area. The location condition is bad. The overwhelming majority of buildings need to resist earthquakes. Many provincial capitals and above 1,000,000 people cities are located at 7 degrees areas, some locate at 8 degrees areas, the minority main industrial cites locate at 9 degrees areas, China has the biggest number of cities need to resists earthquakes in the world, and most cites' location conditions are bad.
- Construction earthquake resistance ability is low, China promulgate the first earthquake resistance standard in 1974. Before 1974 the buildings did not consider the earthquake resistance fortification. But the

construction's earthquake resistance ability is yet low till present.

●The cycle of macroseism repeats to be long, the normal is several hundred years, some ones are over a thousand years. That is the reason why the people easy to fade from the memory.

●The duty of resists earthquakes to be heaviest in China. These characteristics, we should take seriously!

Statistics indicates that in recent years, the new built housing are all over the China every year 300,000,000 m^2 , new built house are more than 400,000,000 m^2. So far, the completed 10 above the high-rise constructions is more than 100,000,000 m^2 in China. more than 10,000 buildings surpassed 100m height. The height surpasses 100m of the steel structure or steel - concretes the structure are more than 50. Surpasses 200 m to have more than 30. The highest is the International Round the World Financial Center, which is 101, 492m. China has more than 12,000 engineering designs enterprise, more than 60,000 construction enterprises, total more than 15,000 hundred million Yuan resilience every year. With the huge construction scale and market, China is the leader of the world.

China is still a developing country, the economy is in developing too.

With the most population in the world, the earthquake damage is the most serious one. And the construction scale is the biggest, the earthquake resistance fortified town are most. The earthquake resistance fortification duty is the heaviest. The economy is not the developed yet. Solving the project seismic design, the meaning is significant. The social efficiency and the economic efficiency are remarkable at the same time.

Professor Hu Yuxian pointed out that the earthquake engineering is a serious defect. The seismography and the structure resist earthquakes lack the relation with each other. Two aspects cannot coordinate the earthquake engineering mutually , in China the flaw existing in this aspect, is more serious.

The seismic design standard and the project work have many problems. the project seismic design is the absorption of shock disaster prevention essential measure. This article discusses in the project seismic design the project earthquake resistance fortification criterion, the project seismic design security, the project ground seismic design, the engineering structure earthquake resistance analysis, the software application, the project seismic design standard and the project work management and several other key questions. In order to help humanist, scientific progress, builds harmonious social and the quakeproof disaster reduction strategy implementation。

2 THE STANDARD OF ENGINEERING EARTHQUAKE FORTIFICATION

2.1 National Related Standard Inconsistent Question.

According to the national quakeproof disaster reduction's method request, the State Bureau of Seismology Department has established Seismic ground motion parameter regionalization map of China GB18306-2001, Code for seismic safety evaluation of engineering sites GB 17741-2005 and "Seismic intensity table of China (1999)" GB/T 17742-1999, and so on. These national earthquake standard have solved basic problem of the project seismic design.

What needs to point out is that the Chinese seismic motion parameter regionalization map GB 18306-2001 establishment, is an breakthrough of the Chinese earthquake intensity regionalization map. But it should be realized that Chinese seismic zoning work has not been able to meet the need of quakeproof disaster reduction work. First, seismic zoning accurate urgently needed enhancement. Before the Tangshan 7.8 magnitude of earthquakes, the intensity regionalization is 6 degrees, but in 1976 Tangshan had 7.8 magnitude of earthquakes. The epicentral intensity is 11 degrees; Sichuan Wenchuan earthquake's main seismic region original regionalization Deyang Mianyang is 6 degrees areas, Wenchuan, Beichuan, the Jiangyou, Shifang is assorted 7 degrees areas, Mow County, Pingwu is 7.5 degrees. This earthquake, Wenchuan is 11 degrees, other main

seismic regions are 11 to 8 degrees and 0.2 are macroseism observation work strengthen urgently needed, our country's strong-motion seismograph only has 500, but US, countries and so on Japan have 3000 respectively, Taiwan also has 700.

The national quakeproof disaster reduction law pointed out explicitly that the State Council Department concerned, according to the responsibility division of labor, has its own responsibility, coordinates closely, completes the quakeproof disaster reduction work together. The project seismic design standard with the above national earthquake standard comparison, the related national standards has many inconsistent problems.

a) For seismic design of buildings GB 50011-2001 and GB/T 17742-1999 and in literature (Hao Min) the peak value acceleration difference are big. See table 2.1.

Table 2.1 Peak value acceleration (g) EPA

Literature	Earthquake intensity			
	6	7	8	9
1-GB50011-2001	0.05	0.1	0.2	0.4
2—GB/T 17742-1999	0.063(0.045~0.089)	0.125(0.09~0.177)	0.25 (0.178~0.353)	0.5(0.353~0.707)
3--Literature(Hao Min)		0.15~0.35	.35~0.45	0.45~0.6
2/1	1.25	1.25	1.25	1.25
3/1		1.5~3.5	1.75~2.25	1.125~1.5

As seen in table 1, EPA is 1.25 times smaller according to the GB 50011-2001 compared to GB/T 17742-1999, EPA is unsafe in favor of according to GB50011-2001. EPA is 1.5 times ~3.5 times smaller than that according to GB 50011-2001 compared to literature 6 ,7, 8 degrees, EPA according to GB50011-2001 is unsafe.

b） Chinese seismic motion parameter regionalization map GB 18306-2001 points out that this standard uses the seismic motion parameter directly (seismic motion peak value acceleration and seismic motion response spectrum characteristic cycle), but did not use the earthquake basic intensity. In present, related technical standard involves the earthquake basic intensity concept, should be revised gradually. In the technical standard and so on not yet revises (before partial revision), may refer to the following method to determine:

1) The seismic design checking calculation uses the seismic motion parameter which provide directly this standard;

2) When involve the ground treatment, the structure measure or the quakeproof disaster reduction measure, the earthquake basic intensity value may examine and obtain the seismic motion peak value acceleration by this standard and determine according to table D1, may also according to need to make a more careful division.

Seismic motion peak value acceleration district (g)	<0.05	0.05	0.1	0.15	0.2	0.3	≥0.4
earthquake basic intensity value	<Ⅵ	Ⅵ	Ⅶ	Ⅶ	Ⅷ	Ⅷ	≥ Ⅸ

GB 50011-2001 gives the main cities earthquake resistance fortification intensity in China, the basic earthquake acceleration and the earthquake in appendix A groups. According to this achievement each cities project seismic design computation key data is easy to get. The standard shows that with the Chinese seismic motion parameter regionalization map, α_{max} in Table 5.1.4 except continues to use design basic earthquake acceleration beyond consideration which 1989 standard 6, 7, 8, 9 degrees institutes correspond. Between 7~8, 8~9 degree increases a grade respectively, with the parentheses in digital presentation. Corresponds in the design basic earthquake acceleration is 0.15g and 0.3g, which is very obvious. 0.15g and 0.3g are equal to 7.5 degree and 8.5 degree, are still in favor of according to 7 degree and 8 degree design. Which is unsafe. GB 50011- 2001 does not conform

to Chinese seismic motion parameter regionalization map GB18306-2001, the seismic design checking calculation use the seismic motion parameter stipulation which this standard provides directly.

c) GB50011-2001 and GB 18306-2001, in the seismic motion response spectrum characteristic cycle's table. The main terminology are different. First calls the design earthquake grouping and the location category, the latter name characteristic cycle district and location division type (hard, hard, medium-soft, weak). It divides in the GB50011-2001 category by the soil type and layer thickness of location overburden. In two important concept of national standard is not identically. No wonder in some seismic design literature, confused in the location type and the location category. Design code for ant-seismic of special structures GB 50191-93 classification of middle place is according to the location division index, but the characteristic cycle is according to the location computation index. These are not as same as the above two standards. The division of the location category according to the location index is a useful method in reference.

d) GB 50011-2001 also explained the established of the earthquake resistance fortification regionalization in the cites. It should allow seismic motion parameter and using the corresponding earthquake influence coefficient. The Ministry of Construction on December 27, 1995, issued the anti-{1995}22 article notice, issued that the earthquake resistance fortification regionalization establishment work temporary provisions (implementation) . Stipulation to point out that the earthquake resistance fortification regionalization work determination earthquake function intensity's distribution. What is the earthquake function intensity distribution? How to distinguish the seismic motion parameter? Obviously in GB 18306-2001 and GB 17741-2005, both do not conform to the national quakeproof disaster reduction law.

e) The Ministry of Construction issued "Construction project Protection Earthquake disaster Administrative provisions" in November 1994. Set the earthquake resistance disaster prevention plan request, and pointed out that earthquake resistance safety evaluation of the engineering construction location at the same time. The earthquake resistance fortification standard, the defended intensity should construct the administration department responsible for the work concerned requirements execution according to the State Council. These stipulations also in national earthquake standard symbol.

In recent years, the urban earthquake resistance disaster prevention plan standard had also issued. The earthquake resist in cities carries the plan to have abide by regulations. But in fact, from Tangshan earthquake, the earthquake resistance fortification regionalization, the earthquake resistance disaster prevention plan, the protection earthquake disaster administrative provisions, the quakeproof disaster reduction rule which the earthquake authority department issued, related laws and regulations literature, the edition many, are mutually redundant in the near 30 years. At this point, Beijing resists the disaster of earthquakes prevention plan the initial work, completes just now. Also in some cites', earthquake resistance disaster prevention plan, is entrusted the earthquake authority department by the construction department to complete, but the related department does not have the authorization. So some advices were put aside without conservation in the recent 20 years.

f) The Code for investigation of geotechnical engineering GB 50021-2001 has the meizoseismal area location. The ground and the activity breaks both, including earthquake risk analysis and seismic motion parameter requests and determination, with national standards GB 18306-2001 and GB17741-2005 inconsistent. It is think that these stipulations of GB 50021-2001 do not conform to the national quakeproof disaster reduction law.

2.2 Seismic Design Method Based on Performance Project

The experts and scholars pointed out that the seismic design may according to “three standard earthquakes, three stage designs”. The way is able to guarantee the engineering structure earthquake resistance performance . Its goal is analyzes the anti-seismic structure when meet three standard earthquakes. Both should examine in slightly shakes, shakes may repair in the big quake, and the structure must to control appear essential consumes energy the mechanism. The guarantee anti-seismic structure ductility performance.

Literature (Han Xiaolei)pointed out that the US - and "San Francisco Performance High Gauge 2007" based on the performance high-rise construction structural design standard, tallies based on the structure performance seismic design method, causes the structure seismic design the macroscopic qualitative goal to the concrete quantification multiple goal transition. In recent years, the domestic experts to gave the very high expectation and the intense appeal based on the performance project seismic design theory and the method.

The General rule for performance-based seismic design of buildings (test) CECS160:2004 is the brand-new project seismic design way, the project seismography and the project earthquake resistance study union closely with each other. Domestic and abroad way based on the performance project seismic design theory and the Chinese project seismic design practice organic synthesis product. It basic idea is, the comprehensive basis and the usage, the research seismic motion regionalization's achievement, the earthquake resistance project according to its use function, establishes the lowest condition goal. According to its importance, the use function and the seismic motion standard divided into different seismic design classification, according to the three standard earthquakes, the second-level design's method, achieves “slightly shakes does not go bad, shakes may repair with the big quake” the defended goal. General rule science , reasonable adjustment and architectural engineering earthquake resistance fortification standard.

3. PROJECT SEISMIC DESIGN SECURE

3.1 Chinese Construction Structural Design Standard is Much Lower Than Oversea

Chen Zhaoyuan published "Must Enhance Construction Structure Large scale Degree of security" in January, 1999. He pointed out that in the sub-item load coefficient and in the sub-item material strength coefficient, there are great difference in China and other countries, see table 3.1.

Table 3.1 Load sub-item coefficient and material strength sub-item coefficient comparison

	China	Foreign country
dead load sub-item safety coefficient	1.2 (new standard changes 1.35)	1.4
live load sub-item safety coefficient	1.4	1.6~1. 7
material design intensity sub-item safety coefficient	1.3	1.15

Reference (Xu Youlin) points out that concrete structure safety margin is not accurate, and the durability is insufficient. It is difficult to satisfy the sustainable development.

3.2 Big Disparity in Earthquake Function Computation Among GB 50011-2001, International Standard ISO3010, Japanese Standard and ASCE7-93

"Code for Earthquake Function " which will be published in recent, GB 50011-2001 and international standard IS03010, the Japanese standard comparison, have great difference in earthquake function computation,.

a) The seismic motion regionalization, ISO3010, the earthquake country coefficient differs in 4 times. The Japanese standard four area changes is smooth. The seismic motion peak value acceleration takes the high value. GB 18306-2001 value is 0.05 to 0.4, 0.05 to 0.1 the scope is big, and the value is small.

b) Important coefficient, ISO3010, 5 times differs in size, enlarging in scale. GB 50011-2001 only increases the earthquake function in the very minority Class A construction. To the overwhelming majority construction, the earthquake function does not have the difference. The suggestion to the important constructions, the earthquake cannot interrupt uses the construction, increases the earthquake function suitably. '

c) The structure coefficient and the power coefficient are big and scale is large in ISO3010 and the Japanese standard. The value in GB 50011-2001 is small.

d) The characteristic cycle, IS03010, the size differs 4 times. The Japanese standard change is small, the value is big, the GB18306-2001 value is from 0.25 to 0.9, differs in 3.6 times.
e) The earthquake function distributes highly along the structure, IS03010 and the Japanese standard value is big, scale enlarging, the GB 50011-2001 value is small.
f) The eccentric stiffness coefficient is big in IS03010 and the Japanese standard, the difference size value is big. GB 50011-2001 enters according to the CQC law a line of computation, the corner post enlarges the earthquake endogenic force, should consider when the earthquake structure twist fully.
g) The damping ratio, size value difference is big in IS030lO and the Japanese standard, but GB50011-2001 considers few.
h) Big, small earthquake's difference. IS0301O and the Japanese standard differs 5 times. GB50011-2001 slightly shakes with the basic earthquake differs 2.875 time, slightly shakes the earthquake function to be small, big quake and basic earthquake when 7, 8, 9 degrees differs 2.2 time, 2.0 times with l. 56 times. The big quake earthquake function is also small. CECS160:2004 improves, the earthquake standard by 2~3% changes 5%.
i) Ground movement component consideration. IS0301O considerate less. Supposed the earthquake two orthogonal main axle x, y direction along the architectural plane, horizontal earthquake ashamedly with component getting along together, see (3.2.1) and (3.2.2).

$$E=Ex+\lambda Ey \quad (3.2.1)$$
$$E=\lambda Ex+Ey \quad (3.2.2)$$

Here λ =0.3. According to record of earthquake in Bingku County, Japan January 17, 1995, component of north and south is 818gal, the vertical component is 332gal. Therefore, the vertical earthquake active component needs to considered careful.
The Code for seismic design of railway engineering GBJ 111-87 (requests authorization manuscript) with its new standard to compare, the earthquake function's computation, the new standard (requested authorization manuscript) compared to old standard is 2~5 times bigger. Can the bridge design according to old standard carry on the earthquake resistance appraisal and the reinforcement? How many bridges are still in work?

3.3 Reliability Question of Engineering Structure Earthquake Resistance

In reference 14 the author elaborated existence subject matter structure earthquake resistance reliability, and put forward related proposals.
In "Construction Structure Reliability Design Unified standards" (request authorization manuscript) the main characteristic" , Li Mingshun confirmed that structure reliability design has three subject matters in China. First, related statistical data in 1980s, still could not anew consideration in present; Second, reliability of underground structure, anti-seismic structure, ground structure and structure system, are still weak and even in blank; Third, in the limited condition, serviceable reliability does not yet to solve normally. In "Structural design Standard Reliability Design method Question" , Chen Zhaoyuan et al. pointed out that structural design's degree of security in China is obvious lower than that of overseas in April, 2002. Also pointed out that the flaw and the questions of the structural design standard uses reliability design method. And has carried on the appraisal to the structure reliability theory and the application. Simultaneously put forward the related proposal. It is believed that the above questions are correct, the related suggestion is beneficial.
The Unified standard for reliability design of building structures GB 50068-2001 indication, regarding basic variable's coefficient of variation, the limiting condition equation misalignment degree very higher situation, the reliable target uses the more precise method computation suitably.
The structure earthquake response is a short complex vibration process. Although the structure seismic failure's

understanding is insufficient, the earthquake function and the structure earthquake resisting force has the very big uncertainty, brings the difficulty for the anti-seismic structure reliability's analysis. But the rich seismic zoning achievement can be used, the earthquake damage experience and under fully the low week repeatedly load function the structure or component's experiment statistical data, either uses the improvement a second moment law or links up the earthquake risk analysis and the structure mechanics analysis carries on the anti-seismic structure reliability analysis. Namely fxi(xj/a) obtains Xi distribution first by seismic motion peak acceleration's probability density function fA(a) and the ith kind of destruction state control variable Xi conditional probability distribution function, then by structure earthquake resisting force probability density function fyi(z) q obtains component earthquake resistance reliability, extracts in finally one year in structure earthquake resistance reliability and T year structure earthquake resistance reliability. Obviously, such analysis is very complex, but should complete this work diligently. In order to be clear about the engineering structure system's earthquake resistance reliability.

4. GROUND SEISMIC DESIGN

4.1 Copulate Ground Attached Subsidence of Earthquakes

Calculates the ground distortion with the compression modulus, cannot reflect the actual distortion characteristic of ground soil layer. These bring big erroneous and scissors' type mistake. Based on earth this modellings computation ground distortion, because the earth deformation coordinates obtain are difficult, calculates the ground distortion result also with the actual value existence very big difference, applies with difficulty in the project.

The chord modulus law calculates the ground distortion, has theory basic, and has, several hundred project's examinations for several dozens years. The project practice indicated that the chord modulus law is a reliable method (Men Kai etc.) calculates the ground distortion.

The computation of ground attached subsidence of earthquake is in the conventional load in the ground distortion computation foundation when the foundation has withstood the additional bending moment which the horizontal earthquake function produces ground subsidence. Calculating the attach subsidence in the chord modulus law is one kind of new attempt.

4.2 Seismic Design of Ground Should According to the Supporting Capacity Limiting Condition

GB50011-2001 constructs the ground earthquake resistance supporting capacity checking calculation is according to the normal use limiting condition, the GB 50191-93 in Beijing, Shanghai, Tianjin, Guangzhou and so on, ground foundation standards presses the supporting capacity limiting condition checking calculation ground earthquake resistance supporting capacity.

The Code for design of building foundation GB 50007-2002 to stipulate that ground supporting capacity according to normal use limiting condition checking calculation, this does not conform to structure reliability design unified standards GB 50068-2001 stipulation. It is also unable to make it clear about the ground design the security, also with standard GB 50007-2002 in 1.0.1 explanation control big distortion request not symbol, therefore it is inappropriate.

The structural design standard used by the sub-item coefficient expression ground supporting capacity limiting condition design type is in the 70s total security method of correlates foundation, by “calibration law” basis project actual statistical analysis determination load sub-item coefficient and resisting force sub-item coefficient in China. In the ground design aspect, the Shanghai standard to uses the Hansen formula to calculate the ground supporting capacity to use the resisting force sub-item coefficient and various shearing strength target basis load

test and the settlement observation data analysis research is quite thorough, is concrete, can therefore be clear about the ground design the degree of security and the reliable target. But standard GB 50007-2002 is short in this aspect. is somewhat low according to our country structural design degree of security and the structural design standard uses reliability design method the flaw and the question.

Unifies the ground design the complexity and the importance, we thought when ground design according to supporting capacity limiting condition checking calculation, best according to always the safety coefficient method to carry on, namely the Tianjin standard uses ground supporting capacity limit value dividing always the safety coefficient (generally is 2~3, if cohesive soil is 2, sandy soil is 3, in the Japanese standard, long-term supporting capacity is 3 short-term supporting capacities is 2), causes the structural design personnel easy to understand and to grasp the ground design the safety margin.

4.3 Ground According to Distortion Control Design

The design ground of is carries on the checking calculation according to the supporting capacity and the distortion. But the supporting capacity checking calculation materially is also the distortion checking calculation.

The standard stipulated that the ground earthquake resistance supporting capacity should take the supporting capacity characteristic value to be multiplied by the ground earthquake resistance supporting capacity regulation factor (1.5~1.0) computation, obviously this is very rough. The national standards stipulated that the ground foundation design by the ground supporting capacity's computation primarily, uses the isotropic linear deformable body theory regarding the distortion computation. This tallies with the reality regarding the low compressibility earth comparison, but in China, high-rise construction crowded big city like Beijing, Shanghai, Guangzhou earthquake intensity is high, wind load is big (for example cities and so on Haikou, Fuzhou, Xiamen) engineering geology condition are difference – Shanghai is Ⅲ kind of location; Beijing, Tianjin, Fuzhou are the soft soil, the cover soil layer are very thick; Shenzhen, Guangzhou, Haikou are the marine facies alluvium, places such as Xi'an, Lanzhou many to be self-possessed fall wet the loess, the loess area amount to 640,000 square kilometers. Regarding macroseism, under the gale function, the high compressibility foundation soil, will be at the elastoplasticity condition, therefore the anti-seismic structure will be likely same, will downplay the supporting capacity checking calculation, by the elastic-plasticity distortion control ground foundation design theory and the method primarily will be ground engineering development .

The engineering and the academic circle generally believe that the ground distortion design's method should replace the ground supporting capacity checking calculation gradually. Draws the project ground accident's lesson, prevents the ground differential settlement and the ground big distortion to the structure adverse effect. But distorts the core question of the mainly design is the correct computation ground amount of deformity and the attached the subsidence of the ground earthquake.

4.4 Project Ground Seismic Design Degree of Security

About the ground design's degree of security question, Lu Zhaojun pointed out that the earthwork reliable theory's research and the application, possibly are the blank or weak link. The project ground seismic design's degree of security is one urgently awaits to study the solution the important topic.

4.5 Superstructures, Basement Foundation and Ground Combined Action

Affects the ground foundation computation the factor to have many, is very complex, it involves to the nature of the soil parameter and so on basic computation parameter use, as a result of the standard unceasing consummation, computational method's difference, structural engineer the level irregularity, causes the ground foundation the design quality to come under the very tremendous influence. Superstructure's earthquake

responded that the analysis supposes the superstructure to inlay generally through the basement foundation solidifies in the foundation soil bracket structure, does not consider the superstructure, the basement, the foundation and the ground interaction. GBJ 50011-2001 stipulated that to certain structures, if includes the ground and the structure power interaction influence, may give to the rigid ground hypothesis computation's horizontal earthquake shearing force to discount, this only when to resists earthquakes the advantageous situation, but in the soft soil ground, falls wet the loess foundation, liquefied earth ground in and so on high compressibility ground, consideration superstructure basement, foundation and ground power interaction, also possibly to the superstructure, foundation and ground existence adverse effect. Obviously when macroseism, building's ground will distort will enlarge, will create the foundation failure, the building falls.

The general rule has the specific stipulation in the earth - structure interaction aspect. The earth and the structure power interaction analysis, has analyzed some projects in Haikou with ADINA, as the consideration superstructure, the basement, the pile raft foundation and the ground combined action. And analyzed some high-rise construction soil - structure interaction. Tiananmen west station of Beijing subway analyzed by ANSYS to the revival gate station sector tunnel, suitable Wan Xianmou three station tunnels and so on.

5. ENGINEERING STRUCTURE EARTHQUAKE RESISTANCE ANALYSIS AND SOFTWARE APPLICATION

The engineering design is the soul of the engineering construction. The basis standard design, the design needs the structure analysis software, the structure analysis software's development basis related standard, computation mechanics and the computer technology. The GB 50011-2001 stipulations, the structure earthquake resistance anatomic model should conform to the structure practical condition.

5.1 Engineering Structure Elastic-plasticity Time Interval Analysis

The GB 50011-2001 emphasis anti-seismic structure nonlinear analysis's difficulty is big, thus limits the nonlinear analysis the structure scope. It is think that it is insufficiently appropriate because the nonlinear analysis does not carry on. The anti-seismic structures, is control the big quake in difficulty but not actually.

The structure earthquake responded the elastic-plasticity time interval analysis, stipulated according to standard GB50011-2001, should, the suitable checking calculation elastic-plasticity distort the structural engineering, possibly reaches more than 100 items. If according to Japan to the high-rise structure seismic design's request, is bigger than 60 meters buildings to highly carry on the elastic-plasticity analysis. Then China needs to carry on the elastic-plasticity analysis the project possibly the approximately three, 400 items. These projects should carry on the elastic-plasticity time interval analysis, guarantees “the big quake not but actually”, in the software application aspect, should not say many major difficult. Domestically produced software NTAMS, HBFA, EPDA, and overseas software as software ANSYS, ALGOR, ETABS, SAP2000, MIDAS/Gen, CANNY may be applied .

"Steel bar tong High-rise structure's Elastic-plasticity Analysis" elaborated the high-level RC construction structure elastic-plasticity analysis method. It is analyze the software and the project example, as well as high-level RC construction structure elastic-plasticity analysis importance and feasibility. GB5001-2001 stipulated that anomalous when it has the obvious weak spot possibly causes the earthquake the heavy damage construction structure, should carry on according to the standard concerned requirements meets under the earthquake function rarely the elastic-plasticity distortion analysis. The project practice also indicated that requests to certain structures carry on the elastic-plasticity distortion analysis is necessary, reasonable, and feasible. Following are introduce of several extra-high building application structure analysis software .

●The Shanghai Round the World Financial Center, the Designing department with software ETABS, SATWE carries on the elastic computation. The ultra altitude limit construction examination with ETABS, SAP2000, SATWE, and MIDAS/Gen calculates. It has not seen the elastic-plasticity time interval analysis the material.

●The Shanghai Jinmao Building uses software AEC/SOM which establishes together with SOM and IBM Corporation (with ETABS, SAP90 is extremely similar) . It has not seen the elastic-plasticity time interval analysis of the material.

●The Zhongxing Square in Guangzhou, with the software ETABS-Plus computation. Uses a pole Yuan model and the shear pattern level model, during the plastic level the angle of displacement is 1/210, that is smaller than the standard stipulation limiting value 1/100.

●Dalian International Trade Center, when design in software TAT, SATWE, ETABS, STAAD/CHINA and MIDAS/Gen, carries on the Pushover computation with ANSYS, the ultra altitude limit construction examination with software TAT, SATWE, STAAD/CHINA and MIDAS/Gen calculates.

●Beijing LG Building, the elastic computation uses software and so on software SATWE, SAP84, MIDAS/Gen. The elastic-plasticity computation uses software EPDA. During the elastic-plasticity level the angle of displacement is 1/107 most greatly, is quite consistent with the shake table test result.

●Shanxi Province Information Building, which is 52 floor, height in 189.4 meters, 8 degrees fortifications, Ⅲ A kind of location, set on wet the loess area, is the domestic octave area highest combination tube body RC structure. The elastic computation uses software TAT, STAWE. The elastic-plasticity computation with software CANNY99, carries on the Pushover computation and the elastic-plasticity time interval computation. During the elastic-plasticity level the angle of displacement is 1/116, is bigger than the stipulation limiting value 1/120. Calculated basically the clear structure the elastic-plasticity earthquake resistance performance, the structure has satisfied “the big quake not but actually” request.

●Dalian Open Sea Building, (the Tsinghua University) calculates with software HBFA, between the cushionply the angle of displacement is smaller than 1/600. The consideration reverse, during elastic-plasticity level column's the angle of displacement is most greatly 1/223 . Satisfies the standard the stipulation limiting value.

●The Guangzhou Son of Heaven center building, 46, room crest elevation 161.55m, (the Tsinghua University) carries on the elastic computation with software TUS, (The Tsinghua University) carries on the elastic-plasticity with NTAMS to calculate .

●The Shenzhen Beijing international building, uses NTAMS to carry on the elastic-plasticity time interval analysis. If the consideration reverse influence, during 31 levels the angle of displacement is 1/30,33 angle of displacement is 1/50, the level the angle of displacement is bigger than 1/100 spot to need to strengthen .

It is obvious, including ultra limits the high-rise construction the high-rise construction structure analysis, the elastic analysis with software and so on SATWE, ETABS, SAP84, the Pushover analysis and the elastoplasticity time interval analysis uses software and so on ANSYS, ALGOR, MIDAS, ETABS, EPDA. The software can satisfy the structure elasticity and the elastic-plasticity analysis need.

5.2 Engineering Structure Earthquake Resistance Reliability Analysis

The literature "based on ANSYS Software's Large-scale Multiple structure Reliability Analysis" , north of the good harbour large-scale country stockpiles the grain storage reinforced concrete soil the reinforcement plan is an example, in makes the improvement to a second moment law and two spot auto-adapted method fitting limiting condition surface in the foundation, carries on the re-development to the ANSYS software, carries on the analysis to the RC soil roof panel structure reinforcement plan and granary warehouse wall's reliability. This analysis is multiple structure earthquake resistance reliability analyzes a typical example, is very meaningful to our country engineering structure design's reliability analysis's research. Chinese major construction project can look like this one as the same. Carrying on the earthquake resistance reliability the analysis, is clear about these

major construction project earthquake resistance reliability, its significance will be very significant. The practice indicated that the numerical simulation is the solution multiple structure reliability efficient path.

5.3 Engineering Structure Earthquake Resistance Optimization Analysis

Software as ANSYS has the formidable optimization design function. It has an optimized toolbox. The optimization design may be carried on to each kind of engineering structure. Its basic principle looks like incomplete, (For example material amount used are least) after the determination optimization design's related parameter - objective function. The design variable (structure geometry, material, load and so on related input variable), the state variable (structure stress, distortion and so on) and so on parameters, carry on the optimization design analysis. Optimization design's process in fact is a revision design variable, satisfies the control requirement (supporting capacity request, distortion request and so on), finally achieves the most superior objective function the process. In recent years, software as ANSYS used in project example of civil engineering structure optimized is popular.

6. PROJECT EARTHQUAKE RESISTANCE FORTIFICATION STANDARD AND RECONNAISSANCE MANAGEMENT

The standard management system is often affecting the technological innovation and the project application. In overseas, generally is by the project academic society or the association management engineering reconnaissance design standard, but is authorizes in our country by the construction management department, (for example China Building Science Research Institute) establishes the project reconnaissance design standard primarily by its subordinate's scientific research institution. GB 50011-2001, are mainly establishes by China Building Science Research Institute, Project Earthquake resistance Research institute. Chinese seismic engineering academic society has two; first, the Chinese Construction Academic society resists earthquakes the disaster prevention branch; second, Chinese Earthquake Academic society seismic engineering specialized committee member, accommodates alongside in the construction management department and the earthquake control section respectively. The seismography and the structure resists earthquakes between both lack the relation. Two aspects cannot coordinate mutually.

The architectural engineering earthquake resistance condition design general rule (test) CECS160:2004 is issued by earthquake Control section's scientific research institution engineering mechanics behavior chief editor. If the project earthquake resistance fortification sign counts the standard to organize by China Seismic engineering Federation to establish, possibly will be more advantage to the related technological innovation and the project application. It will not present standard without mutually unified, and will be mutually redundant question. It is suggested that the national Department concerned can coordinate the each related department, finish this job. In order to advance the Chinese quakeproof disaster reduction work smooth.

China has enterprise of design 12,000, but most enterprises are eager in success. The technology level is not high, the quality is hard to make sure. On project management, the regional construction committees sets up an examination office, this office increased the design inspection procedure, also increased the expense.

Originally parts should be designed by the design enterprise takes the legal liability the matter. It has received the administrative intervention. Chinese design enterprise crown by the research institute, besides the individual design research institute, the overwhelming majority design research institute does not pay any attention to research. Structural engineers understand little to the earthquake engineering. Many design institutes do not have national earthquake standards as Chinese seismic motion parameter regionalization map GB18306-2001. Most structural engineers design by the software as PKPM.

7. CONCLUSIONS

a) Related seismic motion parameter's value should unify in Chinese seismic motion parameter regionalization map. Take the General rule for performance-based seismic design of buildings (test) CECS160:2004 as a foundation, learns the Sichuan Wenchuan earthquake's experience, revises the project seismic design standard comprehensively.
b) Chinese structural design standard's safe establishment standard be much lower than that of overseas. Earthquake function computation and international standard existence big disparity. Structure earthquake resistance reliability question urgently needed solution.
c) Project ground earthquake attaches the subsidence the computation, the project ground seismic design, the ground according to the distortion control design, project ground seismic design questions as degree of security waits for further studying the solution.
d). Engineering structure's elastic-plasticity time interval analysis, the earthquake resistance reliability analysis, the earthquake resistance optimization analysis's method and the software application, the condition has, needs widely to promote applies in the engineering structure earthquake resistance analysis.
e) Project earthquake resistance fortification standard and project management advocate marketability, mainly participation by the Academic body, avoids the administrative intervention. In order to help project seismic design standard level and design quality enhancement.

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