

# On Matters Needing Attention in Building Structure Design

Ruiping Huo\*

Hongye Architectural Design Co., Ltd., Guangzhou, Guangdong 510000, China

**ABSTRACT** Although there have been good developments in China's construction industry with increasing building technology and design levels, there are still some issues that require attention and to be solved by designers in constructing structure designs. The stability of building structure and the quality of construction can only be ensured with continual rectifying and solving problems in structural design. In this study, the discussion examines some design problems encountered in actual construction work.

## KEYWORDS

Basic principles  
Structure design  
Common problem

## 1. Introduction

With continuous growth of economy and improvement of people's living standards, cities are developing rapidly and more constructions of new buildings are springing up. A number of factors, such as continuous improvements in building function and novel modeling, have led to complicated engineering designs. High prices and expanded choices have given people higher expectations for appearance, performance, quality and other aspects of housing at the time of purchase.

Building structure design theory is continually developing towards advanced levels, and advanced techniques are constantly being applied and continually strengthening and improving in practice. We should study new materials with high strength, light weight and green environmental protection in order to improve safety and applicability of housing constructions, and to develop house building structure design towards a reliable, practical and cost-effective direction.

## 2. Basic principles of building structure design that need to be followed

### 2.1. Rational structure, clear force

Includes structured flat, reasonable column spacing.

### 2.2. Several seismic defenses

For example, shear walls in the frame structure are appropriately increased to resist horizontal forces.

### 2.3. Integration of rigidity and flexibility

Force tolerance and force resistance, such as the architecture of strong columns and weak beams, can play a force resistance to reduce the extent of damage to buildings when earthquake happens.

Overall, a practical structural system can maintain the balance of the building and keep houses in original static state. Designers should strive to improve their quality and design levels, and strive to design an economical and sensible building structure by reasonably and orderly combining all architectural elements together into an organic whole [1].

## 3. Features of building structure design

### 3.1. Large load

Housing construction has tremendous height and many layers. The live load caused by structure's weight, wall weight, floor and roof as well as vertical load caused by required basic equipment are large, and vertical axial forces has a linearly proportional relationship with the housing height. Internal forces caused by wind load and earthquake are primarily bending moment and shear force: bending moment of structure's bottom is proportional to the square of the structure's height, and lateral displacement at the apex of structure is proportional to the biquadrate of height.

Internal forces, deformations of high-rise building structure, and cost of building project are mainly affected by horizontal force. Internal force caused by vertical load of high-rise building is much larger than that is caused by

Copyright © 2015 Ruiping Huo  
doi: 10.18686/wcj.v4i3.9

Received: August 3, 2015; Accepted: August 27, 2015; Published online: September 19, 2015

This is an open-access article distributed under the terms of the Creative Commons Attribution Unported License (<http://creativecommons.org/licenses/by-nc/4.0/>), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited.

\*Corresponding author: Hongye Architectural Design Co., Ltd., Guangzhou, Guangdong 510000, China. E-mail: [rph1584@sina.com](mailto:rph1584@sina.com)

vertical load of low-rise buildings, and hence horizontal effect (load) becomes the main control load when designing high-rise structures.

### **3.2. Large lateral displacement**

Lateral displacement at the top of high-rise building is much larger than low-rise buildings. Too much lateral displacement will make people uncomfortable and elevators scarcely able to function, affecting people's normal work and life. It can also lead to building cracking or even shedding, and therefore affecting aesthetics, sound insulation and others. Shedding may result in personal accidents, leading to additional deformations, additional internal forces and cracks in the body structure. In serious cases, it can even lead to damage or collapse of building. In actual projects, we should avoid excessive lateral displacement and we should strengthen lateral stiffness [2].

## **4. Common problem in building structure design**

### **4.1. Foundation and infrastructure aspects**

(1) For single-family units or housings with few residents, a construction company can afford to engage a geological survey unit conducting detailed geological survey to provide comprehensive technical information for the engineering design. For multilayered housing construction in a large area, the probe points of prospecting units cannot usually be arranged in strict accordance with relevant technical requirements due to exploration expenses. Many monomer buildings refer to one probe point, so there is a bigger difference between actual geology and exploration report. Foundation and foundation design should be reasonable, safe and applicable, and designs must be based on detailed, real geological survey data.

(2) Commonly, soft foundation is treated by graded sand-stone, yet simply listing fill depth and ultimate foundation bearing capacity requirements is a misapprehension of the strict enforcement in technology. These are only treatment regimens, and there are no detailed excavation edges for specific building such as excavation edges of area with axis changes, evagination or recess, etc., and there are also no specific values for stress diffusion angle of sand-gravel cushion. Therefore, in foundation construction of many projects, the foundation treatment often cannot be conducted effectively. scribbled

(3) In basic design, specific technical parameters for concrete independent foundation, raft foundation, strip foundation, node design and structural design are often unclear; for example, whether anchor length and lap length is seismic or non-seismic, which will be resulting in prevariation phenomenon in specific implementation phase.

(4) In the main structure design of high-rise concrete structure, usually the rank difference between concrete beams and columns is large, and design drawing often does not make a clear technical disclosure on how to process beam-column joints of concrete. Since beam-column

joint itself is a complex force node, it will become the weak point due to design flaws.

### **4.2. Issues of floor plan stiffness**

Some designs adopt calculation programs for floor deformation in absence of basic structural design concepts or structural arrangement and necessary measures, causing structural hazards or too large safety reserve in some parts or components, and other phenomenon in structural design.

### **4.3. Common problems in selection, layout and construction aspects of reinforced concrete load-bearing structural system**

#### **4.3.1. Housing height and aspect ratio exceeds limit of current norms and procedures**

Current rules and norms list applicable maximum housing height and aspect ratio limit, but housing height and aspect ratio of some high-rise building go beyond the prescribed limits and have no reliable design basis, with no effective seismic strengthening measures in the seismic zone and bringing some seismic risk [3].

#### **4.3.2. Unreasonable structural arrangement, irregular shape**

Reasonable arrangement can help structures comply with "rules" as much as possible, which is a very important part in seismic concept design whereby the "rules" include a comprehensive requirement for the building's flat and vertical surface dimensions, layout of lateral force resisting member, mass distribution, carrying capacity distribution and many other factors. Due to many factors causing the irregular structure, especially for complex building size, it is difficult to divide the degree of irregularity and stipulate the scope of limitation by several simplified quantitative indicators.

#### **4.3.3. Reinforcement structure is unreasonable or does not comply with relevant provisions**

When reinforcement ratio of longitudinal reinforcement of column is larger than 3%, the enclosed welding is therefore not built according to specifications for column stirrups. As for frame pillar with small shear span ratio, no full high encryption is made for stirrups according to seismic norm requirements.

### **4.4. Common problems in selection, layout and construction aspects of load-bearing structural system**

#### **4.4.1. Housing height and floors of multistory masonry structure exceed limit**

Seismic specifications set rules for layers and height of multilayer brick housing, including bottom frame brick housing which has been included in the mandatory provisions of construction. Yet, for instance, some designers simply set roof elevation at the height limit of house, ig-

noring the level difference between  $\pm 0.000$  elevation and outdoor ground.

#### **4.4.2. Beams and columns reinforcement does not comply with relevant provisions of seismic design**

An example would be structural column stirrups of multi-story masonry structure without the required encryption. According to requirements of “reinforced concrete construction column of multistory masonry seismic technical regulations”, stirrups should be properly encrypted at the node of structural columns and ring beams, and the spacing should not be greater than 100 mm.

### **4.5. Common problems in board design**

#### **4.5.1. Simple calculation**

Due to lack of knowledge about the stress state of board, for example, simply calculating bidirectional board action by considering it as unidirectional board will not match the calculation assumptions to actual stress state, resulting in too large reinforcement in one direction and insufficient reinforcement in the other direction, therefore causing cracks.

#### **4.5.2. Calculation of bending moment when bearing line load**

In civil construction, some non-load-bearing walls are often arranged during the floor design. Therefore, in floor design, calculations for floor reinforcement are usually performed after the line load is converted into an equivalent uniform load. For convenience, some designers mistakenly attach total load of wall to total area of the plate, which will result in insufficient reinforcement volume within the non-load-bearing wall distribution width, while reinforcement in other portions of the plate is too large, that floor cracks will appear at the partition [4].

#### **4.5.3. Effective height value of bidirectional board is too large**

Bidirectional board produces bending moment in both di-

rections, and thereby the positive moment of span central reinforcements of bidirectional board is placed through vertical and horizontal stacking. The span central reinforcement of short span direction should be placed below, and the span central reinforcement of long-span direction should be placed above, with effective height of each direction used when calculating. Generally, the effective height of long direction is  $d$  smaller than that of short direction (where  $d$  is the diameter of reinforcement of short direction).

### **5. Conclusion**

In short, building structure design is a systematic and comprehensive work which needs not only a solid theoretical knowledge foundation but also a flexible and innovative thinking as well as a serious and responsible attitude. A thousand miles begins with one step, and therefore designers should calculate each basic component with knowledge of what the components are, as well as how and why they function, and designers should have a deep understanding of the meaning and requirements of norms and procedures, and work closely with other professionals' requirements for design. They should also take part in all kinds of work, studying them often, and timely sum up the experience and lessons learned in order to promote continuous improvement of the quality of construction.

### **Reference**

1. Huang, Z. X. (2007). On the matters needing attention in building structure design. *Heilongjiang Science and Technology Information*, 14, 68–70.
2. Li, G. S. (2007). Discussion on problem of building structure design. *Science and Technology Information (Science and Research)*, 34, 26–27.
3. Chen, X. S. (2010). On matters needing attention in mine construction engineering structure design. *Science and Technology Information*, 15, 85–89.
4. Wei, R. (2011). The basic principles of building structure design and reasonable design plan. *Private Technology*, 5, 116.