

# “3 Degrees and 8 Combinations” Teaching Mode of Anti-Seismic Design of Building Structures

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**Abstract:** Earthquakes pose a significant threat to people’s property and personal safety. Improving the teaching of civil engineering and building structure anti-seismic design courses can enable students to do a good job in anti-seismic design in the future and effectively reduce the damage on buildings caused by earthquakes. In this paper, we analyzed the basic characteristics of a course in civil engineering major, which is Anti-Seismic Design of Building Structures, and the shortcomings of traditional teaching. It is proposed that the 3-degrees and 8-combinations teaching mode of anti-seismic design of building structures can effectively improve students’ autonomy and enthusiasm in learning, helps to cultivate professional ethics among students, and improve their ability to apply what they have learned.

**Keywords:** Anti-Seismic Design of Building Structures; 3-Degrees and 8-Combinations; Anti-seismic structure

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## 1. Introduction

China is a country with frequent earthquakes, and earthquakes have caused immeasurable loss of lives and property. Compared to other natural disasters such as floods, droughts, typhoons, earthquakes are more destructive and instantaneous. The powerful energy burst from the source will destroy buildings in a very short time<sup>[1]</sup>, causing severe casualties and property losses, often accompanied by secondary disasters, such as fires, plagues, landslides, and many more. Many studies have shown that scientific and professional anti-seismic design of building structures can effectively prevent and reduce the damage caused by earthquakes. Anti-Seismic Design of Building Structures is one of the professional courses in the civil engineering major, and it is a highly practical course with relatively professional and complex content, which plays an important role in cultivating technical professionals.

## 2. Research background

A city is the center of a country’s economy, society, and culture. With the continuous development of our country’s economy, the level of urbanization is also increasing, forming a large-scale urban agglomeration. The economic connection between central cities and the surrounding cities is close, bringing large economic benefits and significantly promoting economic development. However, some urban agglomerations are located in earthquake-prone areas. Once an earthquake occurs, it will bring huge economic losses and threaten the safety of residents<sup>[2]</sup>. Earthquakes will cause more severe consequences in urban agglomerations with dense population and engineering facilities compared to rural areas. Once a large number of dense buildings collapse, it will not only cause serious casualties, but also cause damage to urban infrastructure and communication systems. Irreparable losses make it difficult to maintain the livelihood of

residents <sup>[3]</sup>. Studies have shown that professional anti-seismic design of building structures can effectively prevent earthquake disasters and minimize the risk of collapse and casualties in the event of an earthquake <sup>[4]</sup>. Anti-Seismic Design of Building Structures is an important subject-oriented professional course in the degree of civil engineering, which is highly theoretical and practical. In this course, students will be trained in terms of calculations and the basic principles and methods of anti-seismic design of building structures, which are very important for professional anti-seismic design.

Anti-Seismic Design of Building Structures focuses on seismic design and methods, which involves earthquake engineering knowledge and structural mechanics, and this requires students to have good learning and practical abilities. However, the traditional teaching mode is relatively rigid and unable to achieve the course objectives and social needs. Scholars should not put their lifelong learning into the course of building anti-seismic design. Instead, they should adopt modern teaching methods and actively modify them to make the knowledge easier to understand.

### **3. Basic features of Anti-Seismic Design of Building Structures**

#### **3.1. Wide course content and less class hours**

Anti-Seismic Design of Building Structures is a professional course for civil engineering students in their junior and senior years, and usually starts in the last eight weeks of the semester. As the class hours for this course are short, students do not have enough time to master the relevant knowledge. In addition, as a basic course, students are required to master the previous professional courses: Mechanics of Materials, Structural Mechanics, and Theoretical Mechanics, and many more. Students are also required to have strong mathematical ability and a wide range of knowledge. Therefore, students usually take a long time to understand the content of this course, and eight weeks of class time is far from enough. How to arrange the content reasonably within the short time schedule is a primary problem.

#### **3.2. Difficult basic principles and insufficient practical lessons**

Anti-Seismic Design of Building Structures is a comprehensive subject, which requires a good understanding of basic mechanics and related design principles. However, the basic concepts in the textbooks are difficult, deep, and require excellent logical thinking skills, which make it hard for students to thoroughly understand them from simple and mechanical teaching. However, in the setting of traditional teaching, there are few requirements for the practical part, and the lack of proper curriculum design and practical activities make it difficult for students to truly understand the relevant principles and even more difficult to apply them to their own anti-seismic design. Therefore, it is crucial to design the content of the course properly so that students can strengthen their understanding and application of basic knowledge.

#### **3.3. Many difficult formulas which make the course content dull**

As one of the professional courses of civil engineering majors, the anti-seismic design course requires strong computing and comprehension skills. There are a lot of formulas in the teaching materials, and the formulas are complicated and difficult to understand, making the course content relatively dull. Therefore, it is difficult for students to be interested in the course content and to apply their knowledge flexibly. Hence, it is important to link boring and monotonous formulas in the textbooks together and make them easier for students to understand.

#### **3.4. Comprehensive curriculum design content**

As far as the current teaching setting of Anti-Seismic Design of Building Structures and related courses is concerned, students need to integrate relevant knowledge from other courses flexibly. For example, in terms of “analysis of anti-seismic response spectrum theory,” students should not simply analyze dynamic

problems, but should also apply a single-degree-of-freedom system, which involves problems with different preeminence periods and damping ratios, which require comprehensive abilities <sup>[5]</sup>. Therefore, it is important to cultivate students' comprehensive abilities and system analysis ability for them to form clear design ideas and skillfully use various theories after they engage in related industries.

#### **4. Problems in the Anti-Seismic Design of Building Structures course**

##### **4.1. Unreasonable content arrangement**

Since the anti-seismic design course has more teaching content but less class hours, it is necessary design the course structure in a way that emphasizes more on the key parts and less on the less important parts <sup>[6]</sup>. However, in reality, some teachers do not rationally arrange the teaching content according to importance, and seldom consider the rationality of the teaching content. Teachers often arrange the course content based on difficulty levels, which is not ideal, and the important parts are not emphasized. As a result, students have a poor understanding of those parts and is unable to use them flexibly.

##### **4.2. Improper handling of formulas**

There are many theories involved in Anti-Seismic Design of Building Structures, and students need to have a thorough understanding of the derivation process of the formula and the basic principles. Only when they are familiar with the derivation process of the formula can they apply them in the analysis of specific problems. Therefore, some teachers only focus on explaining the derivation of the formula, which makes it difficult for some students with poor theoretical knowledge to keep up with the lessons and lose their enthusiasm in learning.

##### **4.3. Disconnection between teaching and norms**

In the design of an anti-seismic building, the designer must strictly abide by the relevant national standards and safety specifications, so as to ensure the use function, safety, and reliability of the building. Some teachers are not clear about the relevant norms, so they rarely include relevant legal norms in teaching. Consequently, students do not have a clear understanding of the importance of laws and regulations.

##### **4.4. Lack of practice**

The anti-seismic course is very practical. Assignments related to earthquake analysis can be given to students, so that they can learn how to collect data, analyze cases, and come up with designs to improve the anti-seismic performance of buildings. However, some teachers pay more attention to the teaching of theoretical knowledge and neglect the practical parts. As a result, students only learn mechanically and are not able to apply their knowledge.

#### **5. “3 degrees” of anti-seismic course teaching**

##### **5.1. Increasing learning enthusiasm**

Stimulating enthusiasm and interest in learning among students is the key to the success of teaching. Teachers can show real-life pictures and earthquake relief videos to grab students' attention in class. Playing videos of the buildings collapsing due to earthquakes in the classroom will have a strong impact on the students' senses. Teachers can then analyze the causes of structural damage from the angle of collapse and other related content based on the video, and then explain how to improve the anti-seismic and strength of the building, so as to improve students' interest in learning and sense of mission <sup>[7]</sup>.

##### **5.2. Reducing the difficulty of theory-based content**

Nowadays, an anti-seismic design can be completed using software, which is difficult to learn. To reduce

the difficulty of learning, teachers should arrange the teaching content in different levels according to the students' learning ability and theoretical knowledge. For students who want to continue their studies or are interested in venturing into architectural design, teachers can appropriately increase the depth of the content; for students with many courses and poor theoretical foundations, simpler language should be used for teaching without including in-depth formula derivation and other complex content.

### **5.3. Reducing the scope of syllabus**

In order to improve the systematization and completeness of the content, the explanation of specific cases generally incorporates many anti-seismic topics, and the scope is relatively large. It involves topics related to reinforced concrete structures and other courses, making the scope of content relatively broad, which make it difficult for students to accurately grasp each topic and apply them flexibly. Therefore, teachers should focus on explaining one or two sections, and teach them in a targeted manner, so that students can better grasp the content more easily and proceed to other sections of the course smoothly.

## **6. “8 combinations” of anti-seismic course teaching**

### **6.1. Combining professional education with ideological and political education**

Education is not only about gaining knowledge and abilities, but also about learning ideologies and politics, and improving sense of morality and responsibility <sup>[8]</sup>. The architectural design industry is related to the safety and happiness of the people, and civil engineering is the core of the industry. Therefore, when establishing the curriculum content for universities, it is necessary to pay attention to basic knowledge while integrating ideological and political education to cultivate professionalism and morality among students. For example, we should intersperse some education on socialist core values into the lessons of other courses to guide a correct path of life for students.

### **6.2. Combining the teaching content with other courses**

Anti-Seismic Design of Building Structures is different from social science majors in that it is closely connected to other courses, requires the application of knowledge from other courses, and requires students to think from multiple aspects, in order create a better anti-seismic design. Therefore, teachers should connect the theories of this course with other related courses in a lesson. When analyzing specific cases, let students review relevant knowledge points, clarify the differences and connections between courses, promote students to master relevant knowledge, and broaden the depth and breadth of learning.

### **6.3. Combining of online and offline teaching**

The content of Anti-Seismic Design of Building Structures is relatively complex and extensive, with limited hours of study, great emphasis on theoretical derivation, making it difficult for students to learn. Therefore, a combination of online and offline methods can be used in teaching to improve students' enthusiasm for learning and while improving the work efficiency of teachers <sup>[9]</sup>. With the help of a shared platform, teachers can upload content related to teaching background and theoretical derivation to provide students with more learning alternatives. Students can focus on learning what they do not understand. Besides, teachers can also focus on explaining difficult points and answer their students' questions in a timely manner to improve their learning efficiency.

### **6.4. Combining traditional teaching with project teaching**

With the continuous deepening of teaching, the cultivation of practical skills and autonomy has been increasingly highlighted. Project teaching can be used for complicated content where traditional teaching is limited, whereas theories and difficult content can be taught through traditional lectures. For other multi-

level and multi-dimensional topics that emphasize practical skills and relatively easy content, students can complete projects in groups, which can improve students' autonomy. Through the guidance of teachers, the students' analytical skills and critical thinking skills can be improved <sup>[10]</sup>.

### **6.5. Combination of theory and practice**

Anti-Seismic Design of Building Structures is a highly professional and comprehensive course that focuses on practical skills. It is difficult for students to understand design ideas purely from theoretical analysis. Therefore, appropriate adjustments can be made during the lessons, focusing on the combination of theory and practical skills. For example, teachers can let students collect data and analyze cases, and then give targeted explanations. In this way, they can better understand design ideas, and when they encounter similar types of design in the future, they can deal with those designs confidently <sup>[11]</sup>.

### **6.6. Combination of curriculum and norms**

Anti-seismic courses are closely related to municipal engineering, and the quality of design is related to the personal safety of residents. Therefore, strict industry regulations are required. Teachers should emphasize the importance of relevant norms in their lessons, and they can link those norms to the course content, so that students can strengthen their understanding of the course content and grasp the key points and relevant laws and regulations of anti-seismic design and use appropriate design methods.

### **6.7. Combination of anti-seismic calculation and structural measures**

The anti-seismic design in our country mainly focuses the integration of three aspects: conceptual design, anti-seismic calculation, and structural measures. Only carrying out anti-seismic calculations but ignoring concepts and structural measures is far from ideal. Earthquake calculations require data measurement and the use of highly complex and difficult formulas. After mastering the calculation methods, students can have a deeper understanding of knowledge and use it flexibly. Structural measures can ensure the integrity of the structure and strengthen the strength of the building. During teaching, specific pictures can be used to allow students to understand the structural measures more intuitively.

### **6.8. Combining anti-seismic theory with earthquake prevention and disaster reduction**

Anti-seismic theories are formed through the experiences and lessons learned after earthquakes. After an earthquake analysis, the theories are applied to the anti-seismic design, which can in turn minimize the impact caused by the same type of earthquake. The combination of anti-seismic theory and earthquake disaster reduction can enable students to have a deeper understanding of earthquake theories, analyze problems dialectically, and form a complete knowledge system.

## **7. Conclusion**

In-depth analysis of the basic characteristics of Anti-Seismic Design of Building Structure, summarizing the existing problems in teaching, and proposing the teaching mode of "3 degrees and 8 combinations," with the purpose of improving the independent thinking and practical skills of students. Besides, this teaching mode also aims to enable students to apply anti-seismic theories flexibly and improve their interest and enthusiasm in learning.

### **Disclosure statement**

The author declares no conflict of interest.

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