Analysis of Measures to Strengthen the Safety of Civil Engineering Structure Design

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Abstract—This article analyzes the relevant content of the safety design of civil engineering structures. This paper studies the common problems in the safety design of civil engineering structures, including design methods to be optimized, relatively low training efforts, relatively poor innovation capabilities, more construction safety hazards, unreasonable internal force combination design, and low safety supervision. The author studied how to optimize structural design methods, how to strengthen personnel training, how to deal with system innovation, how to strictly control building conditions, how to optimize the design of internal forces, and how to strengthen safety supervision. The purpose of this article is to improve the level of civil engineering structural design and improve the construction quality of construction projects.

1. INTRODUCTION
In the process of continuous optimization of the construction technology system, the scale of civil engineering operations is also expanding. At the same time, the potential safety hazards of civil engineering during the construction period have become increasingly prominent, which has brought serious economic losses to the construction unit. Based on this, in the structural design of early civil engineering, we need to do a good job of sorting out the basic data, and complete the safety design on this basis. This not only helps to improve the rationality of the structural design content, but also lays the foundation for the orderly development of subsequent construction activities.

2. ANALYSIS OF RELEVANT CONTENT OF CIVIL ENGINEERING STRUCTURE SAFETY DESIGN

2.1. Structure and Function Design
In the analysis process of the additional effect of structure, its content includes the following points. (1) The structural design adopts the limit state design method. The structure and its components must have proper safety and proper reliability within its design service life. It should meet the basic functional requirements of the following three aspects. ①Satisfy the suitability requirements for normal use under general action or environmental action. ②It has sufficient bearing capacity under the general action and accidental action that may occur, and can resist the serious damage such as collapse. (2) Ensure structural safety. To ensure the safety of the structure, the following points must be achieved. ①Under the general action that may occur and the accidental action of the regulations, each member of the structure (such as beams, plates, columns and their connections) has sufficient strength and stability. That is, the safety of the component in the bearing capacity. ②The structure must have overall firmness. Regardless of natural and man-made disasters, the structure should not have serious damage
that is disproportionate to it. ③ Under the influence of environment, the deterioration of structural material performance should be controlled to an acceptable level.

2.2. Analysis of Component Bearing Capacity
In the analysis of this content, the following points are mainly included. First, in the structural design code, the general calculation formula for the ultimate state design of bearing capacity is: $S (\gamma R G, \gamma Q, \ldots) \leq R (f_{yk}/\gamma y, f_{ck}/\gamma c, \ldots)$. Regardless of the standard value of material strength in the limit state design method of reliability or safety factor, the material strength with 95% guarantee rate is generally used as the standard value at present. Second, the sub-factor and safety factor. Under general loads, the material strength sub-factors specified in the Chinese code when calculating the bearing capacity are about 10-15% lower than the corresponding safety factors in the United Kingdom and the United States. It can be found from Table 1 that the safety setting level of the component bearing capacity of the Chinese structural design code is the lowest in the world.

| Project | Live Load Sub-factor | Permanent Load Sub-factor |
|---------|----------------------|---------------------------|
| China   | 1.4                  | 1.2                       |
| Britain | 1.6                  | 1.4                       |
| America | 1.7                  | 1.4                       |

In the determination of the accidental load effect, the Chinese regulations classify the effect as an accidental event, and the structure still needs to maintain the corresponding load for stability. Moreover, the incidents mentioned mainly refer to earthquakes and fire accidents. However, there is no clear specification requirement for sudden explosion incidents, impact problems, serious man-made accidents, etc. This also improves the one-sidedness of the analysis content to a certain extent.

2.3. Environmental Impact Analysis
Except to the above-mentioned related content, it is also necessary to pay attention to the reflection of environmental effects when analyzing the structural safety design. At present, the strength requirements for building structures formulated by China are mainly for the load state that the structure exhibits after being subjected to various loads. However, in the entire process, insufficient attention has been paid to the effects of environmental effects, such as changes in temperature between day and night, freezing and thawing conditions, regional water system interference, and chemical media corrosion. These environmental effects will also interfere with the stability of the civil engineering structure, which is also the content that needs to be paid attention to in the follow-up research process.

3. COMMON PROBLEMS IN THE SAFETY DESIGN OF CIVIL ENGINEERING STRUCTURES

3.1. The Design Method Needs to Be Optimized
In the structural safety design, the important problem is the low degree of optimization of the design method, which is embodied in the following aspects. First, the two-dimensional level is still inclined in structural design, that is, the use of hand-drawn drawings for structural design. Designers not only need to have good spatial thinking when reading such drawings, but also need to take into account the interrelationships between structures. If there is a fault in a certain content, it will also affect the rationality of the overall design content. Second, the conflict issue has not been dealt with in a timely manner. Civil engineering contains many application structures, which are closely related to each other. This also requires the designer to reasonably design the structure size, material, location, etc., and also need to consider the conflict with other structures to reduce the probability of safety problems. But judging from the actual application situation, many conflicts cannot be dealt with in time in the early stage, and they are only discovered during construction. This not only increases the expenditure of rework costs, but also brings greater security threats.
3.2. The Training Intensity is Relatively Low
The safe conduct of civil engineering construction activities is directly related to the employees' awareness of safe operation. According to reliable statistics, more than 70% of safety accidents are directly or indirectly caused by humans. Therefore, it is very important to do a good job in employee safety awareness training, which is directly related to the safety of the operating environment. But judging from the actual application situation, it has the following problems. (1) The training frequency is relatively low. In most cases, there is no clear time for the training arrangement, and several trainings are carried out symbolically. In most cases, the designer still relies on the designer to develop good habits, which also reduces the average overall level of the designer. (2) The training content is less targeted. Most of the training courses drawn up by the unit are directly copied from other companies, without taking into account the actual situation of the company’s employees. This can't help the improvement of the staff's comprehensive ability, and limits the speed of the improvement of the staff's ability.

3.3. Innovative Ability is Relatively Poor
According to statistics from 2015 to 2020, the number of high-rise buildings is increasing at an annual rate of 5%-10%. Among them, there are many super high-rise buildings, which also put forward new requirements for the safety of structural design. At the same time, under individual requirements, construction companies also need to do a good job in structural innovation to meet the actual needs of construction projects. However, from the actual situation, there is generally a situation of poor innovation ability, the main reasons are as follows. Firstly, the market's acceptance of innovative content is low, the time period from innovation to investment is longer, and the amount of capital invested is relatively large. This has also led many companies to ignore the issue of technological innovation and gradually fall behind in the strong market competition. Secondly, the talent pool is relatively small. Many companies have not done a good job of talent reserve in advance, but rely on existing employees to create value. This has also led to the continuous disconnection between enterprises and society, and was eventually eliminated by the market.

3.4. Construction Safety Hazards
Civil engineering involves many items in the construction process, and there are many hidden safety hazards. If it cannot be handled properly, it will increase the probability of security problems. Summarizing past experience, the common safety hazards are as follows. (1) Hidden dangers of temporary electricity use. Many electrical equipment such as cutting machines, electric welding machines, and mobile equipment will be used in the construction process. All of these need to set up a temporary power grid on site. If the wires are worn and used improperly, it will also cause electric shock. (2) Falling objects from high altitude. Many structural parts are used in construction, and their placement needs to be planned in advance. If the planning and design are not completed as required, then unreasonable placement of items will also become a fuse for hidden safety hazards. According to relevant data, more than 10% of structural safety accidents during construction are accidents involving falling objects from high altitudes.

3.5. Unreasonable Internal Force Combination Design
In the structural safety design, there is still the problem of unreasonable internal force combination design. The main reasons include the following points. First, it failed to do a good job in scientific calculations. In the early stage of the structure design, the static load analysis, dynamic load change, stress distribution change, etc. were not carried out in accordance with the requirements. This also leads to internal stress concentration and insufficient structural strength when the structure is designed in combination, which increases the probability of potential problems. Second, the feasibility of the existing internal force combination design method has not been evaluated. There are also big differences in the internal force combination methods used in different regions, different heights, and different geological environments during construction. However, after selecting the structure
combination, it was not checked as required. This also affects the safety of the entire structural design content, laying a greater safety hazard [1].

3.6. Low Safety Supervision
Except to the application problems mentioned above, in the safety design of civil engineering structures, there is also the problem of low safety supervision. From the perspective of actual application, the main reasons for such problems are as follows. Firstly, the degree of completeness of the supervision and management system is relatively low, and the supervision and management system used by more than 50% of enterprises lags behind the current norms. Such a supervision system cannot play a good guiding role. In this way, many uncertain factors have been added during the supervision work, which affects the effect of supervision work. Secondly, there is no reliable supervision and management team. The members of many corporate supervisory teams are mostly recommended by the department, and they do not have strong comprehensive capabilities. In the context of increasing diversification of structural design, its ability is not enough to give reasonable suggestions, thus increasing the degree of freedom of design content [2].

4. MEASURES TO STRENGTHEN THE SAFETY OF CIVIL ENGINEERING STRUCTURE DESIGN

4.1. Optimized Structure Design Method
Optimizing the structural design method can improve the rationality of the design plan and optimize the working environment of civil engineering. Firstly, the introduction of BIM technology in structural design. The use of technology to build a three-dimensional model can effectively improve the intuitiveness of the structural design content. Moreover, we can also take into account the interrelationship between the structures, discover faults in the design process in time, and formulate measures to deal with them, thereby improving the rationality of the overall design content. Second, deal with conflicts in a timely manner. Civil engineering structures are closely related to each other, and conflict experiments need to be established in the early stage. We should conduct a conflicting assessment of the size, material, location and other content of the associated structure. We can use the collision experiment in BIM technology to discover the existing conflict problem, adjust the structural parameters in time, and conduct the conflict experiment again. In this way, more than 80% of conflicts can be investigated, and more than 70% of rework incidents can be reduced, thereby improving the safety of the construction process [3].

4.2. Strengthen Personnel Training
Strengthening personnel training can improve the comprehensive ability of designers and reduce the probability of potential hazards. The following should be noted in specific practice. (1) To stabilize the training frequency of enterprises, enterprises need to clearly stipulate the training schedule based on the current actual situation. Moreover, companies need to appropriately increase the training frequency in the early stage, such as once a week and twice a week. The follow-up can be adjusted to once every two weeks and once a month to help designers develop good habits and improve the average overall level of designers. (2) Improve the pertinence of training content. The training courses drawn up by the unit not only need to integrate the actual situation of the employees, but also need to do a good job of testing after training. Enterprises can adjust the training content of the next stage according to the feedback results, so as to provide reliable help for the improvement of employees’ comprehensive ability and speed up the improvement of personnel ability [4].

4.3. Do A Good Job in System Innovation
Doing a good job of system innovation can increase the richness of civil engineering structure design content and enhance the market competitiveness of enterprises. The specific innovation process is as follows. Firstly, in view of the long time period from innovation to investment and the large amount of capital invested, corporate management needs to be far-sighted and increase the importance of
innovative content. The management of the enterprise needs to adjust the amount of research and development expenses for technological innovation according to the operation status of the enterprise in actual operation, or seek cooperation with other enterprises. This can not only enhance the innovation ability of the enterprise, but also enable it to seize a favorable position in the strong market competition. Secondly, increase the talent reserve of enterprises. Companies need to do a good job of talent reserve in advance according to the current age structure distribution, or cooperate with universities to train some targeted talents. In this way, it can avoid the situation of enterprise talents from appearing in the gap, but also can improve the value creation of employees, and enhance the competitiveness of the enterprise in the market [5].

4.4. Strictly Control Building Conditions
Strict control of building conditions can reduce the probability of potential safety hazards, thereby improving the safety of the operating environment. In the actual application process also need to pay attention to the following points. (1) The company should establish a security risk assessment system. Enterprises should identify potential hazards during structural construction. Moreover, companies also need to distinguish the difficulty of structural construction, mark them in the design, remind the construction personnel to pay attention to the work content of this link, so as to reduce the potential safety hazards caused by improper operation of personnel. (2) During the engineering operation, no operation content beyond the design scope is allowed. If some “out-of-circle” operations need to be performed, the company needs to report to the management, and the operation can only be performed after obtaining consent. Moreover, for the structural parts used in construction, their placement needs to be planned in advance and used according to requirements. This can reduce the probability of safety hazards [6].

4.5. Optimize Internal Force Combination Design
Optimizing the internal force combination design can improve the compliance of the selected structure and ensure the stability of the structure. In its specific application, the following points should also be noted. Firstly, companies should do scientific calculations. In the early stage of structural design, companies need to perform static load analysis, dynamic load changes, and stress distribution changes according to requirements. Meanwhile, companies can use BIM technology to establish a virtual model, analyze whether there will be stress concentration in the structure, adjust parameters in time, and improve the rationality of the design content. Secondly, for the existing internal force combination design methods, companies also need to collect regional basic data such as geological environment, climate environment, and proposed building height. Companies should use BIM technology to build a three-dimensional model, change one of the parameters, and understand whether the structural combination meets the requirements. Enterprises can choose a feasible internal force combination structure to improve the safety of the entire structure design content [7].

4.6. Strengthen Safety Supervision
Strengthening safety supervision can promptly correct errors in the design process and improve the reliability of structural design results. In the specific application process, also need to pay attention to the following points. Firstly, enterprises should improve the perfection of the supervision and management system and update the content of the existing supervision and management system. In this way, it can meet the requirements of current regulations and play a good guiding role. Moreover, a sound supervision and management system can also reduce the influence of uncertain factors during the design period, thereby improving the effectiveness of supervision. Secondly, companies should form a reliable supervision and management team. In addition to the internal recommendation of the department, companies also need to do a good job in the introduction of talents, so that the team's comprehensive ability can be improved, so as to provide reliable recommendations in the design content evaluation [8].
5. CONCLUSION
In summary, the optimized structure design method can improve the rationality of the design plan. Strengthening personnel training can improve the comprehensive capabilities of designers. And doing a good job of system innovation can improve the richness of civil engineering structure design content. Strict control of building conditions can reduce the incidence of safety hazards. Optimizing the internal force combination design can improve the compliance of the selected structure. Optimizing the internal force combination design can improve the compliance of the selected structure. Strengthening safety supervision can promptly correct errors in the design process. Enterprises can take reasonable measures to improve the safety of structural design, which has positive significance for improving the quality of engineering operations.

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