

Study on Safety and Durability of Civil Structural Engineering Based on System Dynamics

Zhou Xiaofan

Jinan University, Guangzhou, Guangdong, China, 510000

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Abstract: The continuous expansion of civil engineering scale has greatly promoted the process of urbanization and the rapid development of China's economy. In the design of civil structure engineering, the study of its safety and durability is very important, which determines the quality level of the project. However, the level of safety setting in terms of safety and durability is generally lower than that of similar foreign standards, which should be paid enough attention by relevant authorities and design and construction units in China. In order to ensure the safety and durability of civil engineering, it is necessary to do a good job in the quality management of civil engineering, and to supervise and review all stages of civil engineering construction. Make clear the inspection of the project and the normal maintenance and repair system, and gradually dilute the mandatory nature of the technical specifications in the preparation, revision and management of technical standards. Using system dynamics to fully demonstrate and analyze the construction safety cost index and safety impact factor system has positive practical significance and effect on the further development of civil engineering safety and durability.

1. Introduction

Social development is faster and faster, and science and technology are also progressing, so people's needs become more and more. Especially in areas closely related to life, the construction industry has also developed rapidly [1]. With the rapid development of the construction industry, the construction projects in our country have become increasingly abundant in recent years and are playing an increasingly important role. Although there are many similarities between civil engineering and other projects [2]. But civil engineering has its special use, and the structure is different from other projects. As a basic part of civil engineering, its safety and durability are directly related to the quality, safety and durability of the whole construction project. Therefore, how to ensure the characteristics of these two aspects of the project is particularly important for civil engineering.

China's civil structural engineering has been developing up to now. Concrete is mainly used for structural construction [3]. Therefore, the quality of civil structural engineering mainly depends on the effect of concrete structure. It can be inferred from the history of civil structural engineering that the safety and durability of civil structural engineering will be the mainstream of its future research. The quality evaluation standard of civil engineering structure is to evaluate the safety and durability of the project, and the research on this has become an important topic of civil engineering [4]. A good study of the safety and durability of civil engineering can not only ensure the quality of construction projects, but also avoid building accidents and ensure the safety of people's lives. Therefore, we must pay enough attention to the safety and durability of civil engineering, and take effective measures to ensure the safety and durability of civil engineering through extensive application and in-depth study of system dynamics [5]. At the same time, we should encourage institutional innovation and improve the production and management system.

2. Safety and Durability of Civil Structural Engineering

2.1. Contents and Important Significance of Safety and Durability of Civil Structural Engineering

Safety of civil structure is one of the most important requirements in civil structure engineering, which directly determines whether the project can be well used. Safety is mainly composed of three aspects: bearing capacity, durable safety and overall firmness. The bearing capacity of components will directly affect the safety of the project [6]. Civil structural engineering has a certain service life. The durability of civil structural engineering is to satisfy people's use function and ensure people's normal life and learning. The safety and applicability of civil structure engineering are the two main manifestations of its durability, so we should discuss the durability of civil structure engineering from these two aspects. In terms of safety, it is necessary to select materials that can bear the normal pressure and external stress of the building. In terms of applicability, materials with strong durability should be selected according to the specific conditions of the project. Different projects have different specific situations and should be built with suitable materials. In general, in areas with superior natural environment, the service life of civil engineering structures can reach more than 50 years. In areas with poor natural environment, the service life of civil engineering structures is between 15 and 20 years.

The importance of safety and durability of civil engineering structures is mainly embodied in the following two aspects: on the one hand, safety can improve the quality and level of civil engineering structures. In the whole process of civil engineering construction, the safety factor is a great uncertainty factor. Because of the particularity of the construction industry itself, there are many external risks. Therefore, it is particularly important to do a good job in the safety of civil engineering structures. The occurrence of safety accidents not only affects the personal safety of operators, but also brings huge economic losses to enterprises and society. See Table 1 for construction safety risk loss standards for the classification of safety accident severity.

Table 1 Level of Direct Economic Losses from Construction Safety Risk Accidents

| Grade standard for direct economic losses of the project itself and the third party | | | | | |
|---|---------------------------|-------------------|--------------------|--------------------|--------------------|
| Grade | A | B | C | D | E |
| Severity | Catastrophic | Very serious | Serious | What to Consider | Negligible |
| The project itself | More than 10 million yuan | 5-10 million yuan | 1-5 million yuan | 500-1 million yuan | Under 500,000 yuan |
| Third party | More than 2 million yuan | 1-2 million yuan | 500-1 million yuan | 100-500,000 yuan | Under 100,000 yuan |

Therefore, it is necessary to analyze and manage some safety problems that may exist in civil engineering construction, so as to have a systematic understanding and mastery of the whole civil engineering construction. In order to prevent civil engineering safety construction problems. It can not only improve the overall quality and level of the construction industry, but also ensure the safety of residents' lives and property.

2.2. Safety Setting Level of Civil Structures

Structural safety is the ability of structure to prevent destruction and collapse, and is the most important quality index of structural engineering. For the design of structural engineering, the safety of the structure is mainly embodied in the safety of bearing capacity of structural components, the overall firmness of the structure and the durability of the structure. The two factors that have the greatest relationship between the safety setting level of bearing capacity of members and the safety level of structural members are how much load the structure should bear and the magnitude of the load sub-factor and the material strength sub-factor stipulated in the code. The coefficients expressed

by these consumption values reflect the safety degree of structural members under a given standard load and the need for safety reserve in the design method of safety coefficient. In the reliability design method, it is called partial coefficient, which reflects a certain nominal failure probability or reliability index. Although the safety reserve set by China's design code is relatively low, the amount of materials used in some projects is higher than that of state-owned and state-owned projects. The main problem here is that the design adheres to conventions and lacks innovation in structural scheme, material selection, analysis and calculation, and structural structure.

2.3. Durability of Civil Structure Engineering

The durability of civil structural engineering is related to the service life of the engineering. It is the ability of the structure to maintain its normal function during the service life. This normal function includes the safety of the structure and the applicability of the structure, and is more reflected in the applicability. At present, most civil structures are constructed of concrete. Durability of concrete structures is a worldwide problem that troubles civil infrastructure projects at present and is not unique to our country. However, it has not yet attracted enough attention from our government departments and the vast design and construction departments. The seriousness and urgency of the durability problem lies in the fact that many of our ongoing projects have not yet learned a lot of painful lessons from both international and domestic projects. Some experts estimate that the climax of the construction of "major trunk" infrastructure projects in China can continue for another 20 years. Due to the neglect of durability, there will be a 20-year climax of "overhaul" to meet us. This climax may soon come, and its cost will double the investment in the construction of these projects.

The main reasons for the further aggravation of the durability of concrete structures are as follows: because of the habit of quality inspection in coagulation, a single strength index is used as a measurement standard, which leads to the inappropriate pursuit of cement strength in the cement industry and the increase of cement fineness. The construction units improperly speed up the construction progress, especially the inappropriate interference of the government administrative leaders in the construction progress. Environmental deterioration, such as waste gas and acid rain. At present, the urgent work to be done is to work out the technical regulations for durability design of infrastructure projects as soon as possible, revise and supplement the requirements for structural durability in the current specifications, and attach importance to the durability of concrete structures, which is also the need for sustainable development. Considering the huge economic losses and waste of resources caused by insufficient durability, there has been a trend in the world in recent years to further extend the minimum working life of these projects.

2.4. Perfecting the Safety and Durability Analysis of Civil Structure

Establish a system of project maintenance and standardization to solve the problems existing in the civil structure. First of all, we should strengthen the establishment and improvement of standardized rules and regulations. In terms of safety and quality of civil engineering structures, to improve the durability of civil engineering structures, prevention should be given priority to, and hidden troubles should be solved in the process of maintenance. Good maintenance and maintenance can effectively reduce the occurrence of accidents, not only greatly improve the durability of civil engineering structure, but also strengthen its safety and durability. Therefore, the relevant departments of our country should standardize the daily maintenance and maintenance requirements of civil structure projects after completion at the level of legal system, and establish and improve relevant systems and norms. Strengthen the awareness of prevention, from the overall and long-term perspective, and from the risk consequences to predict in advance and guide correctly, require the formulation of plans and programs to be scientific, advanced and operable.

The national production safety supervision department strictly and regularly inspects and supervises according to the legislation related to civil structure. In particular, the registration system for employees of civil structural engineering should be certified, and the supervision of the supervision and management system and all aspects of its institutions should be strengthened. The safety and durability of civil engineering structures are gradually incorporated into the supervision

and management system. With the great changes in China's economic situation, it is necessary to re-examine the risks of the existing civil structure. On the level of safety setting of building structure, it is suggested that the requirements of safety and durability of building should be further discussed. The competent departments of civil structures need to further adopt different opinions on the standard values of design loads, and the requirements of building safety and durability under the level of economic development in different regions should also be treated differently. At the same time, we should improve the technical standards, innovate according to local conditions and update them in time.

3. Concept and Application of System Dynamics.

Since its establishment, the theory, methods and tools of system dynamics have been constantly improved, and its application direction has been expanding. It has played an important role in dealing with many complex problems of human society, such as industry, economy, ecology, environment, energy, management, agriculture, military and so on. With the gradual aggravation of the complexity, dynamics and variability of modern society, methods such as system dynamics, integrated system theory, cybernetics, information theory and so on are more needed. And cross with economics, so that people can clearly understand and deeply deal with the non-linear and time-varying phenomena produced in modern society, and make long-term, dynamic and strategic analysis and research. This provides a broad platform for the further development of the system dynamics method, and also provides a foundation and challenge for further research on the application of system dynamics in construction engineering.

System dynamics is systematically studied in the time domain. Generally, the order of the system is determined according to the number of state variables in the system. It has the systematic characteristics of information feedback. When solving problems, it follows the principles of shallow to deep, part to whole, qualitative analysis and quantitative analysis. The two complement each other, and spiral upward gradually deepens and solves practical system problems. In the construction engineering, based on the construction safety impact factor system, the causal chain and causal network are taken as the research objects. According to the requirements of the system dynamics model, key factors are selected to study the effect intensity of different influencing factors on the system safety level and the contribution of each index of safety cost to the system safety level, so as to comprehensively and clearly display the structure of safety cost of construction enterprises and the relationship between system variables, and provide the basis for dynamic analysis of the interaction between the safety level of construction system and the safety cost index and the construction of the overall model. The construction safety cost index and safety impact factor system are fully demonstrated and analyzed, and the changes and development trends of the system safety level in the construction process as well as the behavior characteristics of the system are discussed.

4. Reasons for Improvement in Domestic Civil Structure Engineering

4.1. Weak awareness of safety and durability of civil structures

Civil structural engineering is the ability of the whole or part of the civil structure to prevent damage and collapse. A variety of complex factors affect the design of civil structures, structural inspection, maintenance, acceptance standards and technical standards, etc. However, due to the relatively insufficient consciousness of resisting unexpected effects, accidents have occurred. Although in the whole process of civil engineering construction, many construction units send people to carry out safety construction management, but often not full-time personnel, but one person and many jobs. The unsatisfactory implementation of the safety and durability of civil engineering structures will not only affect the quality and level of the construction of civil engineering structures. At the same time, once civil engineering construction problems arise, it is impossible to find a clear person in charge, which directly reduces the quality and level of the whole civil engineering structure.

4.2. Imperfect safety and durability management system of civil engineering structure

Many civil engineering construction sites in our country are arbitrary, and their safety construction protection is arbitrary, which can not meet the relevant safety construction management requirements and standards stipulated by the state. There is no clear person in charge of the safety and durability management of civil engineering structures, the safety and durability management and protection of civil engineering structures are not in place, and there is no basic safety warning or warning sign on the construction site of civil engineering structures. There are many problems in the design and construction of civil engineering structures in China. In the design process, the designers did not make on-the-spot investigation on the construction site of the civil structure engineering, resulting in many unreasonable parts in the design.

5. Countermeasures to Improve Safety and Durability of Civil Structure Engineering

5.1. Strict examination of civil engineering

In order to ensure the safety and durability of the civil structure engineering, it is necessary to do a good job in the quality management of the civil structure engineering and supervise and examine all stages of the construction of the civil structure engineering. In the design stage, in order to ensure that the design scheme is scientific and reasonable and conforms to certain specifications, the design scheme should be reviewed to ensure the smooth implementation of the design scheme and to ensure the safety and stability of civil structure engineering. In the process of construction, we should also supervise the whole process of construction, especially the quality of construction materials and the accuracy of construction methods, to ensure the quality of the project meets the standards. During the acceptance of the project, the project management department and the project supervision department should be jointly accepted to ensure the fairness of the review results, so as to ensure the safety and durability of the civil structure engineering.

5.2. Measures to Improve Safety and Duration of Civil Structure

The load value of the structure should be specified and linked to the material strength to fully ensure the engineering quality. To ensure the firmness of building structure finishing, not only focus on the local, to ensure timely local problems will not affect the overall structure. In order to improve the bearing capacity of components, materials with good quality shall be selected to ensure higher safety and durability of the structure. Extensive technology can be used to detect the strength of civil structures according to different conditions, such as lifting, rebound and ray method, so as to control the disasters of cracks, leakage and denudation. Different technical specifications are formulated according to different projects.

5.3. Construction of Technical Standard System and Management Measures

The department in charge of civil structure design should focus on examining the durability requirements of the project, clarify the inspection and normal maintenance and repair system of important projects, and gradually weaken the mandatory nature of technical specifications in the compilation, revision and management of technical standards. The competent authorities should further collect different opinions on the setting level of design load standard values and bearing capacity safety, and be realistic in promoting reliability methods in various design codes. Establish regular inspection and maintenance and repair system. In order to ensure structural safety and durability, some projects should be regularly inspected and maintained after construction. Due to the lack of detection of design and construction codes for structural engineering, some engineering collapse accidents, such as the collapse of Nanmen Bridge in Yibin, Sichuan Province, are caused by the corrosion of the suspenders between the deck structure and the main arch at the joint. Such accidents may be avoided if regular inspection is carried out.

6. Summary

In summary, in the design of civil engineering in our country, there is no unified standard norm and relevant laws and regulations for safety and durability, which results in different standards in the construction process of civil engineering and uneven quality of the project. The safety and stability of civil engineering is directly related to the safety of people's lives and property, which must be paid attention to. Therefore, it is necessary to establish a sound standard specification for safety and durability of civil engineering structures. In practice, we should not only pay attention to safety and durability problems caused by construction, design and other factors, but also pay more attention to environmental factors. Therefore, in order to improve the safety and durability of China's civil engineering structures, the government should actively formulate some perfect measures and technical policies to ensure that the quality of China's civil engineering is better, and the safety and durability are higher, so that everyone can use the civil engineering at ease.

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