Study on the Construction Period Risk of Long-Span Bridge

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Abstract: Risk is the uncertainty of things, and risk management is to take certain measures based on risk research to develop things to the beneficial side. Risk research is the use of statistical methods to deal with a large number of seemingly independent incidents, in-depth investigation of the cause of the event, scientific prediction of the probability and consequences of the event. Bridges are an important part of traffic, but the construction of bridges, especially large bridges, is often under complex geological conditions, and the bridges themselves are large in scale, long in construction period, complex in internal structures, and difficult to construct. These characteristics Decided that there must be risk factors in the bridge construction stage. Engineering experience confirms that the risk in the bridge construction phase is far greater than the risk in the bridge use phase, especially for long-span bridges, so risk management runs through the entire process of bridge construction.

1. Introduction

Bridges occupy an important page in the development of human civilization. In human history, transportation in all directions plays an important role. Vigorously developing modern transportation and establishing a modern transportation network extending in all directions are of great significance for strengthening national unity, promoting cultural exchanges, promoting commercial trade, and improving the national economy and national defense strength. Bridges are buildings built by humans to overcome natural obstacles, such as crossing mountains, rivers, and rivers. They are the oldest and most spectacular buildings in the history of human development. Archeological finds that the earliest remains of bridges in the world are in the region of Asia Minor from 6000 BC to 4000 BC. The earliest bridge site found in China is the Neolithic clan village site around 4000 BC. In ancient times, the materials used for bridges were mostly natural materials such as wood, stone, rattan, and bamboo, with simple structure and small span. With the continuous progress of human civilization, the prosperity period of building stone arch bridges appeared in history. The Garde stone arch bridge in Nimes in southern France, the Liato bridge in Venice, Italy, China has the world-famous Zhaozhou Bridge in Zhao County, Hebei Province, and Lugou Bridge in Beijing. During this period, stone was the main building material for bridges. For nearly a century, people have updated their understanding of bridges, various new bridges have been emerging, and the spanning capacity of bridges has been greatly improved. South Korea's Yeongjong Bridge, located on the highway from Seoul Incheon International Airport to Seoul, is the world's first double-deck public-rail dual-use self-anchored suspension bridge.It was built in Italy in 1962 and designed by Morandi in Venezuela. The Maraeaibo Bridge is the world's first concrete cable-stayed bridge. In 1955, the Stromsund Bridge in Sweden was the world's first steel cable-stayed bridge. The Runyang Yangtze River Bridge opened to traffic in October 2005, with a main span of 149Om, the first in China. The world's third-span suspension bridge. In 2007, the Sutong Bridge built in Jiangsu, China, with a main span of 1088m, was the world's first-span cable-stayed bridge. The bridge ’s world record is constantly refreshed, and a large number of functions Complete and beautiful bridges have been completed. However, since the construction of bridge projects, especially large and complex bridge projects, often operates in a complex and changeable natural and social environment, it has its own large scale, long construction period, complex internal structure, and extensive external connections, etc. These characteristics determine that there must be many uncertain factors in the bridge construction stage, so the risks always exist in the

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entire process of bridge construction. In recent years, some research investigations have shown that the risk during the construction period of the bridge is much higher than that during the use period. Bridges are prone to engineering accidents during construction, causing large economic losses and casualties, and bringing adverse social impacts. In order to avoid or reduce losses, risk management in the construction phase of bridge engineering must be paid attention to. However, due to the lack of knowledge of risk management, the risk management of the construction process in China's current bridge construction has not attracted sufficient attention. The systematic research on the risks that may occur during the construction of the bridge is lacking. Therefore, a set of The method of evaluating the construction safety of long-span bridges at this stage has great significance for ensuring the safe construction of long-span bridges.

2. Existing Risks in Long-Span Bridge Construction

The performance of the material itself is uncertain. Different manufacturers and different production methods lead to certain differences in materials with the same specifications. In addition, the performance of material components is different under different construction processes, structural dimensions and on-site environmental conditions, which is the uncertainty of the material. In engineering practice, the performance of materials is expressed by standard test values of standard components. Most of the standard values measured by standard test methods are determined statistically, and standard test conditions often differ greatly from actual engineering conditions. Therefore, standard values It is inherently uncertain. The uncertainty of the geometrical dimensions of structural members means that due to the influence of manufacturing process and installation technology, the dimensions of structural members often change to some extent, resulting in certain differences between the actual dimensions of the members and the theoretical design dimensions. Due to the uncertainty of the geometric dimensions, under the same conditions, the structure with different geometric parameters has different force characteristics, so the uncertainty of the geometric dimensions of the components cannot be ignored.

During the construction of a large-span bridge structure, the main loads that it bears are dead load, live load, construction load, and its own weight. Bridge design is difficult to accurately determine the exact value of various loads on the structure. Generally, the size of the load is determined through engineering practice or code requirements. The design load cannot fully reflect the actual load on the structure. Therefore, the construction process of a large-span bridge structure Uncertainty is applied to the load in. People are the main body of construction activities. From the project decision-making to the completion and acceptance of the project, there are people involved. The influence of human factors on construction activities cannot be ignored. The uncertainty of the influence of human factors on construction activities is mainly manifested in the different professional qualities, psychological factors, and environmental factors of different people, and the decision-making in the process of project implementation is different. In addition, errors and omissions caused by human factors, resulting in uncertainty, have a great impact on the progress, quality and safety of the project. In short, due to the long construction period of long-span bridges and the complicated construction process, there may be few engineering examples for reference. Therefore, there are many uncertainties during the construction of long-span bridges. These uncertain factors affect the safety and quality of long-span bridges during construction. Control, cost control and progress control cause great difficulties. Studying the multidimensionality, randomness, possible probability and possible consequences of these uncertain factors is the risk management of long-span bridges.

3. Risk Management of Long-Span Bridge Construction

The construction risk management process for long-span bridges includes risk identification, risk assessment, risk response, and risk control. Risk identification is to collect information related to construction risks, determine risk factors, and finally prepare a risk report. The risk assessment is to analyze the probability of occurrence of risk factors and the amount of loss by using existing data and engineering practice experience, and then analyze the amount of risk and risk level according to the probability and amount of risk. Risk response is a response to specific risks, such as risk aversion, mitigation, retention, transfer, and combination strategies. Risk control analyzes the risks that may occur during the construction process, and takes certain precautionary measures.

Risk management during the construction of long-span bridges is similar to that of general projects, but there are some differences. The first step of construction risk management of long-span bridges: collect the engineering characteristics and construction technology of long-span bridges, determine the risk occurrence mechanism, process and influencing factors, and prepare a risk identification report in conjunction with the construction plan. Step 2: Based on past risk management experience of long-span bridges and existing collected data, analyze the risk factors that affect long-span bridges, analyze the probability and amount of risk occurrence, and then determine the risk level according to the risk probability and risk loss amount . Step 3: Based on the risk analysis data and the engineering characteristics of the long-span bridge, formulate the corresponding risk management plan. The last step: Based on the above risk management information, predict the possible risks and the possible consequences of the risks. Long-span bridges are constructed in order of foundation construction, pier construction, main girder construction, and cable construction for cable-stayed and suspension bridges.

The foundation of a long-span bridge is to bear various loads transmitted to the foundation through a pier or abutment, and transfer these loads to the foundation. The difference in the type of foundation and construction scheme of a long-span bridge not only affects the construction cost of the long-span bridge The construction progress is often related to the size of the construction risk. There are many risks in the construction of long-span bridge foundations. In terms of construction technology, such as: incorrect construction position caused by incorrect placement; insufficient excavation depth of foundation pits, incomplete drainage and drainage, and insufficient stability of pile foundations. In terms of construction management, for example: Failure of the construction machinery, the quality of the construction personnel, and the material acceptance system; the focus of the risk management of foundation construction is the risk of the foundation construction of bored piles. The procedures for the construction of bored piles are: preparation of the construction platform, buried casings, preparation of mud, drilling rigs in place, placing of steel cages, clearing of holes, pouring of underwater concrete, pulling out of the casings, etc. Risks exist with the entire construction process.

Pier construction is divided into cast-in-place and precast. The main procedures for the construction of cast-in-situ concrete piers are the production and installation of formwork and the pouring of concrete. Among the risks in the process of making and installing the piers and formwork are: mechanical failure, the quality of the construction personnel, the quality and size of the formwork, and the supply of materials; In addition to the risks of concrete, the quality of construction personnel, the quality and size of formwork, the supply and quality of materials, and the concrete pumping technology. The construction risks of prefabricated pier mainly include the risks of steel bar construction and concrete construction. Rebar construction risks are different from other construction risk factors such as the binding of reinforcement, the standard value of reinforcement materials, the actual size of reinforcement, and the transportation of reinforcement. Concrete construction risks include the lifting of prefabricated concrete, dimensional deviations of prefabricated components, unreliable bond strength of reinforced concrete, and insufficient reinforcement.

The construction of the main beam is the technical key to the construction of long-span bridges. The construction technology is complex and the construction is difficult. There are three common construction methods for large-span bridges: prefabricated construction, support construction, and hole-by-hole construction. Prefabricated construction can be divided into pre-tensioning and post-tensioning according to the tensile order of the reinforcement. The risk factors for pre-tensioned construction are: the deviation of the tensile steel bar position from the design position, the breakage rate of the steel strand, the loss of prestress, the measured deflection, and the installation of the jack. The post-tensioning method and the pre-tensioning method have almost the same risk factors, with the difference being that the reinforcing bars penetrate. In short, the construction risks of long-span bridges accompany the whole process of construction, and there are different risks at different stages of construction, which is time-effective. In addition, to make the risk management theory more reasonably applied to the risk control of long-span bridge construction, more attention should be paid to collecting the construction characteristics of the long-span bridge itself, so that the engineering characteristics are combined with the management theory.

4. Conclusion

Based on the current status of risk research in China, this paper studies the risk of long-span bridge construction from the aspects of bridge construction risk assessment model design, risk factors, and risk estimation, and achieves the following main results: Based on the concept of long-span bridge construction risk, based on a review of the main construction methods of long-span bridges, combined with the theory of accident causation, a model of long-span bridge construction risk occurrence mechanism was established, and a long-span bridge risk assessment model was designed. Based on statistical analysis of typical disaster accidents of domestic large-span bridge construction risks in recent years, and combined with the characteristics of bridge construction, a detailed table of risk factors for long-span bridges was established. The risk factors were analyzed and screened according to the Delphi method and the expert survey method. The key risk factors for long-span bridge construction were identified. A bridge risk estimation model based on the factor analysis method was established, and an example was used to illustrate the application of the model in the risk assessment of long-span bridge construction.

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