

# Discuss of the Durability in Bridge Design

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**Abstract:** With the rapid development of our country, the bridge construction accordingly enters into a fast development stage. Besides the artistic outlook, the safety and durability are the most important in bridge construction. Thus, in order to solve the design problem on durability, this thesis lays emphasis on the influence factor, precautionary measure and other factors, which will have a positive significance in the bridge design.

**Keywords:** Bridge Design; Safety; Durability; Factors; Measures; Overload

## 1. Introduction

In recent years, domestic integral capabilities developed rapidly. The acceleration of the urbanization caused a rising traffic jam. Thus, safety of the bridge design attracted much attention. The professionals have regarded the safety of the bridge design as the research object during the process and gradually deepen the research. However, in China, we always lay stress on the intensity of the bridge design and ignore its durability, which lead to a consideration of the serviceability limit state of bridge and leave the bridge term out of consideration. Moreover, a series of problems will be caused for long-term use of the bridge if the constructors only pay attention to the bridge construction and ignore the daily maintenance during the construction. This also shows that there are a lot of incomplete things in domestic bridge design theory, which will have many negative influences[1].

## 2. Harm Caused by Insufficient Durability

### 2.1. Enormous Economic Losses

If the designer didn't consider the durability during bridge design, the bridge cannot use in a long term. A large amount of capital will again be cost in the following bridge maintenance and operation, which is a waste of resource.

### 2.2. Serious Construction Accident

Serious construction accident and even bridge collapse will be caused by insufficient durability and safety if these two factors were not being considered during the early design[1].

### 2.3. Terrible Social Impact

The durability of the bridge in the construction will be directly connected with the people's livelihood and the government image. It will destroy the government image and caused a terrible social impact if the bridge broken down within the tenure of use[2].

## 3. The Reasons for Insufficient Durability

### 3.1. The Imperfection of the Design System

The modern bridge designers lay stress on the intensity and rigidity of the bridge construction in different loads and safety in accordance with calculation. However, they ignore the effect of the materials, maintenance, system and surroundings to its durability. It is this idea that had a great effect on the durability of the bridge[2]. The bridge will be affected by various climates, overload, human factors and material aging, which will lead to the damage and collapse of the bridge and cause safety problem. In addition, human errors may occur to some extent during stages of the construction including stages of design, construction and use. It will threaten the durability of the bridge.

According to different environment, usage and design objects, the complete design system shall change in layout and structure correspondingly[3]. The design standard is only guidance. The update of the design standard has certain hysteretic nature, which cannot fit to the update of the modern technology, notion development and application of the new materials. A reasonable bridge design system requires not only the relevant standards, but also a higher design experiences, professional standard and judgment of the designer.

### 3.2. A lower Construction and Management Capacity

Many bridges show defaults in a very short time after completion. The safety and quality are mainly affected by the following two factors. Firstly, the disqualification of the construction technique; Secondly, cheating on workmanship and materials. The construction company is short of construction technique and high management standard. And its administrative staff and constructors have a limited comprehensive capacity[4]. All of these caused a series of serious problems, including disqualified construction technique, nonstandard operation, cheating on workmanship and materials, shoddy, quality unqualified, insufficient intensity and other problems. If the construction quality cannot meet with the design requirement, the bridge will have many safety hazards, cause suddenly collapse and lead to a shorter tenure of

use. These serious quality problems will affect the use of the bridge.

### 3.3. Improper Design

Many designers did not consider the realistic factors in respect of the material quality, usage, structure completion, ductility and other factors during bridge design. Sometimes the design drawing is unclear and fails to display the specific data and requirement, which will directly affect the reasonability of the Bridge structure and its following construction.

### 3.4. Insufficiency after-construction maintenance

After-construction maintenance will directly affect the tenure of use of the bridge, which shall be fully considered[5]. In many cases, other company will responsible for maintenance after construction completed by one company. This will hinder the company who responsible for maintenance to maintain in combination with the construction quality and specialty, which will lead to a unguaranteed effect.

### 3.5. Insufficient Quality Supervision

There are a lot of problems in final acceptance of construction, such as limited technical acceptance ability, inaccurate nondestructive testing of the bridge caused a result that we don't know whether the quality of the materials and application amount of the steel reinforcement meet with the requirement or not, flawed regulatory system caused a result that the quality of many construction aspects excludes in the examination range and corruption during acceptance. If let these situation unsupervised, the development of the domestic bridge construction will be greatly restricted[6].

## 4. Effective Measures to Improve the Durability of the Bridge

To guarantee the durability of the bridge will greatly promote the sustainable development of the domestic traffic and affect the development of the national economy. It is imperative to improve the durability of the bridge.

### 4.1. Well Prepared Before Design

In order to guarantee the construction quality and tenure of use, the design company shall timely arrange the surveying team to explore the geological conditions and hydrologic condition within the construction area after winning the bidding. It will make sure the authenticity and the reliability of the resource and provide more valued files for bridge design. Comprehensive factors in respect of construction form, plan, materials and latter maintenance shall be considered during the bridge design, especially the bridge construction, of which the linear circular, shearing force and the reasonability and scienti-

ficity of the datum line shall be guaranteed. Reasonable determine the carrying capacity of the bridge. [7]The designer shall also anticipate the possible problems that may occur during the bridge construction and work out the corresponding solutions. The administrative staff and constructors could timely take remedial action if any emergency occurs during the construction. Well prepared before design will provide a smooth construction.

### 4.2. Lay Stress on the Durability of the Design

The bridge construction and usage will be affected by various external factors. The longer the bridge used, the more obvious damage to the bridge will be caused by cars. [8]And the material aging will accordingly deepen. The tenure of use of the bridge will be gradually shortened. Many bridges which were built from last century to today are cable-stayed. The cable-stayed bridge has the advantages of stable quality and slightly problems and the disadvantages of changing inhaul cable constantly for long-term use. The process to change inhaul cable is very complex and tedious, which will also cost a lot. The above statement shows the importance of the durability of the bridge. After the research of the bridge durability for decades, we made some achievements. But the research is not comprehensive. The research of the bridge durability pays a lot attention to material selection and pays a little attention to personnel operation and construction technology. Safety hazard caused by long-term use and damages of gap and crack exists in both domestic and foreign countries. Therefore, the bridge durability shall be specially considered. The following construction shall be continued after the confirmation and comprehensive analysis of the structure, layout and details. The daily maintenance shall be strictly conducted as a regulation. The bridge durability is the fundamental factor to guarantee the safety of the bridge design. We shall guarantee the long-term regular use of the bridge and improve the quality of the bridge design.[9]

### 4.3. Maximize the Bridge Overload

The bridge overload is also a problem that needs to be considered in design. From overall analysis, the problem can be divided into three aspects: firstly, heavy traffic pressure. Due to the rising of the car quantities, the vehicle flow rate in bridge design cannot meet with the current situation; secondly, many bridges are built many years ago and have serious damage. It cannot fit to the development of the current traffic; thirdly, insufficient vehicle management. Many oversize vehicles overload very often.

Overload will cause bridge fatigue and rising amplitude, which will further damage the bridge. If the damage continues, serious structure problems and accidents will be caused. Overload will cause certain damage to the bridge

and accordingly affect the bridge durability as time pass by.[9]

#### 4.4. Maximize the Bridge Fatigue Damage

The overload the bridge bearing during the usage is dynamic load, which will cause a certain range of vibration. The heavy traffic will lead to a constant vibration, which will cause accumulated fatigue damage. During the construction, the bridge is generally combined by each part and has not a complete continuity. [10]Inevitably, many tiny flaws will showed up. With the constant dynamic load, the tiny flaws will become the crack. If the designer doesn't pay attention to the tiny flaws in early stage and let it grown, the bridge may cracked. Therefore, fatigue damage is a very important aspect in bridge design. The research of the fatigue damage contains not only the overall structure, but also the key parts of the bridge, which will affect the function of the whole bridge.

#### 4.5. Actively Use the Foreign Experiences for Reference

Domestic bridge design still has many problems at this stage. The main problems are the low efficiency of the structure in normal use, comparatively weak durability and improper selection of the materials. On the contrary, the foreign countries are comparatively advanced in these aspects, which worth learning. In some parts of the Europe, basic performance of the structure including transformation, crack, fatigue and durability is being greatly valued. The design of basic performance is mainly to guarantee the safety and usability. Essentially, the research theory of the basic performance of the structure in Europe is mainly to analyze the reasons for the weakness of the bridge and reducing of tenure of use and seek for solutions based on the analysis. On the contrary, domestic bridge designs are mainly static state, which only take the function into consideration, but ignore the usability. We also pay little attention to function reduction that occurred after a period of time use. We neglect overall consideration and research on this. [9]In other words, we consider the economic cost more than safety and daily maintenance in domestic bridge design. The basic performance of the structure in Europe used by their design-

ers shows they had an overall consideration before design. We should use their advanced design theory and experience for reference to promote the development of the domestic bridge construction.

## 5. Conclusion

To sum up, with the rapid development of the traffic transportation, infrastructure construction is one of the most necessary and essential part. And the design is the key part in bridge construction. The research on durability aroused the attention of the modern designers. The design cannot only value the immediate interests, but the far-reaching vision to guarantee the efficiency and the duration of usage. The designers shall draw on advanced technology and strength the management of the construction, maintenance and operation. Only in these ways, the safety in the bridge design can be solved and the socialist economy can be developed rapidly.

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