

# Discussion on Crack Control in Road Bridge Design and Construction

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**Abstract:** In recent years, China's social economy is in a period of rapid development which has also made great progress in the construction of roads and bridges. Roads and bridges as basic building facilities provides strong support for local transportation and socio-economic development in China. At this stage, roads and bridges are the basic guarantee for the development of the national economy, so great attention must be paid to the quality of their construction and engineering design. At present, the main factor affecting the quality of road bridges in China is the problem of bridge cracks. There are various reasons causes for cracks they must be controlled by effective measures to better improve the quality of road bridges. This article will discuss crack control in road bridge design and construction.

**Keywords:** Road and bridge; Design; Construction; Crack

**Publication date:** April, 2020

**Publication online:** 30 April, 2020

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## 1 Introduction

In today's society, roads and bridges are one of the important components of basic transportation facilities. Due to urbanization the use of roads and bridges has been increased and the frequency of cracks has been exacerbated. Cracks are a very common problem in the construction of roads and bridges which directly affect the quality of the bridge. In severe cases they can reduce the practical functions of the roads and bridges and even endanger the lives and property of

pedestrians. However, at the current stage of road and bridge construction in China and along with the development and innovation of construction technology the frequency of crack problems in road and bridge construction has shown a downward trend<sup>[1-2]</sup>. But it is still impossible to achieve zero cracks. The control methods and measures for cracks in construction need further research<sup>[3]</sup>.

## 2 Hazards of cracks in road and bridge construction

The occurrence of cracks in the construction of roads and bridges will bring the following hazards to the bridge. First, the structural stability of the bridge is endangered. Once cracks appear they will allow penetration of rainwater, sand, etc. Long-term accumulation will cause damage to the interior of the bridge structure which in turn reduce the overall quality of the bridge project and also affect the aesthetics of the bridge. Secondly, it affects the ability of road bridges to bear loads. Cracks will cause road bridges to intensify the depth and extent of cracks under the dual effects of gravity and pressure. They even cause steel bars to break which increase the threat of bridge safety. Finally, cracks will affect the safety of bridge roads and the service life of bridges. Once the cracks appear, it will increase the maintenance cost of the bridge.

## 3 Causes of cracks in road bridge design and construction

At this stage, there are many factors that cause cracks in roads and bridges, such as construction materials, ambient temperature, and human factors. This article analyzes the causes of cracks in the design

and construction of road bridges from four aspects: excessive bridge loads, environmental temperature differences, concrete shrinkage, and human factors.

### **3.1 Excessive bridge load**

Each building bridge has a maximum load limit. During the construction process the bridge design directly determines the bridge load. On the other hand, the construction quality is also an important influencing factor. The load is borne by the bridge which mainly includes the weight of the bridge itself and the weight of the moving vehicle. When the load on the bridge exceeds the maximum load limit cracks will appear on the bridge causing serious damage to the structure of the bridge.

### **3.2 The large environmental temperature difference**

At this stage, the basic materials used in bridge construction in China are concrete and the performance of concrete materials will be affected by the ambient temperature. When the temperature difference in the environment is large the concrete of the bridge will harden and the concrete material will cause cracks in the bridge due to local uneven shrinkage during the hardening process. Also, the hydration heat of plutonium often remains when concrete is poured and the remaining hydration heat of plutonium in the interior of the concrete structure cannot be emitted. Which will also cause a temperature difference between the inside and the outside of the concrete and eventually cause cracks in the concrete material.

### **3.3 Concrete shrinkage factors**

After the road and bridge concrete is poured, it will start to shrink. Generally, there are two types of concrete shrinkage properties. One is the shrinkage caused by cement liquefaction and the other is the shrinkage caused by water evaporation. After the concrete is solidified the water in the concrete will evaporate from inside to outside in the form of water vapour. However, during the evaporation process there is a certain difference in the evaporation speed between inside and outside, which will cause uneven shrinkage of the concrete. This in turn cause cracks in road bridges.

### **3.4 Human factors**

In road and bridge construction, a major cause of bridge cracks is due to the human factor. During the construction process the number of vibrations of the

concrete, the preliminary maintenance work of the concrete and the actual construction speed of the concrete are the factors that affect the cracks in the road and bridge. In the process of bridge construction it is difficult to control the appearance of bridge cracks without scientifically controlling the influencing factors. Besides, the construction crew's awareness of controlling bridge cracks and the standardization of operations will directly affect the quality of the bridge and a little carelessness will increase the possibility of bridge cracks.

## **4 Control measures for cracks in road bridge design and construction**

### **4.1 Improve the theoretical and structural structure system and improve the standardization of the design process**

In the design process of roads and bridges the establishment of a sound theoretical system and structural structure system is the premise of standardized design. When designing roads and bridges designers must pay attention to the study of the bridge structure, bridge materials and construction technology in the face of "Unified standard for reliability design of engineering structures (2008 edition)", to ensure the maximum safety and accuracy of the design. To further improve the scientificity of road and bridge design we must attach great importance to each link in the design process and deeply realize the importance of each link to ensure that we can maintain a scientific, rigorous, serious, careful, and standardized design process. Handle every detail in the design.

### **4.2 Innovate the design ideas of roads and bridges and pay attention to durability design**

After the design and construction of roads and bridges are completed they will be put into use. As the time pass by roads and bridges will get aged according to varying degrees of various factors. In addition to the influence of unavoidable factors such as rain, snow, earthquakes and overloads due to the external environment. Problems such as cracks in road bridges have further affected the service, life and safety performance of bridges. From this point of view in the design of road bridges the durability design of road bridges must be strengthened. Only by improving the durability of the bridges the performance and life of the bridges will not be seriously affected. Therefore when designing the

bridge structure it is necessary to calculate the structure reasonably and precisely. Strictly control the proportion between the structural details and the overall structure and continuously innovate the design methods and design concepts and design ideas.

### **4.3 Strictly control the quality of raw materials for road and bridge construction**

During the construction of road bridges the quality of raw materials is the root cause of bridge cracks. From this point of view to improve the construction quality of roads and bridges we must start from the root. Control the quality of raw materials and start from the aspects of raw material acceptance, source control, and inspection system to strictly control the quality of construction raw materials control. Also, the quality of concrete materials is also an important influencing factor. Therefore, it is necessary to scientifically and reasonably control the admixture ratio of concrete in the process of use to effectively control the probability of cracks in roads and bridges.

### **4.4 Strengthen the management of road and bridge construction**

During the construction of road bridges effectively grasping the overall details of road and bridge construction is also an important method to effectively control the appearance of cracks. First, it is necessary to ensure the construction qualification of road and bridge construction units which is the basis for quality assurance of construction. Second, in-depth research on the design drawings and construction standards of roads and bridges to ensure that construction personnel clarify the detailed requirements of each construction which is conducive to improving the accuracy of construction. Third, continuously improve the comprehensive quality of construction personnel, mainly for on-site management personnel and specific operators of road and bridge construction. Only when the construction site operators have a higher level of professionalism and operation level the road and bridge construction quality can be guaranteed.

### **4.5 Ensuring the effectiveness of the maintenance work in the later stages of construction**

The maintenance work of roads and bridges in the later stages of construction is very important to prevent and reduce the occurrence of cracks and extend the service life of roads and bridges. During the external watering maintenance work, the control of concrete temperature and humidity is its key work. The external watering method can keep the temperature of the concrete constant, thereby improving the construction quality of roads and bridges. During the construction of roads and bridges, although the maintenance work is the last link it is a very important task.

## **5 Conclusion**

In summary, cracks in roads and bridges are often caused by a variety of reasons. There are both controllable human factors and uncontrollable natural factors but no matter what kind of factors must be paid great attention to the construction unit and construction enterprise. Only through effective control methods starting from the design and construction of road bridges, the possibility of cracks in road bridges can be reduced thereby improving the building quality of road bridges, making them have higher safety and service life, and better protection. The performance of road bridges promotes the development of the road and bridge industry in China and improves the overall engineering quality and engineering efficiency of road and bridge construction.

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