

# Cause and Prevention Measures of Concrete Cracks during the Construction of Road and Bridge Engineering

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**Abstract:** Road and bridge engineering is an indispensable part of socialist economic construction in China, whose construction quality significantly affects the infrastructure construction level in the whole society. To meet the rapid economic development of various regions, construction scale and quantity of road and bridge engineering have been continuously expanded and increased, therefore, higher requirements for construction quality and construction standard are also presented. During the construction of road and bridge engineering, concrete crack is a key problem which affects the construction quality. In this regard, this paper analyzes cause and prevention measures of concrete cracks during the construction of road and bridge engineering, and hopes to provide construction personnel with valuable references.

**Keywords:** Road and bridge engineering; Concrete crack; Prevention measure

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## 1. Introduction

In recent years, with China's economic prosperity and development in all fields, and continuously increased infrastructure construction, more and more people have attached great importance to the quality problem of infrastructure construction while enjoying more convenient services. In terms of the road and bridge engineering that has been built in various regions, it provides convenience for people's life, work and production, however, it also does great harm to people due to problems incurred during construction. Among them, concrete crack is the most common one during the use of road and bridge engineering. Given this, I will discuss relevant aspects in combination with the actual situation of road and bridge engineering.

## 2. Harm Caused by Concrete Cracks on Road and Bridge Engineering

Harm caused by concrete cracks incurred during the construction of road and bridge engineering mainly includes the following aspects: firstly, concrete cracks incurred on the road and bridge will damage the overall structure of the bridge, exert adverse effects on the structural performance of the bridge, and make the bridge lose the original usability, therefore, the structural performance of the entire engineering will be gradually adversely affected. Generally, concrete cracks are first formed on the surface

of the road and bridge, and then slowly spread into its internal part, which will have an increasingly impact on the internal structure, thus further destroying the structure of the overall bridge engineering and overall construction quality.<sup>[1]</sup> Secondly, when concrete cracks incur on the surface of road and bridge, some materials inside road and bridge will be exposed to the air, such as steel bar. Such construction materials exposed to the air, influenced by long-term natural environments and weather conditions, will be gradually corroded, thus losing their original usability and affecting the overall quality of road and bridge engineering.<sup>[2]</sup> Finally, concrete cracks incurred due to various reasons mentioned above on road and bridge will shorten the service life of road and bridge engineering, and quickly destroy the structure and material.

## 3. Cause Analysis on Concrete Cracks during the Construction of Road and Bridge Engineering

### 3.1 Poor Quality of Construction Materials

Generally, the concrete construction material is composed of sandstone, water, aggregate, additive and cement, which are stirred together in a certain proportion to form a heterogeneous material with certain elasticity-concrete mixture. However, the concrete crack often occurs due to unreasonable mixture proportion and quality defect of materials during the actual construction.<sup>[3]</sup> For example, too large skeletal particle or too small particle size of materi-

als will affect the construction quality of the concrete, thus causing concrete cracks. Meanwhile, the unreasonable use of concrete additives can also result in serious concrete shrinkage, thus causing concrete cracks. Moreover, the higher the strength of concrete material is, the easier it tends to crack.

### 3.2 Defective Design Scheme

Defects in scheme design would also result in concrete cracks in the process of designing concrete construction plans. Actually, the structure of steel bars and their reasonable collocation will more or less affect overall stability of the material during concrete construction. And when it comes to onsite working, the lack of scientific analysis, the defective design as well as the failure to cover all aspects of the work will result in certain flaws in strength, depth and structure of the final concrete construction.<sup>[4]</sup> Meanwhile, the designer failing to consider deformation of material during the construction will also bring in quality risks.

### 3.3 Impact of Internal and External Temperature Differentials

For concrete pouring processes in road and bridge projects, the pouring temperature will be largely affected by external environment temperature, and the fluctuation of concrete temperature will notably decide the construction quality. To be specific, when the external environment temperature is high, pouring temperature will significantly rise; Otherwise, the concrete pouring temperature will go down.<sup>[5]</sup> As environment temperature fluctuates, the gradient changes of internal and external concrete temperatures will affect the stress of concrete construction, which, when excesses certain value, will result in concrete cracks.

### 3.4 Impact of Hydration Heat

Hydration heat mainly occurs in the curing and hardening process of concrete materials, as some ingredients of the concrete will react with water to produce a lot of heat, causing internal temperature fluctuates of the concrete, which will change the temperature stress and finally bring concrete cracks.<sup>[6]</sup> In fact, concrete material has the feature of heat dissipation, and when its internal temperature continues to rise, the concentrating heat will bring notable change in temperature differential between the internal and external, thus causing cracks.

### 3.5 Impact of Shrinkage Frost Heave

During concrete constructions of road and bridge engineering, shrinkage frost heave is a major factor of concrete cracks. As the environment temperature reaches 0 °C, the concrete surface will start to freeze, affecting the sur-

face strength of the concrete, and resulting in frost heave and sequent concrete cracks.<sup>[7]</sup> Shrinkage mainly refers to the large scale of concrete deformation due to temperature and external forces. When the surface and inside of concrete deformation are unmatched, cracks will appear.

### 3.6 Impact of Construction Environment

In fact, as road and bridge engineering is regularly carried out outdoors, it would always be affected by all kinds of factors on the construction site during the construction, such as high temperature, rains and human factors, etc. At the same time, a lot of heat will be produced as a result of curing of the concrete during the construction, the heat will, if without efficient control, evaporate a huge amount of water, generating lots of pores to further form concrete cracks.<sup>[8]</sup> In addition, high-temperature working environment will also continuously add the tensile stress on the concrete surface, thus producing cracks. On the other hand, low temperature will hinder curing of concrete and adversely impact the project quality. In a word, construction environment could cause concrete cracks.

## 4 Prevention Measures of Concrete Cracks during the Construction of Road and Bridge Engineering

### 4.1 Strict Selection of Construction Materials

To guarantee the quality of construction materials, relevant personnel shall be able to apply the concrete shrinkage-compensating technology as well as learn the category, usage amount and performance of materials. Besides, the usage of swelling agent shall be decided upon sufficient experiments to make sure that the agent used in concrete construction is able to meet construction standards. Moreover, grade and category of concrete materials shall be selected in conformity with specific requirements of construction structures. It should be noted that, as road and bridge engineering always lasts long, construction materials stored for more than three months shall be tested before usage.

### 4.2 Guarantee of the Reasonability of Design Scheme

During the construction of road and bridge engineering, concrete cracks arising from engineering structure and modeling are common. Thus, construction personnel must take measures to effectively deal with the positions that have or might have concrete cracks, while closely paying attention to the stress concentrating problem caused by structural changes; aside from that, measures (such as adding more steel bars or strengthening them) shall be taken to effectively control the corners, so as to keep the struc-

ture stable.<sup>[9]</sup> During the process, construction personnel could use steel bars with small diameters to enhance overall crack resistance of the concrete construction. In addition, in the manufacture process of concrete material, sand is preferred as it could improve the concrete tightness, or adding certain amount of cement mortar to enhance loading capacity of the concrete construction.

### **4.3 Measures to Eliminate the Impact of Temperature Differential**

During the construction of road and bridge engineering, concrete cracks arising from temperature differential are one of the common problems. Targeted measures could be taken as shown below: Firstly, support displacement and expansion joints could be applied on bridge surface to eliminate concrete cracks. Secondly, construction personnel shall take protective measures according to weather changes to avoid noticeable temperature gradient at construction positions that may be affected by temperature changes. In addition, the construction shall be carried out in favorable weather conditions, to avoid sun exposure and maintain construction effect during the construction. During the construction, construction personnel shall strictly follow relevant standards regarding concrete pouring thickness, thus avoiding impacts on pre-stressing force brought by temperature differential change of inside and outside concrete and cracks.

### **4.4 Reduction of the Impact of Hydration Heat**

During the manufacturing of concrete mixture, the usage of single cement ingredients shall be controlled completely in strict accordance with relevant stipulations, to maximally use cement materials with low hydration heat. Meanwhile, the temperature when pouring fine aggregate into molds shall be kept as low as possible. Construction personnel could use thin-layer continuous placing technology or circulating cooling system to dissipate internal heat outwards. It is worth mentioning that, for fine aggregate, large diameter is preferred, and certain quantities of rubbles shall be added while mixing concrete materials according to the actual condition to reduce the percentage of cement and water in concrete mixtures.

### **4.5 Reasonable Construction and Improvement on Maintenance**

During the concrete construction of road and bridge engineering, ingredient proportions of the concrete mixture shall be tested repeatedly to accurately decide the water-cement ratio before pouring so as to get the same result on the construction site as in tests. The temperature of mixing concrete mixtures could be lowered by the way of cold air supply to guarantee concrete construction qual-

ity and performance. To ensure the evenness of concrete construction, continuity of pouring and ordered vibration shall be performed in the process of concrete pouring. When pouring is finished, processes including compaction and screeding shall be strictly in conformity with construction standards to avoid concrete cracks. It needs to be noted that, for the construction at low environment temperatures, certain surface protective measures are needed to prevent cracks from forming in the stage of concrete curing.

### **4.6 Improvement of Construction Site Management**

Construction site management is an essential part of road and bridge engineering, and its performance and effectiveness of onsite management will impact the construction quality; besides, it also plays quite a significant role in preventing concrete cracks. Construction site management mode shall be decided upon different working environments, which requires professional quality and management skill of management personnel. Therefore, relevant personnel shall be cautious and serious on all processes of the construction on the construction site, while continually improving their professional skills and experience. Construction site management personnel may feel stressed due to the large construction scale of road and bridge engineering. Thus, the construction unit shall further execute responsibility system, defining each one's work division and appointing assistants for such personnel to guarantee management efficiency. Meanwhile, management plan shall be made in advance during construction site management, and the person in charge shall be appointed for periodical inspection to ensure the quality. In case that any problems are detected in the course of construction site management, solutions shall be clearly given, and measures shall be taken to effectively deal with concrete cracks and guarantee overall project quality.

### **4.7 Enhancement of Professional Quality of Construction Personnel**

During the construction of road and bridge engineering, professional quality and skill of construction personnel will largely affect the performance of construction. Therefore, the construction unit shall provide training on professional skill and professional quality for relevant personnel. In the meantime, the unit shall make all construction personnel aware of the importance of construction quality and ensure that they understand their tasks, responsibilities as well as construction standards and specifications. Moreover, for posts that require more technical and theoretical knowledge, assessments are needed to make sure that personnel on such posts well know their working

modes, tasks and standards. This will ensure professional quality of construction personnel and further improve the efficiency of construction.

## 5 Conclusion

In conclusion, concrete cracks of road and bridge formed during construction or usage stage might be caused by various factors, including unqualified construction material, defective design scheme, internal and external temperature differential and hydraulic heat. Accordingly, to guarantee the overall quality of road and bridge engineering, the construction unit, together with all relevant personnel, shall strictly manage the selection of construction material, ensure the reasonability of the design scheme, reduce the temperature differential and eliminate the impact of hydraulic heat. With joint efforts of construction unit and personnel, we believe that concrete cracks of road and bridge will be settled after all, and the overall quality of China's road and bridge engineering will further get improved to promote the development of our economy.

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