Reason and Guarantee Measures for Construction Cracks of Pavement Concrete in High Temperature Period

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Abstract: The crack problem of concrete pavement is the key to ensure road safety and long-term service. The special environment of high temperature in summer is easy to lead to concrete cracking, this paper analyzes the reason of concrete cracking according to the situation, and puts forward the maintenance measures of concrete pavement under high temperature from the aspects of raw material quality management, concrete mixing, transportation, pouring and so on, which can provide reference for the quality control of concrete road under the high temperature.

Keywords: Construction Crack; Pavement Concrete; High Temperature

1. Introduction

The concrete pavement is one of the main forms of Chinese road, the quality of construction of pavement directly affects the safety and service life of driving vehicles. In the high temperature environment in summer, it is easy to appear problems such as too fast hydration reaction, resulting in cracks of concrete pavement. At present, there are many researches on temperature cracks of concrete. For example, Liu et al. [1] studied the temperature crack control technology of concrete during the construction of transfer slab in different seasons, and analyzed the temperature variation rule in thick slab concrete. Cui et al. [2] elaborated the temperature crack control technology of mass concrete on the cap. Qiao et al. [3] combined with the algorithm principle and training process of BP neural network, and established a temperature crack analysis model based on BP neural network, which has certain reliability for temperature crack analysis of mass concrete. Combined with the existing research results, Duan et al. [4] combined with the successful experience of the spillway tunnel lining structure design of the Three Gorges, Xiluodu, Baihetan and other giant hydropower stations, and supplemented three-dimensional finite element simulation calculation, systematically analyzed the influence degree of structural design factors, such as structural type, section size, internal reinforcement and seam reinforcement, anchor bolt, mortar cushion between lining and surrounding rock on the temperature crack control of lining concrete. The temperature crack control of concrete should be taken into account in the design of lining structure. Finally, the variation law was concluded for thermal stress field of cast-in-situ mass concrete in the tunnel. However, there are few researches on cracks of road high-temperature concrete, and corresponding preventive measures are not perfect [5-7].

Therefore, this paper reviews the reasons of construction cracks of road concrete in high temperature period, and gives detailed assurance measures, which can provide reference for controlling the quality of concrete pavement under high temperature.

2. Reasons for cracking in high temperature

2.1 Hydration heat reaction and dry shrinkage

When concrete is poured at high temperature, it is necessary to fully consider the excessive evaporation of water caused by high temperature, so as to accelerate concrete condensation. In addition, the hydration reaction between cement and water will also cause the secondary temperature rise of concrete. Too high temperature is easy to lead to concrete swelling and deformation, water evaporation too fast is easy to cause dry shrinkage deformation, resulting in cracks. How to control hydration reaction and shrinkage behavior of concrete at high temperature is the key to control concrete crack.

2.2 Temperature change and improper cutting

The problem of thermal expansion and cold contraction is also common for concrete. In summer, the daytime temperature is higher and the night temperature is lower, which makes the newly poured concrete produce significant thermal expansion and cold contraction, and then cracks appear. In addition, the appropriate concrete joint can better avoid cracks, generally required to control the strength of 5MPa-10MPa, beyond this range, the slit is easy to appear rough cracks. Due to the high temperature in summer, hydration reaction is fast, strength recovery is also fast, the strength of concrete development law should be accurately grasped to control the timing of joint cutting.

2.3 Concrete stratification and temperature between internal and external difference

Due to the construction quality of concrete pouring is not strict, pouring vibration is not timely when the temperature is high, which easy to lead to concrete stratification. This layering makes the internal strength of concrete unable to resist the external load, and it is easy to crack. In addition, the outer surface temperature of concrete formwork is exposed to the sun for a long time, and the temperature is higher, resulting in the hydration reaction of adjacent concrete in contact with the formwork is faster, the temperature difference between inside and outside is larger, and the surface thermal cracks are easy to appear.

3. Guarantee measures

High temperature environment has great influence on the pouring quality of concrete, so how to control the pouring quality of pavement concrete is very key. To this end, this paper will describe the crack control measures of pavement concrete in high temperature period from raw material quality, mixing, transportation, pouring, maintenance and other aspects.

3.1 Strengthening quality management of raw material

Strictly controlling the raw materials, especially key indicators such as slump, mud content, water reduction rate, et an.

After entering the construction site, the materials should be shaded to avoid high temperature exposure, which will lead to high temperature during concrete pouring. For broken stones, the cool down by sprinkling cold water should be carried out. For cement and other materials, multiple transfer bins can be used to avoid high mixing temperature.

3.2 Strengthening concrete mixing management

3.2.1 Temperature estimation of concrete mix

Estimating the temperature of concrete after mixing based on the temperature of raw materials:

$$T = \left[S\left(T_a W_a + T_c W_c\right) + T_t W_t + T_m W_m \right] / \left[S\left(W_a + W_c\right) + W_t + W_m \right]$$

where T is discharge temperature of concrete mix (℃), S is the average specific heat of solid materials (cement and aggregate) is 0.2, W_a is aggregate weight (kg), T_a is aggregate temperature (℃), Wc is cement weight (kg), T_c is cement temperature (℃), W_t is aggregate surface moisture content (kg), T_t is aggregate surface water temperature (℃), T_m is Water consumption for concrete mixing (kg), W_m is temperature of water used for concrete mixing (℃).

According to the above formula, the temperature of water and aggregate has the greatest influence on the mix.

Strictly implementing the mix ratio of the materials determined, and it is strictly prohibited to change it at will. When the mix ratio meets the design requite, the measures such as large aggregate particle size and admixture should be given priority to reduce the amount of cement.

When mixing, cold water can be used to stir or add ice. Retarder should be used for long distance transportation.

In the field control, the concrete preparation, mixing process, aggregate measurement detection should also be strengthened.

3.3 Strengthening concrete transportation management

The concrete transport tank truck should be reliable in quality, meet the requirements of the initial setting time and pouring progress of concrete in quantity, reasonably planning the route and shortening the exposure time as much as possible.

The tank truck should mix slowly during transportation to ensure that the concrete does not appear slurry leakage, segregation, bleeding and other problems. The concrete transported to the site should meet the slump and other requirements,

and it is strictly prohibited to add water.

3.4 Strengthening concrete placement management

When concrete is poured in hot climates, measures should be taken to reduce the temperature of the concrete and adequate manpower, equipment and machinery should be provided to cope with unforeseen adverse conditions in a timely manner.

When pouring concrete on site, sufficient personnel and equipment should be prepared to reasonably organize concrete pouring under high temperature. The casting temperature should be well controlled during casting, and the casting time can be selected after evening when the temperature is low.

Before pouring, the formwork and cushion shall be sprayed with water, and the tankers, conduits and other equipment shall be shaded to reduce the pouring temperature of concrete.

Vibration should be strengthened when pouring, and the principle of slow rise and fast fall should be adopted in a uniform and continuous way to ensure the concrete pouring is dense and accelerate the heat loss. Then, the roller pulping, wood polishing and iron polishing.

3.5 Strengthening concrete curing management

After concrete pouring, the maintenance should be strengthened and special person should be used to take charge of the maintenance mechanism. When there is no floating water on the surface of concrete, it can be covered with sprinkler curing to avoid plastic shrinkage cracks. When the strength of concrete reaches a certain level, it should be cut in time. The cutting seam should coincide with the expansion seam as far as possible and be perpendicular to the road surface. After the end of maintenance, should be caulking, caulking height and the same surface.

Conclusion

The quality of road construction is very important for driving safety and durability. The special environment of high temperature in summer makes hydration heat reaction and shrinkage problems, temperature changes and improper cutting joints, concrete stratification and internal and external temperature differences more prominent. In view of these problems, this paper analyzes the reasons leading to cracks, and puts forward the corresponding assurance measures from the aspects of raw material quality management, concrete mixing, transportation, pouring and maintenance, so as to provide reference for crack control of concrete roads under high temperature.

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