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Analysis and Treatment of Cracks in Cast-In-Place Concrete Slab Beam Structure

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Abstract: ***Cast-in-place concrete slab beam structure is widely used in small - and medium-sized Bridges in our country. In the new period, the traffic volume of road and bridge is increasing, and the phenomenon of vehicle overload is serious. Therefore, cracks will appear in the use of plate and beam Bridges, and some cracks even exceed the maximum value stipulated in the relevant regulations. It will seriously affect the safety and service life of the bridge. It is very important to analyze the cracks of cast-in-place concrete slab and beam structure comprehensively and take effective measures to strengthen them, which plays a very important role in improving the safety of bridge and increasing the service life of bridge. In this paper, the types and causes of cracks in cast-in-place concrete slab and beam structure are analyzed, and effective treatment measures are put forward.***

Keywords: cast-in-place concrete; Plate and beam structure; Crack cause; Treatment measures.

1. INTRODUCTION

Cast-in-place concrete slab and beam structure is simple in form, convenient in construction and operation, wide in application and low in economic cost, making it the best choice for small and medium span Bridges. But the slab and beam structure is prone to cracks, which will affect the safety and service life of the later period. If the crack continues to expand, it will damage the bridge structure and cause different degrees of safety risks to the safe use of the bridge. Therefore, in the later maintenance process, it is necessary to conduct a detailed analysis of the causes of cracks in the plate and beam structure, and comprehensively evaluate the impact of cracks on the bridge safety, so as to serve as a reference for the later maintenance and reinforcement, take effective measures to deal with cracks in combination with the actual situation, comprehensively improve the safety of the bridge and extend the service life.

2. TYPES OF CRACKS IN CAST-IN-PLACE CONCRETE SLAB BEAM STRUCTURE

It can be divided into structural cracks and non-structural cracks according to different causes. The structural cracks are usually caused by external loads. The appearance of such cracks indicates that the bearing capacity of the bridge is insufficient or there are other serious problems. Non-structural cracks are caused by deformation, and the main influencing factors include temperature change and concrete shrinkage, etc., which basically will not affect the bearing capacity of the bridge [1].

2.1 Concrete cracks in bottom plate and web

This kind of crack is usually network, often appear in the concrete surface of the bottom plate and web, mainly due to the concrete contraction of the surface crack, crack distribution is irregular, the crack is fine, touch has a sense of process, this kind of crack will not affect the bearing capacity, can only have a certain impact on the appearance and durability of the bridge.

2.2 Transverse and longitudinal cracks in the bottom plate

Transverse cracks are usually located in the bottom span, the larger the span of the plate beam, the more cracks will appear, the crack spacing is more uniform, and the direction of the force to maintain vertical, cracks will gradually expand, gradually formed U-shaped cracks, mainly because of static load or live load caused by bending cracks. As shown in Figure 2. The longitudinal cracks are usually distributed in the middle of the span of plate and beam, and the distribution direction is consistent with that of the main ribs at the lower edge And discontinuous, longitudinal cracks more cracks near the fulcrum less. Some cracks run through the whole beam.

2.3 Vertical and oblique cracks of web

Vertical cracks are usually located in the thin abdomen, and the width of cracks is larger at the half-height line. Most of the cracks extend upward from the beam ribs and gradually become thinner until they reach the top of the web. Oblique cracks usually occur on both sides of the span and around the support The circumference, cracking direction and beam body present an Angle of 15 degrees to 45 degrees, and gradually develop and extend to the roof compression zone. The cracks around the support are very wide, and the cracks constantly narrow or even disappear.

3. MAIN INFLUENCING FACTORS OF CRACKS IN CAST-IN-PLACE CONCRETE SLAB BEAM STRUCTURE

3.1 Weak flexural bearing capacity of section

Although the section size of the slab and beam structure meets the requirements of the relevant specifications, once the vehicles passing on the bridge exceed the bearing capacity or the vehicles are concentrated, the bridge structure will bend under the excessive load. When the tensile strength of the concrete is smaller than the tensile stress at the bottom of the beam, the transverse cracks will appear on the bottom plate.

3.2 Temperature factor

The thermal conductivity of the concrete material itself is weak, if the surface temperature of the concrete changes dramatically, the temperature of each level inside the concrete can not change, the change is obviously lagging, so the temperature difference between the plate and beam concrete structure is large, will lead to the deformation of the concrete structure, the temperature stress in its internal. Once the external temperature rises and falls sharply, there will be great thermal stress on the surface of the concrete, resulting in cracks on the surface of the concrete structure.

3.3 Shrinkage factors

Concrete structure in the drying process, the volume will change, the drying process is from outside and inside, so there is a difference in the degree of shrinkage, the surface shrinkage is larger, the internal shrinkage is smaller, resulting in uneven shrinkage, will form tensile stress on the surface, resulting in the surface of the fine cracks.

3.4 Factors of concrete protective layer thickness

If there is too thick protective layer outside the concrete, then the reinforcement restraint effect is not obvious, by temperature changes and external load, can not give effective control of the shape change of the outer layer of concrete, will lead to the outer layer of concrete and the main reinforcement vertical transverse cracks. If the external protective layer of concrete is insufficient, it will affect the cohesiveness, and the bond between concrete and reinforcement cannot be guaranteed. The reinforcement will gradually be corroded and expanded in volume, resulting in expansion effect, which will squeeze the surrounding concrete and lead to longitudinal cracks [2].

3.5 Construction thickness and vibration factors

If the concrete thickness is not enough in construction and the vibration compactness is poor, it will lead to poor concrete strength of slab and beam section and reduce the bearing capacity of slab and beam. With poor concrete compactness, outside air and water will enter along the tiny holes and cracks, corroding the internal structure and causing cracks in the slab and beam.

4. EFFECTIVE MEASURES FOR CRACK TREATMENT OF CAST-IN-PLACE CONCRETE SLAB AND BEAM STRUCTURE

4.1 Closed surface treatment method

Closed surface treatment method refers to the use of special materials to brush the surface of member, used to repair some small cracks on the surface of member, usually using adhesives, cement mortar and other materials, crack width is not more than 0.15mm for this method. The main purpose is to avoid carbonization of the concrete protective layer and prevent harmful substances from corroding the concrete. Before using this method, the surface around the crack needs to be located. If there are pores or other defects in the crack area, the concrete surface needs to be filled with concrete materials, and the use of emery cloth for grinding, to ensure the smooth working surface, while keeping the surface dry, and then the repair material evenly smearing, according to the actual situation can also be pressure scraping. The cracks of cast-in-place concrete slab and beam structure can be divided into three types: live seam, dead seam and growing seam. For these three different types of cracks need to use different methods to repair. If it is a dead seam, then it is best to choose rigid materials when filling; If it is a live seam, then you need to use elastic material when repairing, if you choose rigid material when filling, then it will cause repair failure, will cause new cracks near the repaired area. When repairing the live seam, the factors leading to the activity should be identified first, and effective measures should be taken to control it, and then the repair should be carried out. If it is clear that it is a growth seam, it is necessary to conduct a comprehensive and accurate analysis of the factors that lead to cracks, and then repair after effectively dealing with the relevant factors. Otherwise, simple repair cannot effectively solve the problem, and cracks will still appear after repair.

4.2 Low pressure automatic injection treatment

Low pressure automatic seepage treatment method refers to the colloid with good permeability is injected into the crack using low pressure grouting equipment, using this operation method can improve and restore the integrity of the concrete slab beam structure, can avoid the maximum extent of the concrete by the external environment of air, water and dust erosion. This operation is suitable for cracks ranging in width from 0.1mm to 1.5mm. First of all, the debris and dust inside and around the crack should be cleaned up, and the concrete surface within the crack range should be wiped clean with acetone. The spacing of fixed grouting nozzle is designed reasonably considering the depth and width of crack, and the grouting nozzle is pasted and fixed at the designed position with the focus of crack. At the same time, attention should be paid to the full closure of all cracks outside the grouting nozzle, through the outer mouth of the crack; When the sealing material is completely hardened, it is necessary to ensure that the permeating device filled with binder is inserted into the grouting mouth one by one on the same crack, and the check valve of the permeating device is opened, so that the binder constantly penetrates into the gap under the action of pressure; The remaining binder in the infusing apparatus should be dynamically monitored until the volume is no longer reduced and the infusing can be stopped; After the completion of the prescribed time of curing, remove the rubber nozzle seat and sealing material in time.

4.3 Pressure grouting treatment

Pressure grouting method refers to the use of pressure action to repair cracks of the glue into the cracks, can obtain good filling and compaction effect. It is usually suitable for deep cracks with widths greater than 0.15mm. Before adopting this method, the crack surface should be treated reasonably. The depth and width of the crack should be taken as the standard, and the position of the buried grouting nozzle should be reasonably designed. The interval between each position should be kept 200 to 400mm, and the grouting nozzle should also be buried at the widest, crossing, penetrating and end of the crack [3]. Must ensure that each crack has an exhaust nozzle, grouting nozzle and grouting nozzle; First of all, the crack should be sealed by sealing material before operation to avoid leakage; After confirming that the hardness of the sealing material meets the standard, the compressed air is injected into the crack through the grouting nozzle for air leakage test. If it is found that there is air leakage, it should be repaired in time, and then the air leakage test is carried out again until there is no air leakage point. The grouting is carried out on the oblique and vertical joints from top to bottom, and the pressure grouting is carried out one by one on the horizontal joints from one end until the last grouting nozzle begins to take out the grouting, and the pressure can not be stopped until the constant pressure is maintained and the grouting continues for 5 minutes Grouting; Test the effect in time after curing the injected binder, and clean up the external support and sealing material of the rubber injector after meeting the requirements.

4.4 Filling and repairing treatment

Filling and repairing is an effective treatment method suitable for repairing wide cracks with diameter greater than 0.5mm. In practice, V-shaped or U-shaped grooves should be chiseled along the cracks, and 10cm of width should be left at the top of the grooves to fill the sealing material into the grooves. Commonly used materials for filling are epoxy mortar, polymer cement mortar, cement mortar and elastic epoxy mortar, etc. If it is found that the reinforcement in the reinforced concrete structure has been modified during the repair process, the first need to chisel all the concrete surrounded by the rusty reinforcement, and then remove the rust marks on the reinforcement, and then rust prevention treatment, and finally the epoxy resin mortar or polymer cement mortar and other suitable materials filled into the tank body. If you encounter a live seam, you need to chisel a U-shaped groove along the direction of the gap, and at the bottom of the groove to pad a layer of materials such as plastic materials and concrete will not adhere to the material, and then in the tank using elastic caulking material to fill, to ensure that the filling material can effectively stick together on both sides of the tank. After this operation, the caulking material can change freely within the width range of the tank, even if the crack is subjected to tensile deformation, it will not open the caulking material.

4.5 Internal structure self-healing treatment

Internal structure self-healing treatment is an intelligent crack treatment method. The idea of this method is derived from the special substances secreted by organisms after trauma, so that the parts affected by trauma can realize automatic healing. In the process of repair, some special components are added to the traditional concrete components, such as liquid core fibers containing binder or liquid core capsules, so that an intelligent bionic neural network system can be formed inside the concrete with the ability of automatic healing. Once the concrete is affected by external factors when cracks appear, the liquid core fiber or liquid core capsule containing binder can secretory core fiber, can make the crack heal automatically.

4.6 Method of structural reinforcement

If cracks affect the performance of concrete slab and beam structure, it is necessary to adopt the reinforcement treatment method. The commonly used methods are: increase the cross-sectional area of the concrete structure, outsource the corner of the component, take the prestressed reinforcement method, paste steel plate reinforcement method, increase the fulcrum or shotcrete reinforcement method, etc.

5. CONCLUSION

Cracks are a common phenomenon in the structure of cast-in-place concrete slab and beam. Bridge concrete slab and beam are

allowed to be used with cracks, but we should pay attention to the comprehensive analysis of cracks, so as to have an accurate assessment of the safety of the bridge. It is necessary to take reasonable treatment measures according to the influence of cracks on the bridge structure to prevent cracks from developing, and ensure the stability and safety of the bridge and plate and beam structure to the maximum extent.

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