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OVERHAUL OF THE CROSSBARS SYSTEMS OF BRIDGE SUPPORTS WITH THE INSTALLATION OF REINFORCED CONCRETE BRACKETS

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Анотація

Ця наукова робота описує методологію підсилення дефектних залізобетонних ригельних систем улаштуванням густо армованих обойм для забезпечення подальшої безвідмовної експлуатації мостової споруди, підвищення вантажопідйомності ригельної системи зокрема, та усієї мостової споруди, загалом. Окреслено основні дефекти і пошкодження, які виникають у ригельних системах мостів протягом тривалої експлуатації, причини, що призвели до цих пошкоджень, а, також, методи усунення зазначених дефектів. Доведено перевагу методу улаштування обойм над класичним методом ін'єктування тріщин епоксидними сумішами.

Ключові слова: міст, залізобетонна опора, ригель, напружено-деформований стан, тріщини, карбонізація, ін'єктування, обойма.

Abstract

This scientific work describes the methodology of strengthening defective reinforced concrete crossbar systems with the arrangement of densely reinforced brackets to ensure further trouble-free operation of the bridge structure, increasing the carrying capacity of the crossbar system in particular, and of the entire bridge structure in general. Have been outlined the main defects and damages that occur in the transom systems of bridges during long-term operation, the reasons that led to these damages, and also the methods of eliminating these defects. Have been proven the advantage of the method of arranging clips over the method of injecting cracks with epoxy mixtures.

Key words: bridge, reinforced concrete support, crossbar, stress strain state, cracks, carbonization, injection, bracket.

Introduction

The vast majority of all small-sized and medium-sized bridge structures in China and all around the world, which are made of reinforced concrete, are beam structures. The design of such bridges can be single-span or multi-span. Further, we will talk exclusively about multi-span bridges and their intermediate supports.

The typical bridge support of a beam bridge consists of foundations on which the support shaft rests, on top of which a two-console transom system is arranged. The span structures of the bridge rest on the crossbar, in turn. The design of the crossbars and their structural form depends on many factors. Most often, a crossbar is a reinforced concrete beam with a rectangular cross-section of constant or variable height along the length (fig. 1, 2). From the point of view of strength, the crossbars systems that are the most loaded structures of bridge supports [1, 2]. In addition, these systems have the largest width in plan, that is, the least protected from atmospheric influences, especially in the cantilever sections. The combination of a high level of loads and significant atmospheric effects leads to the appearance of significant defects and damage on the bridges crossbar systems.

The most typical and dangerous defects include: destruction of the protective layer of concrete with exposure and corrosion of the working and structural reinforcement, cracks in concrete with an opening width of more than 3 mm, plastic deformations of the working reinforcement of the stretched zone (fig. 3).

Today, such defects and damage are repaired by injecting cracks with epoxy mixtures, repairing the protective layer with polymer-cement mixtures, and treating fittings with corrosion-resistant zinc-containing coatings. But this typical method of strengthening does not eliminate the main cause of defects, namely, an increase in the load on the transom system and, accordingly, the insufficient load-bearing capacity of the transom itself.

Figure 1 – Example of a typical crossbar system (constant height) of a beam bridge, where the pile foundations perform the function of the shaft of the bridge abutment

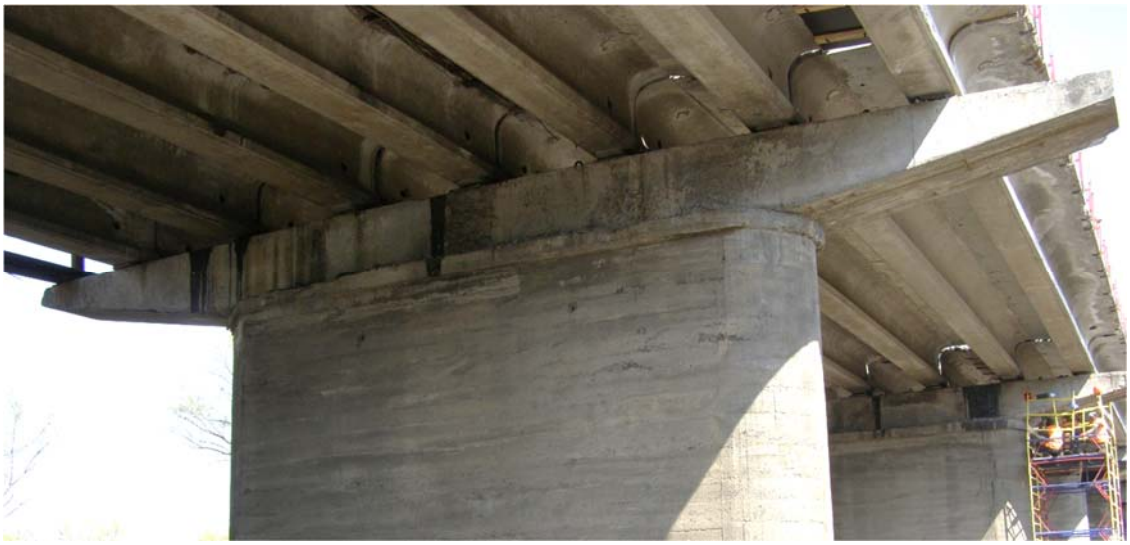
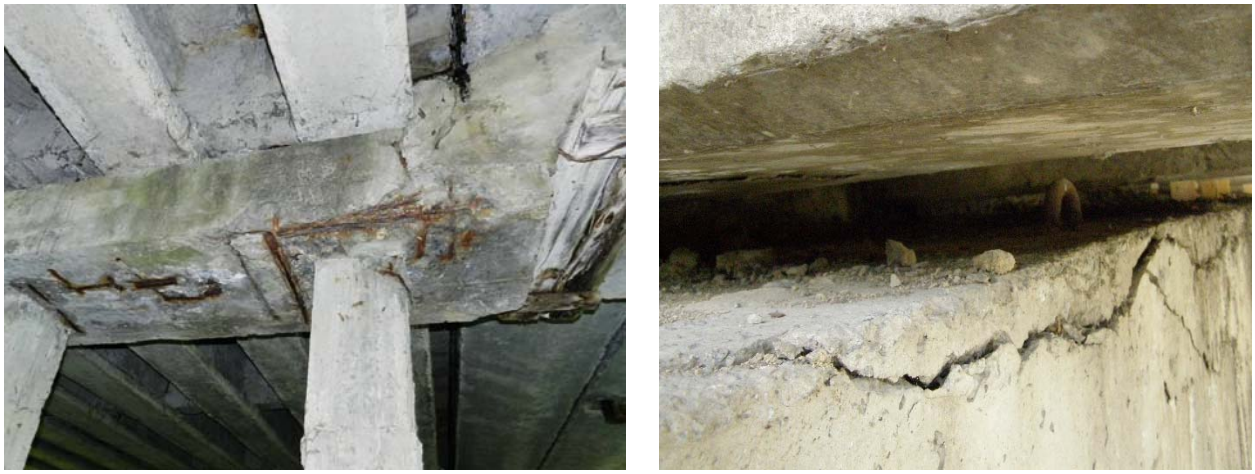


Figure 2 – Example of a typical crossbar system (variable height) of a beam bridge, where the central trunk of the bridge support is made in the form of a massive rod



a) b)

Figure 3 – Typical defects and damage to the crossbars: a – destruction of the protective layer of concrete with exposure and corrosion of reinforcement, b – wide longitudinal cracks of the protective layer of concrete in the stretched zone, which indicate defects in the working reinforcement.

Main part of research

Therefore, have been offered the more reliable, albeit more time-consuming, method of strengthening by placing densely reinforced concrete clips around the crossbar system.

For the constructive implementation of the brackets, it is necessary to carry out a complex of technological operations, which includes:

- unloading of the crossbar system;
- dismantling the protective layer of concrete up to the working reinforcement;
- the design of the required reinforcement of the brackets, without taking into account the existing reinforcement of the crossbar;
- arrangement of reinforcement of the bracket [4];
- connection of the reinforcement rods with the existing reinforcement;
- the installation of formwork;
- application of an adhesive layer on repair surfaces and reinforcements;
- concreting the bracket.

The offered method was used to repair the reinforced concrete structures of the crossbars of several bridges (fig. 4). Load testing of bridge supports confirmed the reliability and effectiveness of this method.

a) b) c)

Figure 4 –An example of the reinforcement of the crossbar reinforcement bracket: a – cleaning of the defective crossbar from the remains of concrete up to the working reinforcement; b – working reinforcement and bracket formwork covering by Sika MonoTop-910 N; c – finished reinforced concrete bracket.

Conclusions

Have been offered an effective method of strengthening the crossbar systems of bridge supports by installing a densely reinforced concrete bracket. This method consists in increasing the cross-section of the crossbar system by concreting it with the installation of additional working reinforcement. The method has certain limitations. It is advisable to use it only if the working surfaces of the crossbar are accessible for repair work. For the guaranteed inclusion of the clip in the operation under the reinforcement load, the clip must be sufficiently intense. Adhesion of the concrete of the clamp to the existing repaired elements have been ensured by highly effective adhesive polymer-cement coatings, for example, Sika MonoTop-910 N. Further scientific research on the mentioned topic will be devoted to the optimization of structural solutions for reinforcing brackets and structural forms of brackets.

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