Epoxy bonded steel plate method for repairing deteriorated slabs

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Epoxy Bonded Steel Plate Method for Repairing Deteriorated Slabs

Réparation de dalles en béton à l'aide de plaques d'acier collées à la résine époxyde

Reparatur von Stahlbetonplatten mit Epoxy-geklebten Stahlblechen

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1. INTRODUCTION

In Japan, for repairing cracked and damaged RC decks of bridge, several methods have been developed. Among them, Epoxy Bonded Steel Plate Method is most familiar. The method is of a reinforcement by bonding a thin steel plate to the bottom surface of deteriorated deck with the aid of adhesion of epoxy resin. The repaired deck behaves like a steel plate and concrete composite slab. A main advantage of this method is that the repair work can be done without stopping a traffic service on deck. This method is executed through the following steps: (1) Holes in the bottom surface of RC deck are made and an anchor bolt is inserted into each hole. (2) A sheet of thin steel plate with a certain width is installed in the anchor bolts with keeping a clearance for epoxy resin grouting layer. (3) After all edges of steel plate are sealed with a sealing material, epoxy resin is grouted by an injection pump. The main purpose of this study is to examine reliability of the method. For sake of this, static and fatigue tests of repaired and non-repaired slabs of model composite girder bridges were carried out under vehicle loadings.

2. METHOD OF EXPERIMENT

The tests slabs supported by a twin girder bridge spanning over 3.6m have 8cm thick, main re-bars in 10cm pitch and distribution re-bars in 15cm pitch, which were modeled to an existing RC deck slab on a typical highway road bridge in Japan. A full size truck cyclically running on six composite girder bridges arranged on a circular test road was used, as shown in Photo. 1. Three steps of tests were carried out. The first was static tests by a central patch load on the slabs. The second was fatigue loading tests before repairing, in order to give some degrees of deterioration to the slabs. The third was fatigue loading tests after repairing. Through those steps, the mechanical behavior of repaired and non-repaired slabs was examined, in particular on cracking pattern, debonding of steel plate, degradation of stiffness and so on. The six test slabs named No.1 to No.6 have the same sizes and reinforcements. The load intensity of truck rear wheel in running was set to 51kN for slabs Nos.1, 3 and 5 and to 42kN for slabs Nos.2, 4 and 6. Slabs Nos.1,2,3 and 4 were repaired after a finite number of loading cycles. Slabs Nos. 5 and 6 remained non-repaired for monitoring. The higher load intensity of rear wheel applied were corresponding to about 1.5 times as large as an equivalent design load specified by the Japanese code [1].

3. RESULTS

Figure 1 shows variations of elastic deflection under the central rear wheel load, which mean the degradation of stiffness of slab. Non-repaired slab No.5 collapsed at about 160000 cycles, and slabs Nos. 1 and 3 with the same loading condition as No.5 were repaired at 17000 and 160000 cycles, respectively. While, slabs Nos.2 and 4 subjected to a lighter loading condition were repaired at earlier stages of 5000 and 17000 cycles, respectively. All test slabs except No.5 did not collapse until 600000 cycles when the tests ceased.

Photo.1 Test View

The collapse mode occurred in slab No.5 was like a punching shear mode without fracture of re-bars. By taking a view of the cross section sawn out after the tests were over, it was known that diagonal shear cracks in concrete might appear at earlier stage, but so severe debonding of steel plate to lead a shear bond failure soon was not seen yet, though only some of small parts of debonding of steel plate occurred from small cavities within epoxy resin layer, which seemed to be already made at the repair stage.

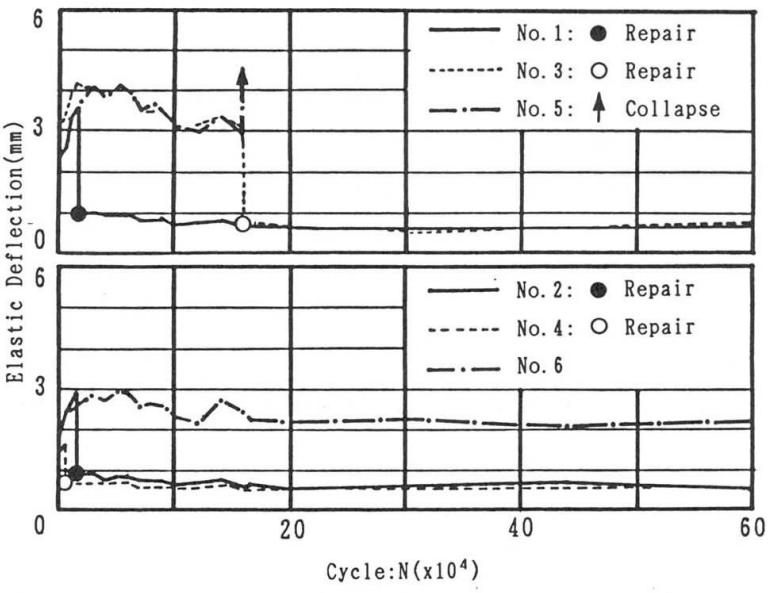

Fig.1 Relationship between Loading Cycle and Elastic Deflection at Center

4. CONCLUSION

1. Epoxy Bonded Steel Plate Method is reliable as a repair method for cracked and damaged RC slabs of bridge deck even at the stage of so severe damage as to cause diagonal shear cracks in concrete, provided that its careful work not to include any cavity in epoxy resin grouting layer is done.
2. Slabs repaired by the method behave as a full-composite slab consisting of compressive concrete and tensile steel plate.
3. Most of peeling or debonding of the steel plate are caused by initial cavities in epoxy resin grouting layer. So, careful work is required to raise reliability of the method.

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