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Experimental study on static and fatigue behavior of composite bridge using precast concrete deck

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ABSTRACT

In precast concrete deck of composite bridge, it is important to verify the flexural performance of precast deck connection through static and fatigue test. Existing loop connection methods of precast decks have limitations of relatively low serviceability at the joint of the precast decks. This study proposed precast deck system which had ribbed loop connection to improve the disadvantage and flexural tests of the proposed system in real scale specimen were conducted. From the test results, static and fatigue behavior of the precast deck system were investigated and the application of the precast deck system on composite bridges was examined.

1. INTRODUCTION

Fig. 1 Load tests of composite bridge using precast concrete deck

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For precast bridge deck system, serviceability problems such as cracks and leakage at precast deck joint are critical. In case of precast deck joint using internal tendons is useful in performance and durability of the structure, but is disadvantageous in costs and constructability. A typical precast deck system with loop bars is cost-effective but difficult to construct quickly because of cast-in-place of joints and have a risk of cracks and leakage at the joints. Therefore, this study proposed precast deck system with ribbed loop reinforcements and verified flexural behavior of composite bridge using precast concrete deck through static and fatigue load tests as shown in Fig. 1.

2. PRECAST DECK SYSTEM

Fig. 2 Connection of precast deck with ribbed loop reinforcement

Fig. 3 Precast deck system allowing vertical installation

Fig. 2 shows the sequential installation connection of precast deck modules with ribbed section shape using loop reinforcements. The precast deck system satisfies the minimum lap lengths with loop joints according to related specifications. Furthermore, construction time is reduced by applying an extended bottom concrete section at the joints which eliminates formwork and cast-in-situ on field. Two precast deck modules are connected together rapidly by pouring non-shrink mortar of high strength between the two modules, allowing vertical installation as shown in Fig. 3.

3. EXPERIMENTAL STUDY

3.1 Overview

For flexural performance verification of the proposed ribbed precast deck, a two-girder composite bridge specimen is made. The mean compressive strength of the precast decks is 40MPa, the yield strength of the deformed bar is 400MPa, and the mean compressive strength of the non-shrink mortar which is filled in connection part of precast decks is 60MPa.

The dimensions of the composite bridge deck has a width of 4.6m, length of 10m, and thickness of 240mm. 16mm diameter deformed bars with spacing on center of 200mm is used. The two girders have a spacing on center of 2.65m and has a simply support configuration at both ends. After two 11.6m steel girders are placed longitudinally, five precast decks are installed on the girders, and the non-shrinkage mortar is placed on the connection part between the decks.

3.2 Flexural tests

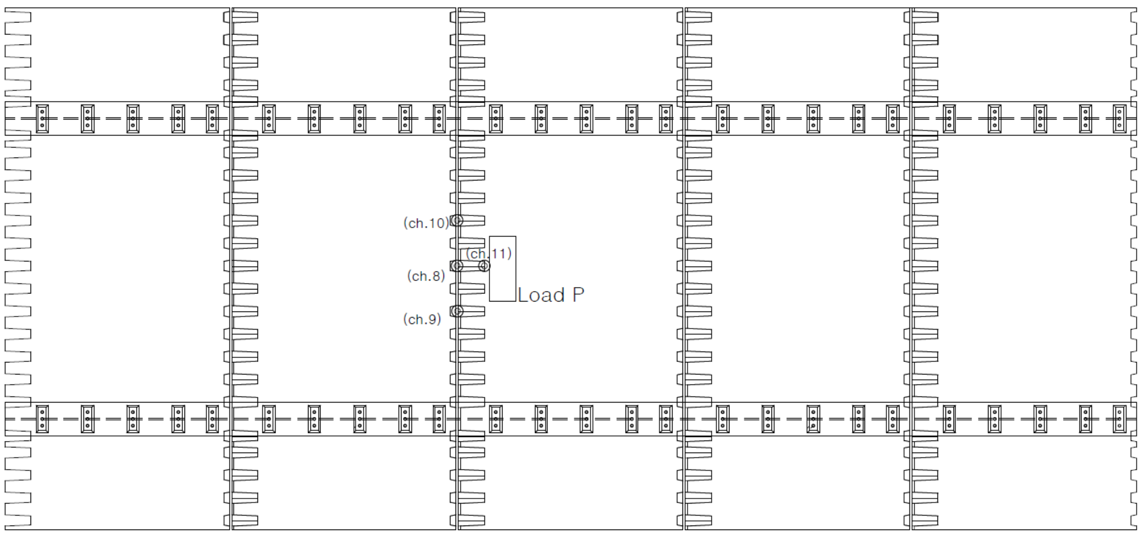

Fig. 4 Static loading setup and crack gauge configuration

For the static and fatigue load tests, a 2000kN and 500Kn load capacity actuators are used to create a concentrated loading condition near the precast deck joint. The loading setup and gauge configuration of the composite bridge specimen is shown in Fig. 4. As the load is applied at the loading point, the deflection and crack width at the precast decks are measured.

3.3 Test results

Load-deflection curve under static and fatigue load(2,000,000 cycles) on the loading point are shown in Fig. 5. That shows a linear behavior up to 250kN after static load test. Regarding fatigue load test, residual deflection was increased but gradient was constant. This shows the stiffness of the decks is constant and still in linear behavior after repeated 2,000,000 cycles of 90 kN load.

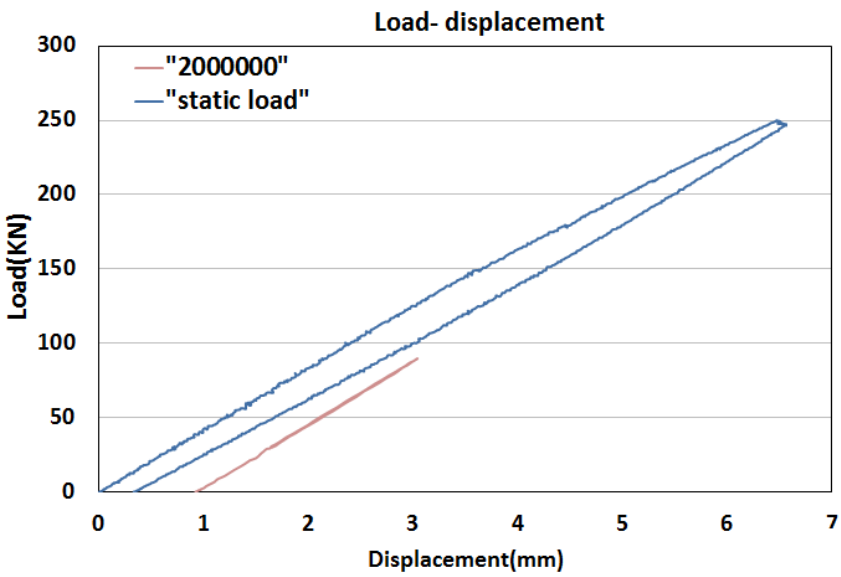

Fig. 5 Load- deflection curve (loading point of specimen)

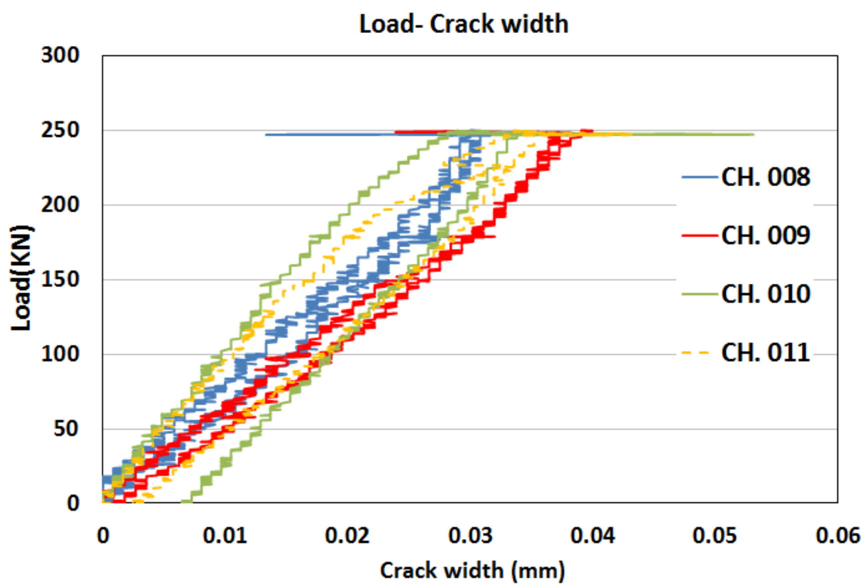

Fig. 6 Load- crack width curve (bottom of joint)

Fig. 6 shows load-crack width curve at the bottom of the joint between decks under static load condition. Crack width stayed at less than allowable crack width of 0.2mm after static load of 250kN. No leakage and lateral crack was monitored.

4. CONCLUSIONS

Precast bridge deck system of ribbed-shaped loop joints that can be rapidly constructed was proposed. Static and fatigue tests had been carried out to observe structural behavior such as deflection and crack width of the proposed system. From the test results, it can be inferred that the proposed precast deck system shows satisfactory structural behavior.

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