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# Field application of precast concrete bridge deck system with ribbed loop joints

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## ABSTRACT

In precast bridge deck system, structural performance, economic feasibility and site constructability are mostly determined by the connection methods between the precast decks. However, two most commonly used connection methods, namely post-tensioning and conventional loop connection, have limitations of high construction cost and low durability respectively. Therefore, this research presents precast bridge deck system which has more updated connection details with ribbed loop joints, and verifies the applicability of the system in real structure.

## 1. INTRODUCTION

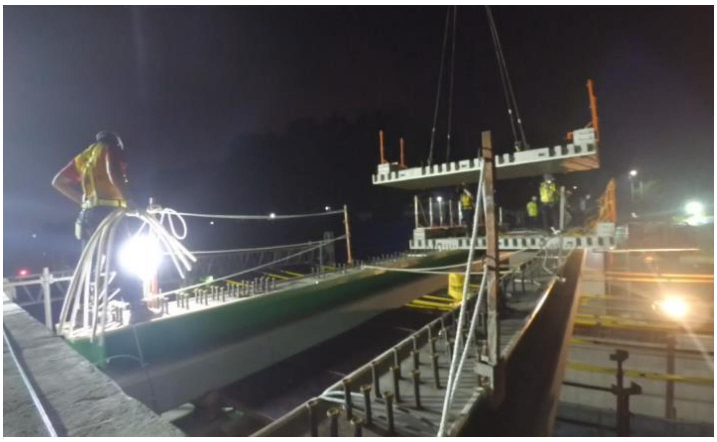

Fig. 1 Construction of precast bridge deck across railways at night

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In the case of bridge structures, the demand for maintenance and rapid construction is increasing due to the deterioration of the superstructure. The precast concrete deck is an effective alternative to cast-in-place deck in the deck replacements, and continues to expand its demand and related field studies.

The connection of precast decks using internal tendons is disadvantageous in terms of cost and workability due to the tendon-related works. An existing precast deck with loop reinforcements has a risk of cracks and leakage in the joints. Therefore, a study on connection method between precast deck panels has been conducted to improve cost-effectiveness and workability. As a result, this study presents precast concrete bridge deck system with ribbed loop joints which is more improved in terms of cost and workability. The flexural performance of the proposed system is verified through experiments in a composite bridge specimen. And two cases applied to the real bridge structure using the system are introduced.

## 2. PRECAST CONCRETE BRIDGE DECK SYSTEM

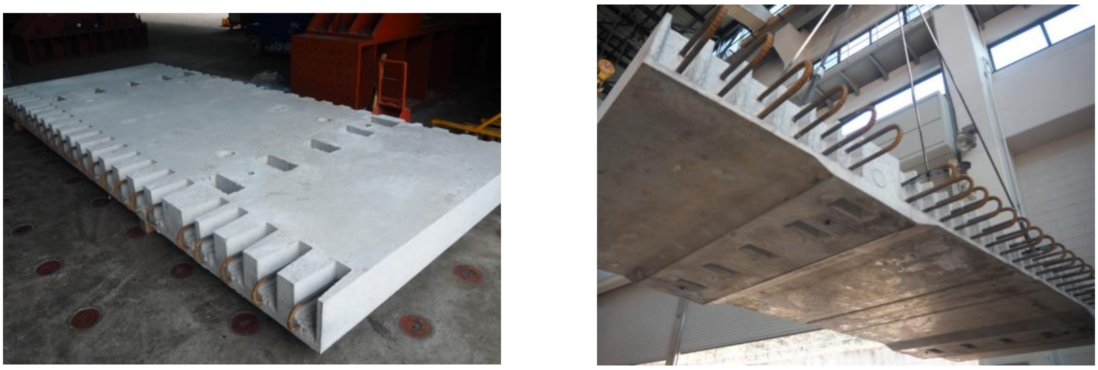


Fig. 2 Precast deck module with ribbed loop joints

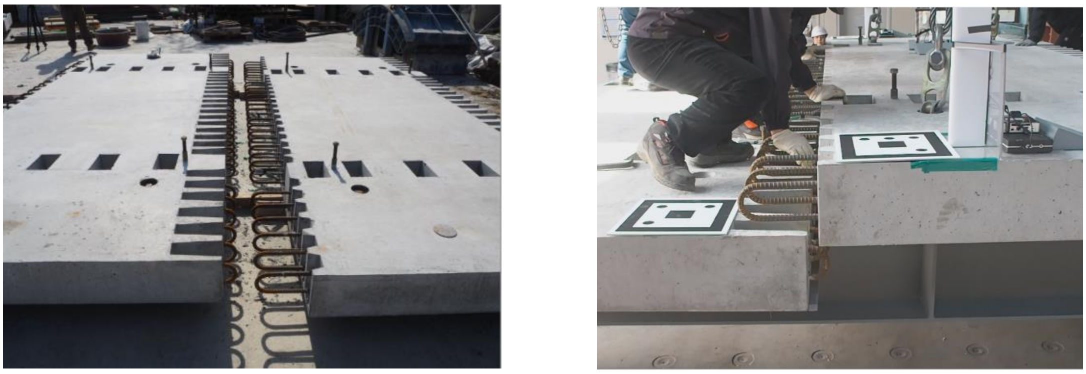


Fig. 3 Connection between precast deck modules

Fig. 2 shows the precast concrete deck modules with ribbed loop joints. The loop reinforcements of the module at both sides are embedded in lower concrete, and the modules have asymmetric shape with different lengths of partition wall at both ends. Fig. 3 presents the connection of the two precast deck modules. Protruding reinforcements at both ends of the precast deck module satisfy the minimum lap lengths with loop reinforcement according to related regulations when the decks are connected in the joints. To enforce the flexural strength in the joints, precast concrete deck panels are designed with ribbed shape at the both sides. Precast deck modules are placed on girders at site, and high strength non-shrinkage mortar is poured into the joints between the decks without separate forms, which results in rapid construction. Since the ribbed section increase the flexural strength of the precast deck joints, the structural behavior of the ribbed section is expected to be better than that of the straight section.

## 3. EXPERIMENT

### *3.1 Overview*

A two-girder composite bridge specimen is fabricated to assess the flexural performance of the proposed precast deck system as shown in Fig. 4. The design strength of the precast concrete deck modules are 40MPa, the yield strength of the deformed bar is 400MPa, and the design strength of the non-shrink mortar is 60MPa. The specimen of the deck has a width of 4.6m, length of 10m, and thickness of 240mm; furthermore, 19mm diameter reinforcing bars with spacing on center of 150mm is used. The girder has a spacing on center of 2.65m and has a simply support configuration at both ends. After placing two 11.6m steel girders longitudinally, five precast concrete deck modules are placed on the steel girders, and the non-shrinkage mortar is placed on the deck joint for fabrication of the composite bridge specimen.

### *3.2 Flexural test*

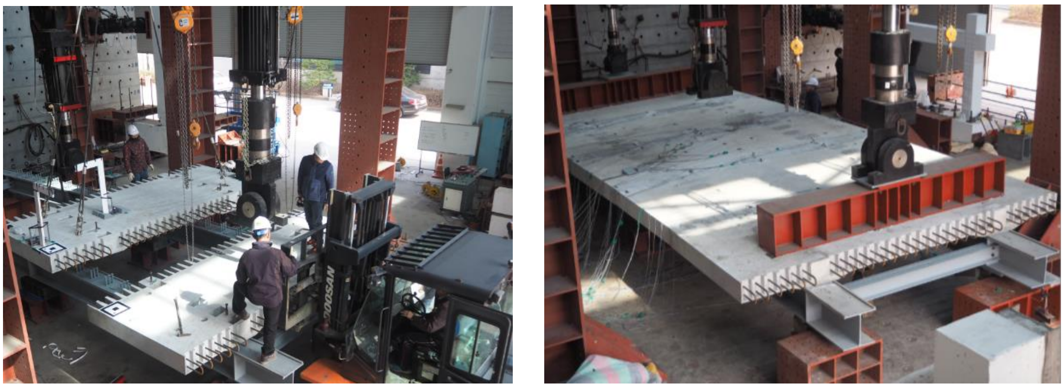


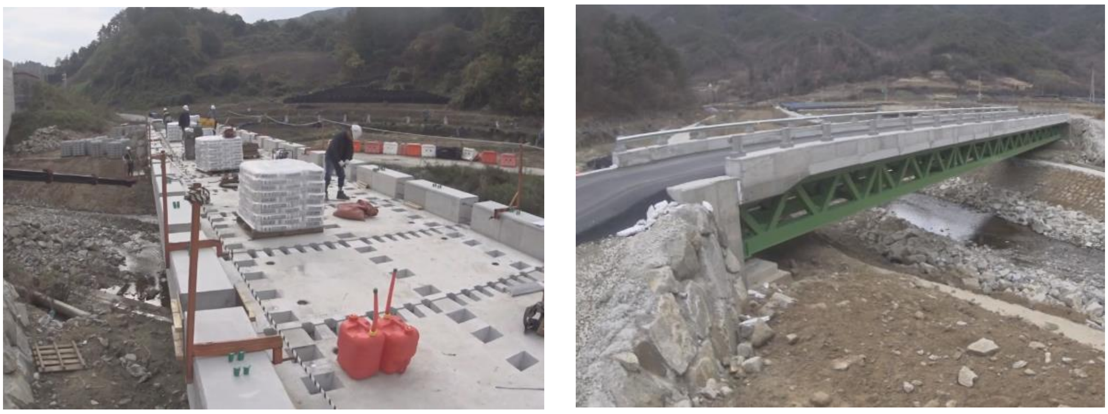
Fig. 4 Test of a two-girder composite bridge using precast decks

The loading setup and configuration of the specimens are shown in Fig. 4. After hydraulic actuators for applying positive and negative moment on the center of the specimen are applied, the deflection and maximum load are measured through the load tests.

## 4. FIELD APPLICATION

Fig. 5 shows the field applications of rapid construction using precast concrete bridge deck with ribbed loop joints. Fig. 5(a) shows a sidewalk bridge that overpasses railway and the precast decks were placed at night when the subway was not in operation. Fig. 5(b) presents a road bridge built by fast construction technique using precast decks without internal tendons.

(a) Pedestrian bridge overpassing railway.



(b) Road bridge

Fig. 5 Field application of the precast concrete bridge deck

## 5. CONCLUSIONS

Precast concrete bridge deck system with ribbed loop joints without internal longitudinal tendons is presented in this research. The precast deck system can be rapidly constructed by placing prefabricated decks on site and pouring non-shrink mortar in the joints of the decks. Flexural performance tests in a composite bridge specimen were implemented to evaluate structural behavior such as structural safety and serviceability of the precast deck system. And field application cases to the real structure using the system are reviewed.

## ACKNOWLEDGEMENT

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## REFERENCES

DAEWOO Corporation E&C (1998). Application and development of precast concrete bridge deck.

DIN 1045 (2001). Plain, reinforced and prestressed concrete structures.

Shim, C. S., Choi, K. Y., and Chang, S. P.(2001). “Design of Transverse Joints in Composite Bridges with Precast Decks”. *J. of Korea Society of Civil Engineering*, 5(1), 17-27.

Chang, S. P., Kim, Y. J., and Ryu, H. K. (2007). “Experimental Study on Static and Fatigue Strength of Loop Joints”. *J. of Engineering Structures*. *Elsevier*, 145-162.

Hao J.B. (2004). “Structural Behavior of Precast Component Joints with Loop Connection”. *Ph.d.-thesis. Department of Civil Engineering, National University of Singapore. Singapore.*

Chang, S. P., Shim, C. S., and Ryu, H, K. (2002). “Application of Precast Decks to Continuous Composite Bridges”. *6th International Conference of Short & Medium Bridges*, 457-464.

Shim, C. S., Lee, P. G., Jang, S. W., and Chang, S. P. (1999), “The Static and fatigue behavior of composite steel-concrete beam with precast concrete decks”, *Journal of the Korean Society of Civil Engineers*, 19(3), 417-425.

Shin, D.H., Park, S.J., Kang, M.K., Kim, I.G., and Kim, Y.J., “Technology Trends Review in Precast Deck Connections”, *Proceedings of the Korea Institute for Structural Maintenance and Inspection*, Vol.18, No.1, 2014, pp.132-135.

Shin, D.H., Park, S.J., Oh, H.C., Kim, I.G., and Kim, Y.J., “Evaluation on Flexural Performance of Precast Bridge Decks with Ribbed Connection”, *Journal of the Korea Institute for Structural Maintenance and Inspection*, Vol.19, No.3, 2015, pp.1-9.