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# Experimental study on shear behavior of the interface between old and new deck slabs

Junichiro Niwa [a], Fakhruddin [a,*], Koji Matsumoto [b], Yuji Sato [c], Masahiko Yamada [c], Takahiro Yamauchi [d]

[a] Department of Civil Engineering, Tokyo Institute of Technology, Japan
[b] Institute of Industrial Science, The University of Tokyo, Japan
[c] Engineering Division, Fuji P.S. Corporation, Japan
[d] Metropolitan Expressway Company, Japan

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ABSTRACT

An experimental study of the interface shear transfer between differently aged concrete (old and new deck slabs) has been performed. The old and new deck slabs parts were crossed by steel bars and subjected to the external prestressing force. The tests were carried out to be representative of a proposed technique used for widening prestressed concrete (PC) highway decks. The experimental program comprised nine specimens tested under double-shear test by taking the initial prestressing levels, connection methods between steel bars, reinforcement ratio and surface roughness as parameters. The experimental results indicated that the failure behavior of the interface was greatly affected by the initial prestressing level, reinforcement ratio and surface roughness of the interface. Finally, a comparison of the experimental shear strength with those given by JSCE Standard Specification, AASHTO and *fib* Model Code 2010 showed a conservative result for low and high prestressing levels, low reinforcement ratio and smooth surface.



## 1. Introduction

Some highway bridges worldwide become functionally obsolete due to inadequate width before they become structurally deficient. The clear width of old bridge has been unable to meet the demand of increasing traffic flow. If the original old bridge is in service, widening may be an attractive option [1].

In the common PC highway deck widening technique as shown in Fig. 1(a), the prestressing tendons in the existing slab should be connected to the new slab [2]. Consequently, some concrete parts in the existing slab should be demolished (at least 1000 mm) to expose the prestressing tendons from the existing slab. The cast-in-place concrete slabs and beams are required for the widening structure. Mechanical anchorage is also needed to increase the integration between the existing and widening structure. Therefore, some problems still exist, such as the need to connect the prestressing tendons that have great effect on traffic of the existing bridge, the massive wet work of the cast-in-place concrete, and high volumes of formwork, which entail great time and financial cost.

To solve these problems, the new widening PC highway deck technique has been proposed in this study and schematically illustrated in Fig. 1(b). It is to be noted that two PC cables (lower and upper) are placed inside the precast ribs and prestressed at the different times. First, the precast rib is installed individually to the old bridge by introducing the first prestressing force to the lower prestressing cables. The distance between two precast ribs is 3000 mm as shown in Fig. 2(a). After that, the precast PC slabs are placed between adjacent precast ribs. The old steel bars are then exposed and connected to the new steel bars. Later, the new RC slab is cast. Finally, the second prestressing force is introduced to the upper PC cable. The advantages of this method are that the existing prestressing tendons need not be connected to the widening structures, and the volumes of cast-in-place concrete and formwork in the construction site can be reduced.

As shown in Fig. 2, the target location of this study was the connection between the old and new deck slabs, exactly at the midspan between two precast ribs (spacing of 3000 mm). When the second prestressing force is introduced to the upper PC cable, some portion of the compression force will be transferred to the new deck slab and subsequently to the interface between the old and new deck slabs through an interface between the precast rib and

* Corresponding author at: M1-17, 2-12-1, O-okayama, Meguro-ku, Tokyo 152-8552, Japan.
*E-mail addresses:* fakhruddin.m.aa@m.titech.ac.jp, fakhrud.civil05@gmail.com (Fakhruddin).

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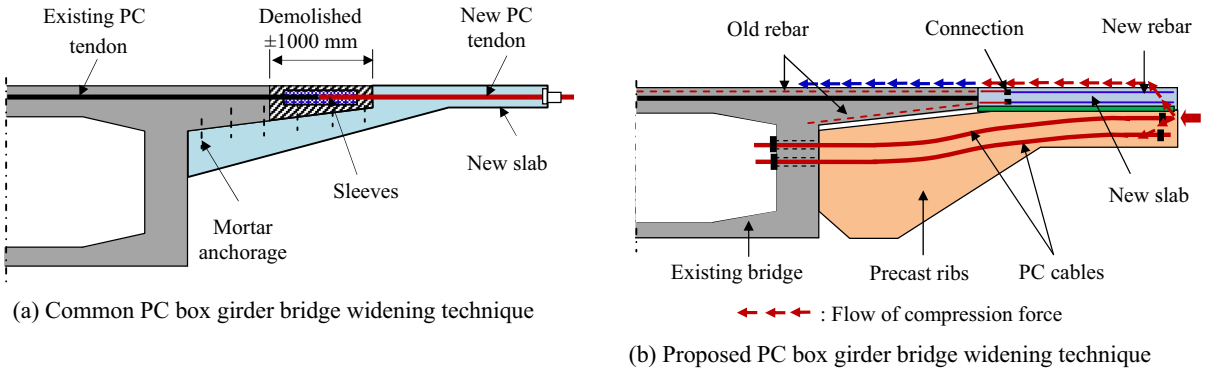
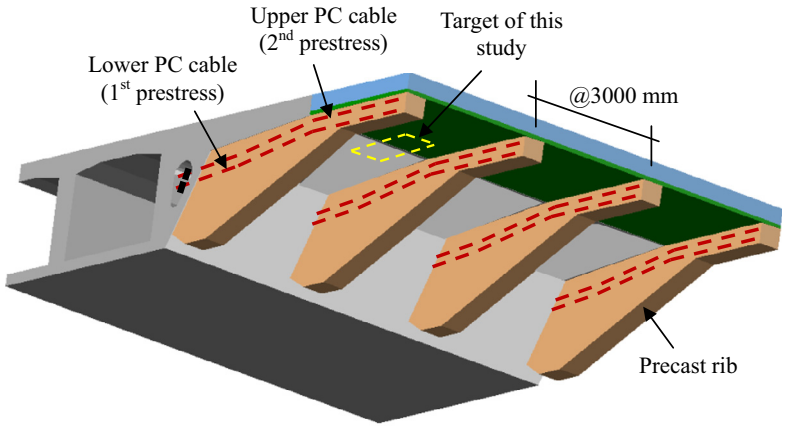


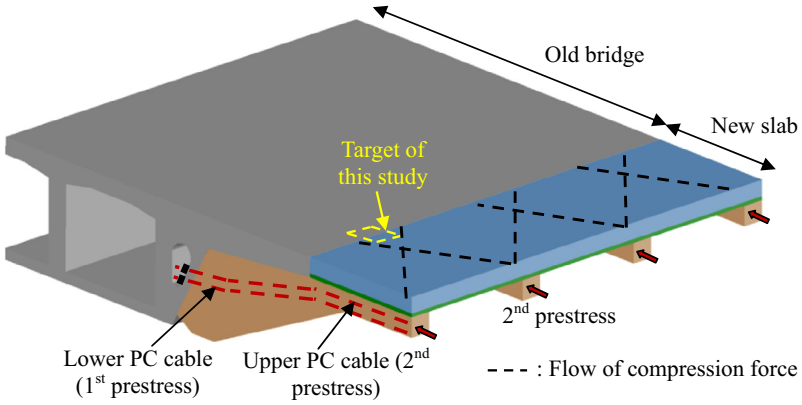

(a) Common PC box girder bridge widening technique

(b) Proposed PC box girder bridge widening technique

**Fig. 1.** Comparison between the common and proposed PC box girder bridge widening technique.




(a) Arrangement of precast ribs and prestressing cables




(b) Flow of compression force after introducing the second prestressing to upper PC cable

**Fig. 2.** Isometric view of the new bridge widening technique.

precast PC slab and another interface between the precast PC slab and the new deck slab. The remaining portion of the prestressing force (introduced by the upper PC cable) is transmitted by the precast rib to the girder web. These behaviors are illustrated in Figs. 1(b) and 2(b). To simulate the portion of the compression force transferred to the interface in the experimental test, the prestressing force was introduced to the interface by using the external prestressing rods. The amount of the compression force transferred to the interface became the main parameter of this study. Moreover, various parameters regarding the construction sequences and details were also carefully selected, such as the connection method between steel bars, reinforcement ratio, and surface roughness of the interface. Furthermore, the results of these parameters will be considered for the direct application of the proposed method.

For this aim, the strip specimen representing the deck slabs section subjected to external prestressing force was used. Several tests have been performed by many researchers to examine the shear strength of the interface with and without compression forces. The investigations with the external compression forces have been conducted by Turmo et al. [3], Zhou et al. [4] and Wakasa et al. [5]. These works, however, were most likely limited to the testing of shear keyed joints without any reinforcement crossing the interface. The investigations of the interface shear strength without external compression forces have been performed by many