Continuous Prestressed Concrete Box Girder Bridge using P&Z Method — Tokai-Kanjo Expressway Nagaragawa Bridge —

P & Z 工法による PC 4 径間連続箱桁橋の施工 — 東海環状自動車道 長良川橋 —

* Hidekatsu OKABAYASHI: P.S. Mitsubishi Construction Co., Ltd.
岡林 秀勝: (株)ピーエス三菱
** Masahiro KAWASHIMA: P.S. Mitsubishi Construction Co., Ltd.
川嶋 正宏: (株)ピーエス三菱
*** Tsuyoshi HASEGAWA: Ministry of Land, Infrastructure, Transport and Tourism
長谷川 強: 国土交通省
Contact: okabayashi@psmic.co.jp
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Synopsis
The Nagaragawa Bridge on the Tokai-Kanjo Expressway is a 343 m long bridge crossing the Nagara River. P&Z cantilever construction method was used in this project for the purposes of enabling year-round construction for a reduced construction period and minimizing environmental impact to the river which was famous for its clear water and traditional cormorant fishing. This report describes the construction of the superstructure of the bridge using the P&Z method.

Structural Data
Structure: 4-span continuous prestressed concrete box girder bridge
Bridge Length: 343 m
Span: 59.5 m + 2 × 111.0 m + 59.5 m
Width: 25.027 m − 24.575 m
Owner: Ministry of Land, Infrastructure, Transport and Tourism
Designer: Nippon Engineering Consultants Co., Ltd.
Contractor: P.S. Mitsubishi - Obayashi JV

Location: Gifu Prefecture, Japan

1. Introduction
The Tokai-Kanjo Expressway is a ring motorway with an extension of 160 km that links major cities located 30 to 40 km from Nagoya City and forms a wide-area expressway network in the Tokai region together with Tomei, Meishin, Chuo, Tokai-Hokuriku and other expressways. The Nagaragawa Bridge on the Tokai-Kanjo Expressway is a 343 m long bridge crossing the Nagara River which is famous for its clear water and cormorant fishing (Fig. 1). The inner (westbound) and outer (eastbound) lanes of the east-west bridge were constructed as separate single-chamber box girders and connected with each other at the upper slab and cross beams for the three of four spans (Fig. 2). The P&Z method was used in this project for the purposes of enabling year-round construction for a reduced construction period and minimizing environmental impact to the river.

Fig. 1 Side view of the Nagaragawa Bridge
impact to the Nagara River\textsuperscript{1}. This report describes the construction of the superstructure of the bridge using the P&Z method.

2. Features of the P&Z Method

The P&Z method is a prestressed concrete bridge erection system developed by Polensky & Zöllner, a German construction company. A launching gantry, or movable erection girder, is installed on the superstructure of a bridge, with two forms hanging from the gantry for segmental cantilever construction on the front and rear of a pier (Fig. 3). Many bridges have been built using this method not only in Europe but in Japan as well (Table 1). This system requires no work from the ground and has a high degree of freedom in terms of applicable span length range (50 to 120 m; Table 2). This makes the system very useful in building multi-span continuous bridges over the sea or a river or across a gorge where scaffolding cannot be built. Features of the P&Z method are summarized below.

- No restrictions from the conditions below the girder:
  Since no work is required from the ground, this system is applicable irrespective of the conditions below the girder such as the sea, a river, a gorge or a built-up area. Work on the column heads is also possible without using cranes or scaffolding near the pier. In this project materials supplied from the ground were carried through the launching gantry, with no additional structures built in the Nagara River, minimizing the environmental loads of the construction to the river.

- Fast construction:
  Construction length per segment (about 10 m) is longer than that in ordinary cantilever construction, and one segment can be completed in about 11 to 12 days. This enables faster construction and a shorter construction period. Assembly of the platform and erection girder during the substructure construction also shortened the

\begin{table}[h]
\centering
\caption{Bridges built by the P&Z method}
\begin{tabular}{|l|l|l|l|}
\hline
Bridge name & Location & Bridge length [m] (max. span) & Construction period \\
\hline
Tsuikiyono Bridge & Gunma & 306.8 (84.5) & 1981-82 \\
Tonegawa Bridge & Gunma & 560.0 (80.0) & 1982-84 \\
Koshirazu Viaduct & Niigata & 422.5 (59.5) & 1986-87 \\
Gassan Bridge & Yamagata & 474.0 (112.0) & 1996-98 \\
Narusegawa Bridge & Miyagi & 488.9 (85.0) & 1997-99 \\
Hamayu Bridge & Shizuoka & 790.0 (95.0) & 2001-04 \\
Yoshimine Bridge & Fukui & 443.5 (50.0) & 2005-07 \\
Nagaragawa Bridge & Gifu & 343.0 (111.0) & 2006-09 \\
\hline
\end{tabular}
\end{table}

\begin{table}[h]
\centering
\caption{Applicable span lengths of the P&Z method}
\begin{tabular}{|c|c|c|c|c|c|c|}
\hline
Span (m) & 0 & 50 & 100 & 150 & 200 & 250 \\
\hline
Precast girders & \checkmark & & & & &  \\
Stationary scaffolding & & \checkmark & & & &  \\
Movable scaffolding & & & \checkmark & & &  \\
Incremental launching & & & & \checkmark & &  \\
P&Z cantilever & & & & & \checkmark & \\
Conventional cantilever & & & & & & \checkmark \\
\hline
* Requires temporary bents.
\end{tabular}
\end{table}
construction period.

- Labor saving mechanization:
  This method is mechanized with electrical equipment, achieving great saving in labor. The cyclic steps allow the operators to learn skills and improve work efficiency. Labor saving efforts in this project included mechanical and hydraulic operation of the launching gantry system and the form open-close system for clearing the piers during transfer.

- High degree of freedom in design:
  With segmental cantilever construction combined with movable scaffolding, this method can be applied to span lengths from 50 to 120 m and long span bridges. The same equipment can be used to build bridges with different spans. Applications also include curved bridges and bridges with varying cross section.

- Reduced unbalanced moment:
  The erection girder absorbs load differential caused by asymmetric cantilever construction, preventing excessive unbalanced moment from occurring at the column head during construction. This allows making temporary fixing work smaller for construction of a continuous girder and reduces bending moment occurring in piers of a rigid frame structure.

3. Construction

Fig. 4 shows the operation steps, and Fig. 5 shows the

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schematic of the construction by the P&Z method. The first step is assembly of the launching gantry. In this project a work platform consisting of an erection girder and steel bents was installed behind P4 for this work (Fig. 6). The completed launching gantry was moved to P3 to start cantilever construction. The launching gantry was moved from P3 to P2 and then to P1 to continue construction (Fig. 7). This bridge consists of two single-chamber box girders built in parallel and connected together using cast-in-place slabs. Therefore, when the inner lane girder was completed, the launching gantry weighing about 5000 kN was returned to P3 and shifted laterally to the position for the outer lane construction (Fig. 8). The inner and outer lane girders of this bridge share the same piers. In order to prevent interference of these piers with the hanging forms during transfer, the form open-close system was modified from the original double door type to the single door type (Fig. 9).

4. Conclusion

The advantages of the P&Z method were fully utilized in this project, with the standard cycle period (11 to 12 days) achieved by various labor saving efforts including preassembly of web reinforcing steels. The bridge was completed in March 2009, without any construction related accidents (Fig. 10). The authors hope this report would be of help for similar bridge projects in future. The authors express their appreciation to all related parties and local communities who cooperated in this project.

References