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 —



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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
Construction Period: Mar. 2006 – Mar. 2009
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

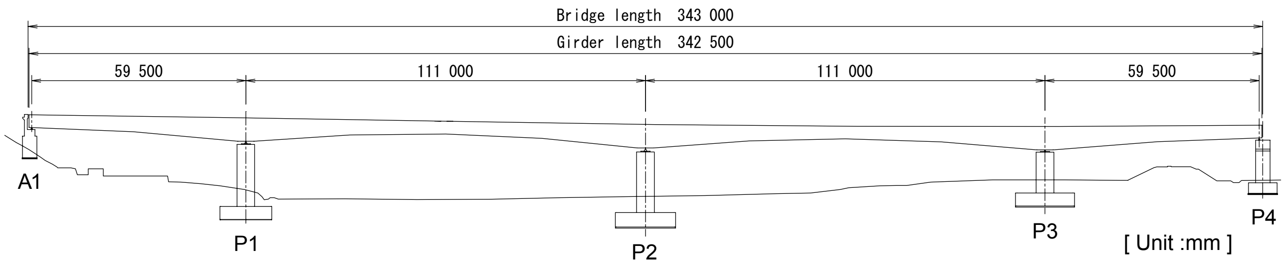


Fig. 1 Side view of the Nagaragawa Bridge

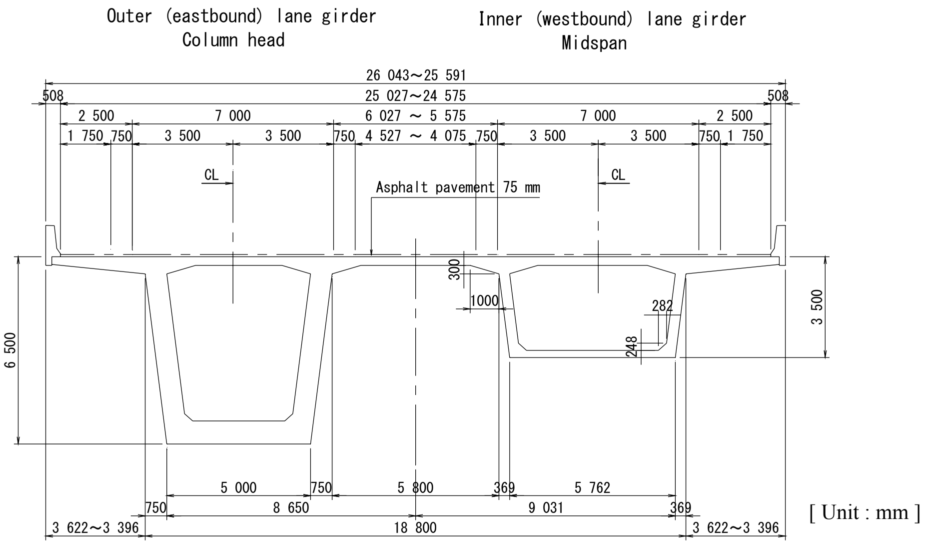


Fig. 2 Cross section

impact to the Nagara River[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:

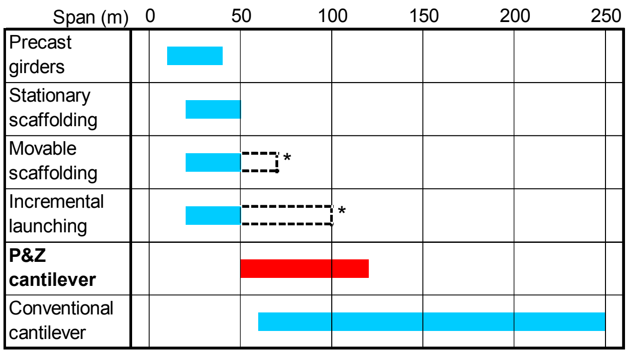
Construction length per segment (about 10 m) is longer than that in ordinary cantilever construction, and one segment can be completed in about 11 to 12 days. This enables faster construction and a shorter construction period. Assembly of the platform and erection girder during the substructure construction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

Fig. 3 Construction by the P&Z method

Table 1 Bridges built by the P&Z method

Bridge name	Location	Bridge length [m] (max. span)	Construction period
Tsukiyono 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

Table 2 Applicable span lengths of the P&Z method



* Requires temporary bents.

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

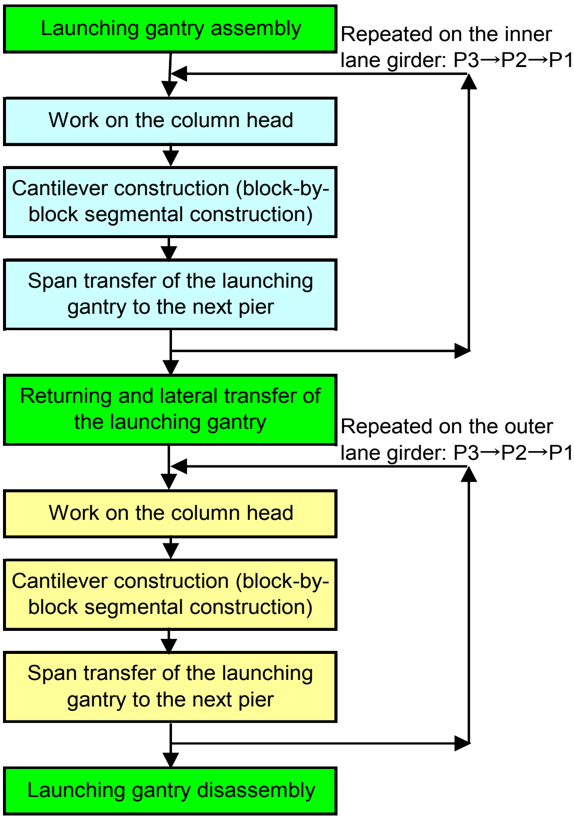


Fig. 4 P&Z method work steps

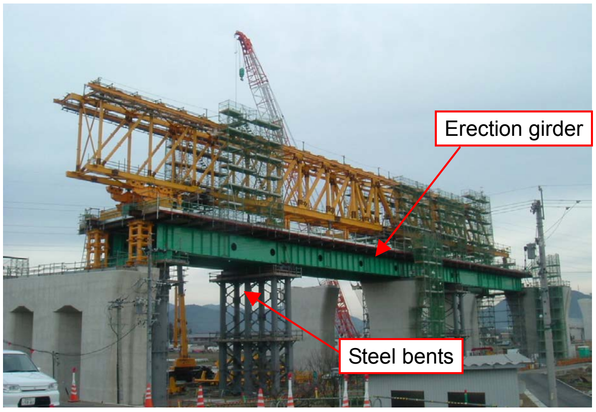


Fig. 6 Launching gantry assembly

Fig. 7 Launching gantry in transfer

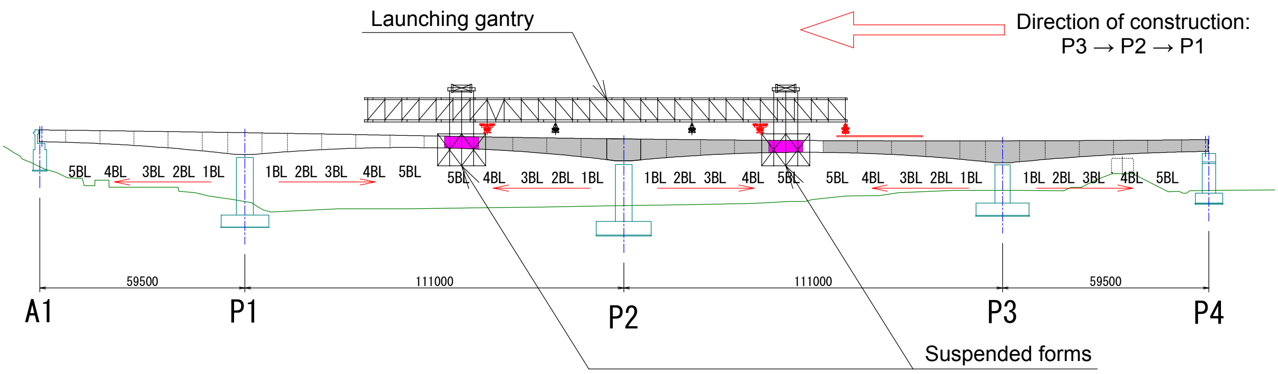


Fig. 5 Schematic of the P&Z method

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

[1] Hasegawa, T., Kawashima, M., Hanai, N.: *Construction of Nagaragawa Bridge*, Bridge and Foundation Engineering, Vol. 43, No. 7, Kensetsutosyo, Tokyo, pp. 5-11, Jul. 2009 (in Japanese)

Fig. 8 Launching gantry shifted from left to right

Fig. 9 Single-door form opened to clear the pier

Fig. 10 Completion of the bridge

概　要

東海環状自動車道は，名古屋市の周辺 30 km から 40 km 圏に位置する諸都市を連絡する環状道路であり，東名・名神高速道路，中央自動車道，東海北陸自動車道などと一体となって東海圏の広域ネットワークを形成する延長約 160 km の自動車専用道路である。

長良川橋は，東海環状自動車道のうち，鵜飼いで有名な清流長良川を東西に跨ぐ，橋長 343 m の橋梁である。本橋は，内回り線（西行き）と外回り線（東行き）を別々に 1 室箱桁として施工し，それぞれの完成後に 4 径間のうち 3 径間部分について上床版および横桁を連結し，内回り線と外回り線を一体化する構造である。また，本工事では通年施工による工期短縮と清流長良川への環境影響低減を目的として P&Z 工法が採用された。本稿は，P&Z 工法による上部工の施工について報告するものである。