Construction of Viaduct Applying New Span-by-Span Erection
— Viaduct of Aoyama Area —

新しいスパンバイスパン架設工法を採用した PC 高架橋の施工
— 青山地区高架橋 —

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Synopsis
The Second Keihan Expressway in Japan, linking Kyoto and Osaka was constructed to bypass the existing road in order to ease the heavy traffic for the local residents. In the bridge construction of the expressway, rapid construction, environmental protection and improvement of safety as well as cost saving are required. To meet such requirements, the unique segmental construction method which suit for the site condition was newly developed in the prestressed concrete viaducts of Aoyama area.
In Aoyama area, it was difficult to have wide casting area near the site or free space below the viaduct due to the site condition. Therefore, after the first starting span was constructed, the deck on the first span was used as an assembling area of precast segments. Segments were lifted and connected by prestressing, moved toward the newly erecting span, and then hung with an erection girder and positioned. The erection method is called “Span by span erection with rear assembly system”.

Structural Data
Structure: 20-span continuous box-girder
Bridge Length: 812.0m
Span: 40.0m, 41.0m
Width: 29.640m
Owner: Kinki Regional Development Bureau, Ministry of Land Infrastructure, Transport and Tourism
Designer: Sumitomo Mitsui Construction Co., Ltd
Contractor: Sumitomo Mitsui Construction Co., Ltd
Location: Osaka Prefecture, Japan

1. Introduction
The Second Keihan Expressway linking Kyoto and Osaka has been constructed as a bypass of the existing national route (**Fig. 1**). Since the expressway passes the suburban residential area, accelerated construction and reduction of the environmental impact during construction as well as improving the safety etc. are required for the construction of the expressway.

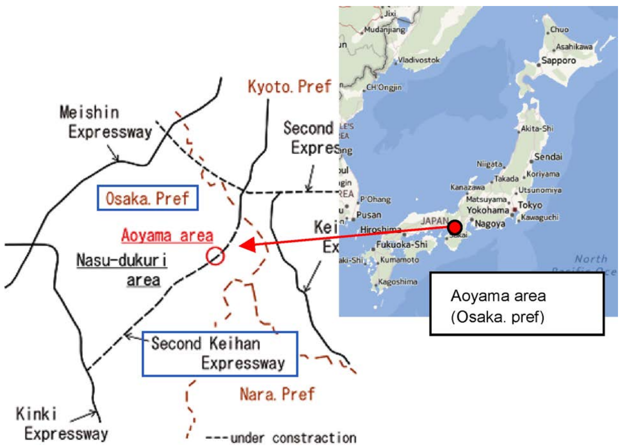

Fig. 1 The Second Keihan Expressway

In Aoyama Area, it was impossible to have enough construction yard around the viaduct, and also it was impossible to use the area under the superstructures due to the topographical conditions. The segments were fabricated at the concrete factory and transported to the site. The girder was divided into several segments longitudinally and the already completed

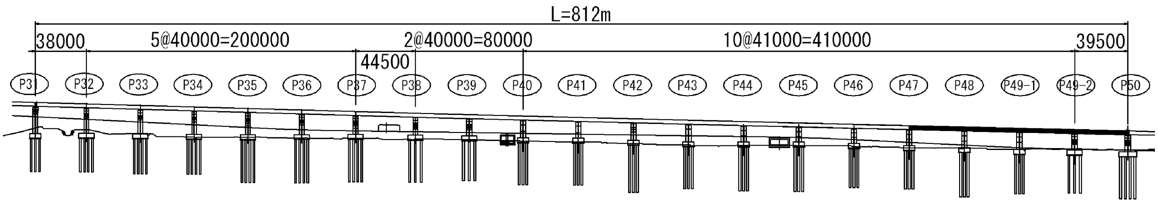

Fig. 2 General view

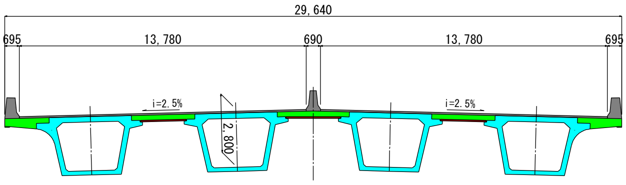

Fig. 3 Cross section

Table 1 Project outlines and properties

Project	Aoyama Viaduct
Profile	20 spans prestressed concrete viaduct
Period	Sep.2007 - Dec.2009
Length	812m
Spans	40m, 41m
Effective Width	2@13.780m
Alignment	R = ∞ - A = 500
Vertical Alignment	2.96% - 2.336%
Horizontal Alignment	2.500%

deck was used as the assembling yard of the segments. The transported segments were lifted up, put on the deck and jointed as a girder. Then the girder was transported on the deck to the newly erecting span with the erection girder. This erection method is called "Span-by-span erection with rear assembly system".
In this viaduct, accelerated construction could be achieved by developing the conventional erection methods, which are suitable for their own construction conditions. It could shorten the erection cycle and could also save the construction cost.
This paper describes this new erection method.

2. Project Summary

(1) General Features

General view of the viaduct is shown in **Fig. 2**, and the cross sections of the girders are shown in **Fig. 3**. The project summary and the viaduct properties are also shown in **Table 1**. The design-built bidding was applied, and the construction method was proposed by the contractor.

(2) Requirements for the Projects

During construction period in the project, following requirements were imposed.

1) Construction period is about two years. However, considering the time for the detail design and other preparation work, only 18 months were remained as the direct construction periods. Therefore, strong time reduction was required.
2) This viaduct is located in the quiet residential area. Therefore, the environmental impact had to be strongly reduced.

3. Construction of the Viaduct in Aoyama Area

(1) Outline of the Erection Method

Since it was impossible to have the casting yard near the construction site and it was difficult to use the area below the superstructures in Aoyama Area, existing concrete factory was utilized as the fabrication yard for the precast segments of the girder. After the factory-fabricated precast segments were transported from the factory to the construction site, the segments are then lifted and assembled on the already constructed deck as an assembling yard. This erection method is called "the span-by-span erection with rear assembly system". The core segment without some length of overhang slab could save the weight of the girder during construction (**Fig. 4**). Transversal movement devices were used in order to reduce the number of erection girder, and the cost of the erection girder was reduced substantially.

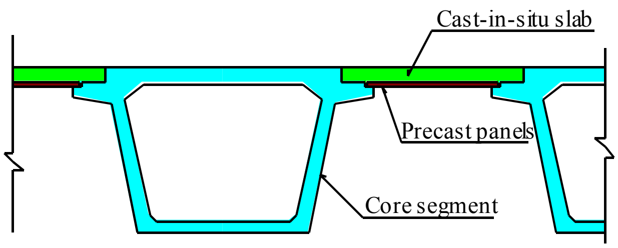

Fig. 4 Girders and slab structures

Construction procedure of the erection method is shown in **Fig. 5** as followed, and the standard construction cycle of the superstructures is shown in **Table 2**.

1) Segments of the girder No.1 are put and jointed together on the already constructed deck. The assembled girder is transported toward the erection girder along the deck and erected with the erection girder. The weight of a girder is about 3,500kN.
2) The girder No.1 is horizontally and transversally moved by the devices and then tensioned. The following girder No.2 is also assembled, transported and erected from the rear span continuously.
3) After the girder No.3 and the girder No.4 are erected in sequence and all the four girders are erected, precast panels are placed and the erection

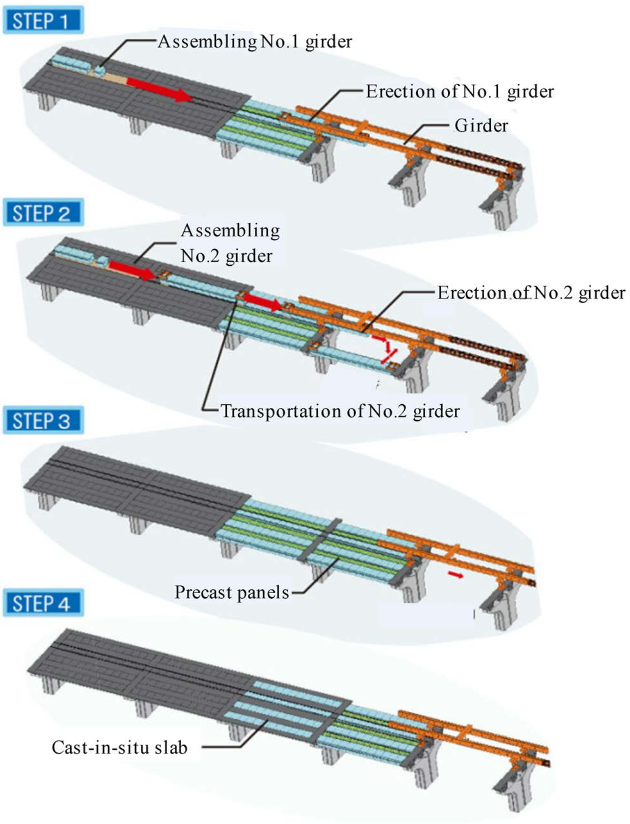

Fig. 5 Overview of the span-by-span erection with near segment assembly

Table 2 Construction cycle

	1	2	3	4	5	6	7	8	9	10	11	12
main girder 1	E		J		S	Er						
main girder2			E		J		S	Er				
main girder3					E		J		J	S	Er	
main girder4							E		J	S	Er	
erection girder	Er											Er

E : Erection J : joint concreting
S : Stressing Er : Erection Girder Equipment

girder is moved toward the next span.

4) Slab concrete is placed.

In Aoyama Area, transporting the segments, lifting up to the deck and joining were performed in one day, and the transportation, erection and transversal movement of the girder on the next day. The segments of the next girder were transported to the site in two days later. Joining work of the next girder was performed concurrently at the rear assembling yard while the installation and tensioning were performed in the erecting span. As results, the construction cycle in one span of four girders took two weeks.

Compared with the conventional span-by-span erection method, this erection method could construct 1/2-1/3 faster by the number of days.

(2) Assembly and Erection of the Segments

Thirteen pieces numbers of segments were transported from the factory with trailers at a time. The segments were placed on the deck with a crane, jointed together as a girder (**Fig. 6**). Then the girder was prestressed and put on the carriers.

Devices for transversal movement were installed at the upper part of both ends of the girder, and the girder was transported toward the erecting span (**Fig. 7**). Since the weight of the girder and the devices reaches about 3,500kN and the girder transported on one of four existing girders, the stress of the girder due to the loading was verified and additional prestressing tendons were arranged.

Fig. 6 Assembling the segments

Fig. 7 Transportation of the girder

After the girder was transported toward the erecting span, the girder was hung by the crane installed on the erection girder (**Fig. 8**). The devices for transversal movement were installed on the rail on the pier segments, and the devices with the girder were moved transversally to the fixed location (**Fig. 9**).

Closure joints were placed at between end of the girder and the pier segments, supported with the transversal movement devices. After placing concrete, each girder was externally prestressed and then the supporting devices were released.

(3) Construction of Slab

Precast panels were placed between the top of the girders (**Fig. 10**), and re-bars assembly and concrete placing were conducted (**Fig. 11**).

By using precast panels with labor saving, the slab

Fig. 8 Erection of the girder

Fig. 9 Transversal movement of the girder

could be constructed at the same days of the erection of four girders in the next span. This procedure was quite effective way to achieve the required construction period.

4. Conclusion

It has been considered that the conventional span-by-span erection using conventional multi precast segments is suitable for the construction of the large-scaled continuous urban viaduct project for the cost saving, achieving the high quality and for the accelerated construction. However, in the urban viaduct projects, there might be some severe site conditions as mentioned above. In such cases, the construction method which newly developed and adopted in the viaduct in Aoyama Area the Second Keihan Expressway can be good solutions. In this project, the rate of construction speed of 2,400m^2 per month was achieved.

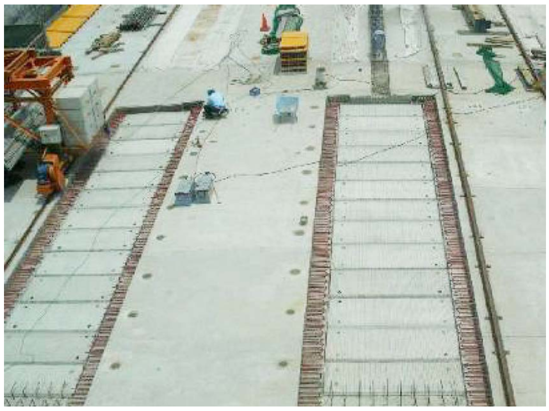

Fig. 10 Precast panels

Fig. 11 Cast-in-situ slab

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概　要

第二京阪道路は，6 車線の自動車専用部と 2 ～ 4 車線の一般部から構成される道路である。青山地区高架橋工事は，大阪府交野市において第二京阪道路の一区間を建設する工事であり，延長812m の自動車専用部と高架下の一般道改良を行う工事である。コスト縮減，品質確保に加え，早期開通のための急速施工，民家の密集地における工事の環境負荷低減等を大きな要求事項とした設計・施工一括発注方式により発注され，上部工の施工に新たに開発した「後方組立方式スパンバイスパン工法」が採用された。

本工法は，工場製作のプレキャスト部材を多用するもので，工程短縮が図れ，架橋現場での施工量を減らして環境負荷を低減できる。工場から搬入したセグメントを既設の橋面上で 1 径間分の主桁に組み立て，橋面上を運搬してエレクションガーダーにより架設するもので，工程短縮を可能とする工法である。本工事では，総幅員約30m の 4 主箱桁を 2 週間に 1 径間，橋面積2400m^2/月の施工速度を実現した。