Construction of Precast Segment Bridge with Consideration of Biodiversity Conservation
— The New Tomei Expressway Matoba Viaduct —

生物多様性に配慮したプレキャストセグメント橋の施工
— 的場高架橋 —




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Synopsis

The Matoba Viaduct is a continuous prestressed concrete box girder bridge located within the Hamamatsu-Inasa Junction on the New Tomei Expressway. The viaduct crosses the Matoba River, which is one of the most important habitats for fireflies. Today, public works are expected to take the environment into consideration, so to ensure conservation of biodiversity, the design of the viaduct took special measures to minimize the impact on the river environment when constructing the main Matoba Viaduct and Ramp D Viaduct 3. To achieve these objectives, the viaducts were constructed by cantilever erection using precast segments so as not to require full staging at the site.

Structural Data

Structure: (Eastbound Lane) 9-span continuous prestressed concrete box girder bridge
(Westbound Lane) 7-span continuous prestressed concrete box girder bridge
(Ramp D-3) 5-span continuous prestressed concrete box girder bridge
Bridge Length: (Eastbound Lane) 403.5m,
(Westbound Lane) 364.0m,
(Ramp D-3) 234.0m
Span: (Eastbound Lane) 27.9m + 7@48.0m + 37.4m
(Westbound Lane) 55.4m + 2@60.0m + 44.5m + 48.0m + 48.5m + 45.4m
(Ramp D-3) 48.9m + 3@46.0m + 44.9m
Width: (Eastbound Lane) 11.625m,
(Westbound Lane) 11.625m,
(Ramp D-3) 8.500m
Owner: Central Nippon Expressway Co.,Ltd., Japan
Location: Shizuoka Prefecture, Japan

1. Introduction

The section of the New Tomei Expressway in Shizuoka prefecture between Gotenba Junction and Mikkabi Junction (Total length 162 km) went into service in April, 2012, boosting the reliability of the transportation system by forming a double network with the existing Tomei Expressway. The Matoba Viaduct is a continuous prestressed concrete box girder

Fig.1 Matoba viaducts

bridge forming part of this new section, located within the Hamamatsu-Inasa Junction.
Special construction requirements for the Matoba Viaduct were conservation of the environment of the Matoba River within the construction site, and a short construction period to enable early handover of the construction yard of the main viaducts and Ramp D Viaduct 3 for pavement construction.

2. Outline of Construction

The Matoba Viaduct project consisted of a total of four viaducts, comprising the main Eastbound Lane and Westbound Lane viaducts ("main viaducts"), Ramp C Viaduct 3, and Ramp D Viaduct 3 ("Ramp D-3"). With the exception of Ramp C Viaduct 3, which is positioned away from the Matoba River, each of these viaducts is designed to minimize the impact of construction on the river environment and to shorten the construction period by using precast segments erected by a cantilever erection. The project incorporated proactive biodiversity conservation by working together with local residents and creating a biotope within the construction site where fireflies can lay their eggs.
The main viaducts used cantilever erection of segments comprising the core section plus ribs. The deck slab is then cast in place after erection. This approach gives a prestressed concrete panel composite slab structure that is efficient to construct. For Ramp D-3, the complex linear shapes typical of expressway ramps required sophisticated management for segment fabrication. As a result of these measures, the viaduct was successfully completed without problems. This report focuses on the design and construction technology that enabled a short construction period despite incorporating special measures to conserve the environment.

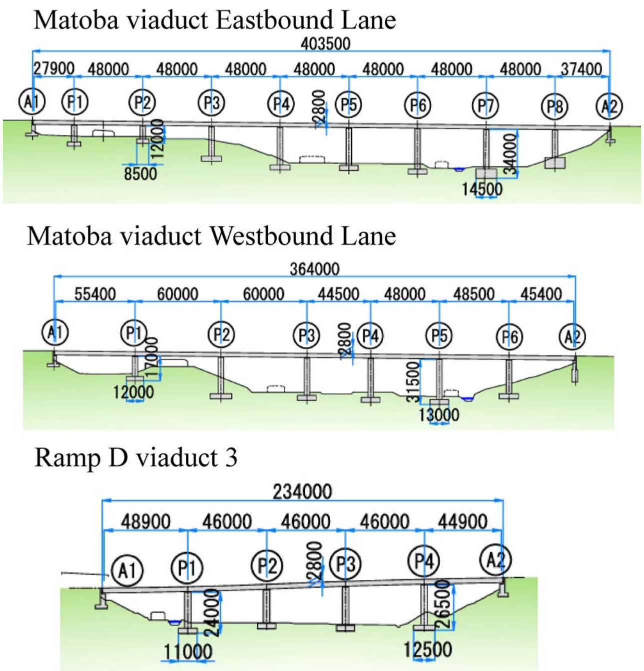

Fig.2 General view

The general views of the structures are shown in **Fig.2**.

3. Cantilever Erection Using Precast Segment

For the main viaducts, the segments were transported on the deck slab of the viaduct and then erected using erection girder. For Ramp D-3, in order not to disturb the fireflies' habitat, the segments were erected from an existing road using a crawler crane. Consequently, the assembly of formwork and steel reinforcements, the placement of concrete, and other work normally performed at the erection site could largely be performed at a separate location. As a result, the work at the erection site was greatly reduced and successfully minimized the environmental impact of the river (**Fig.3**). The erection of the main viaducts and Ramp D-3 are outlined below, together with a description of special approaches used in the cantilever erection of precast segments.

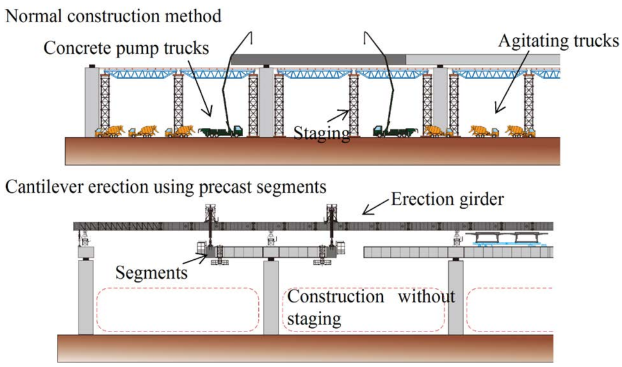

Fig.3 Comparison of construction methods

(1) Outline of Main Viaduct Erection

The steps used in erection of the main viaducts are shown in **Fig.4**. The pier head is constructed first as a cast-in-place unit. The segments are then cast in a casting yard established on the earthworks area behind abutment A2, transported on the slab deck of the viaduct on trolleys, and then erected using erection girder (**Fig.5**). The weight of the erection girder was about 420 t. This approach enabled the elimination of temporary piers and large staging in the vicinity of the river, minimizing the impact of construction on the river environment. The cantilever construction was performed using core segments so that prestressed concrete panels could be laid directly onto ribs after erection, and cast-in-place concrete then placed on the panels, producing a prestressed concrete panel composite slab structure. This prestressed concrete panel composite slab structure was adopted for the purpose of reducing the weight of segments, and also allowed smaller equipment to be used for segment casting and transportation. The size of reduction of erection equipment minimized environmental impact on the river and also economical, as the cost of the erection process was similar to the cost of erection using staging.

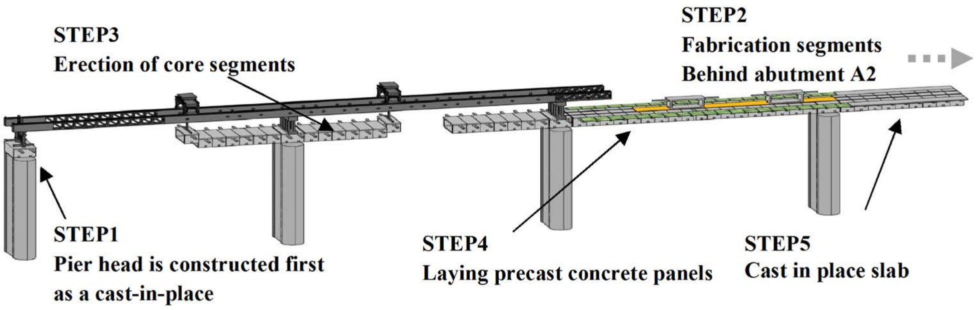

Fig.4 Construction step of main viaduct erection

Fig.5 Cantilever erection using erection girder

Fig.7 Cantilever erection using a crawler crane

(2) Outline of Ramp D-3 Erection

As ramp D-3 runs alongside the Matoba River, a precast segment construction method like that for the main viaducts was used in order to minimize impact on the river environment. To avoid impact on the firefly habitat, erection work on the area immediately adjacent to the Matoba River was paused from March to June when the fireflies are active on land.

The steps used in erection of Ramp D-3 are shown in **Fig.6**. The pier head is constructed first as a cast-in-place unit using full staging. The segments are then cast in a casting yard established on the earthworks area behind abutment A2, transported along a public road on a low bed trailer, and then erected using a crawler crane (**Fig.7**). The segments were erected using cantilever erection for piers P1 - P4, and full staging for the side spans at abutments A1, A2, which are located away from the river. The initial plans called for erection using full stagings, but this method greatly reduced the installation of stagings close to the river.

4. Segment Fabrication

The segments were fabricated by casting using a short line match cast method in a casting yard set up on the earthworks area behind abutment A2. It is a method of fabricating a NEW segment by using OLD segment as a cross section formwork (**Fig.8**). Three fabricating beds

Fig.8 Short line match casting method

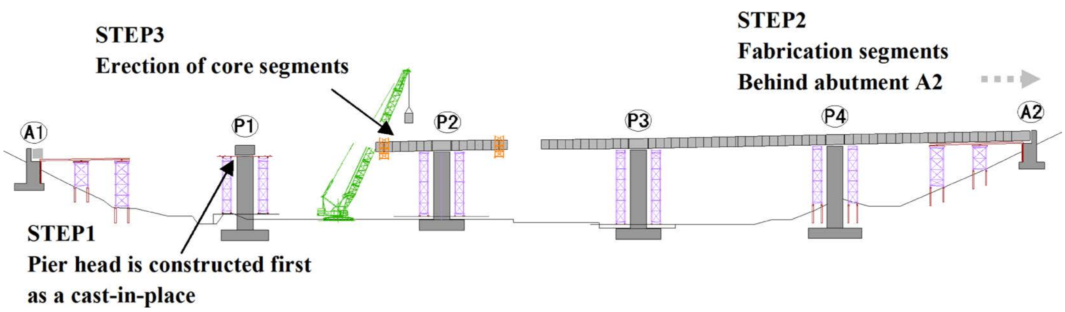

Fig.6 Construction step of Ramp D-3 erection

were used to cast 148 segments for the Eastbound Lane and 138 segments for the Westbound Lane and 110 segments for the Ramp D-3, with the heaviest segment weight of 43 t.

5. Ultra-High Strength Strand Used For External Tendons

For the external tendons, 19φ15.7 epoxy-coated tendons with ultra-high strength strands (tensile strength = 2233MPa / yield strength = 1900MPa) were introduced (**Fig.9**). This operation gave tensile strength and yield strength that were approximately 20% higher than those for conventional 19φ15.2 tendons, enable the reduction of the amount of tendons. Segment weight could be reduced and enable to leave space within the girder for maintenance access. The use of stronger tendons also reduces the weight of tendons, which contributes to reducing CO_2 emissions at the manufacturing stage.

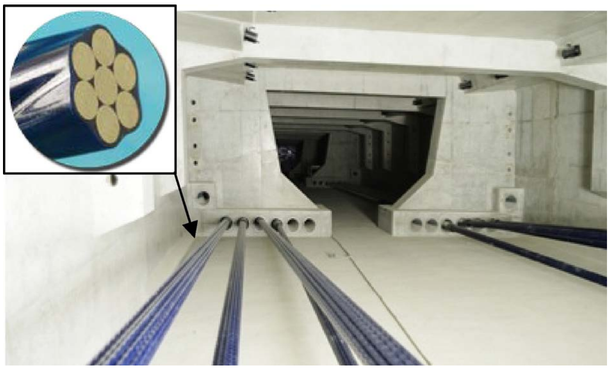

Fig.9 Epoxy-coated tendons with ultra-high strength strands

6. Conservation of Firefly Habitant During Construction

Adopting a precast segment construction method created a space below the viaduct, which was used to construct a firefly biotope (**Fig.10**). River improvement work has changed the cross-section of the Matoba River, and the sandbanks and similar places that provide a habitat where firefly larvae can hatch are now often inundated when the level of water in the river rises. The biotope was designed to provide an additional riverside area for the fireflies to lay their eggs. It was designed by Prof. Yamada at Fuji Tokoha

Fig.10 Over view of firefly biotope

University, providing a total of 45 m of restored river environment with rocks, trees, and grass. The water flowing through the biotope is provided by gravity feed to ensure the permanence of the facility.

7. Conclusions

Construction of this viaduct required conservation of the Matoba River environment and a short construction term. Selecting cantilever erection with precast segments as the construction method minimized the environmental impact.

Through this project, many new ideas were tried in order to take conservation of the environment into consideration in construction. By efforts to maintain the Matoba river environment during construction, the habitat of fireflies was able to be sustained. In addition, by placing the biotope, we could expand the habitat of fireflies. More over, we told the younger generation the importance of the natural environment of the region. We would like to hope that the environment will be maintained in the future.

We hope that this paper will be of use for planning future bridges with consideration for the environment.

References

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概　要

的場高架橋は新東名高速道路の浜松いなさジャンクション内に位置する PC 連続箱桁橋である。近年，建設工事においては，環境に配慮した施工が望まれている。本橋の架橋位置には，ホタルの生息箇所として有名な的場川があり，その生物多様性保全対策として的場川を横断する的場高架橋上下線，D ランプ第三橋を，河川環境への影響を最小限とし，かつ工期を短縮するために，架橋位置で固定支保工による施工を行わないプレキャストセグメントによる張出し架設工法で施工した。また，本工事では，現場内にホタルの産卵場としてビオトープの整備を行うなど，積極的に生物多様性保全活動に取り組んだ。