Design and Construction of the AOKIGAWA Bridge — New Tomei Expressway —

第二東名高速道路青木川橋の設計と施工

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Fig.1 Aokigawa Bridge

Synopsis

Aokigawa Bridge is the one of the major bridges, which consists the New Tomei expressway (Total 254km) in Aichi prefecture in Japan. The tender was carried out with the total evaluation system including a design–build system for the first time as the Owner, Central Nippon Expressway Company Ltd. The TAISEI-Oriental Shiraishi JV was awarded on January 2007. The construction work started soon after the detail design work and the bridge completed on May 2013 (**Fig.1**).

New Tomei expressway will be fully completed on 2020.

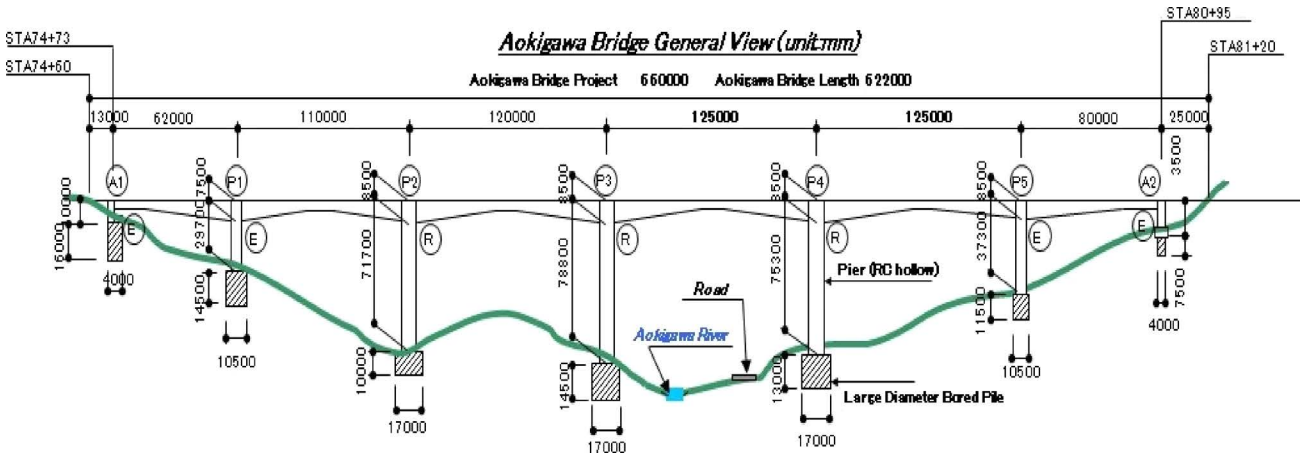

Fig.2 General view

Structural Data

Super Structure: Prestressed concrete 6-span continuous box girder with steel corrugated webs
Bridge Length: 622m
Span: 62m + 110m + 120m + 125m + 125m + 80m
Width: 21.65m
Sub Structure: Bored pile foundations (φ4.0 - 17.0m), Reinforced concrete hollow piers (H = 29.7 - 78.8m), Reinforced concrete abutment
Owner: Central Nippon Expressway Company Ltd.
Designer: TAISEI –Oriental Shiraishi Joint Venture.
Contractor: TAISEI-Oriental Shiraishi Joint Venture.
Construction Period: Jan. 2007 – Mar. 2013
Location: Aichi Prefecture, Japan

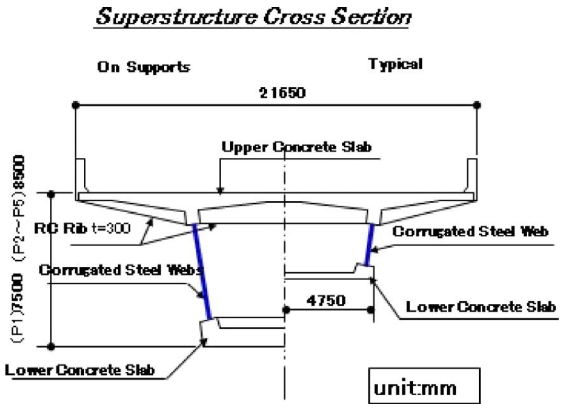

Fig.3 Cross section

Introduction

The New Tomei expressway is a major Japanese expressway and will be completed totally on 2020. The total length will be 254km. On 2012, the part of the expressway (162km) was opened. The expressway runs along the pacific ocean side of Japan and has and will have a bypass function for the current Tomei expressway. So far, several bridges were built using Japanese unique and new bridge technologies.

The Aokigawa bridge which was completed on May, 2013 is also one of the major bridges in the expressway. The tender was carried out in 2006 with the design-build system for the first time as the Owner. TAISEI-Oriental Shiraishi joint venture proposed the prestressed concrete bridge which is 6-span continuous box girder with steel corrugated webs as a superstructure and reinforced concrete hollow high rise piers and abutments. The tender was evaluated both technically and financially by the Owner. This bridge is the largest one box girder bridge with steel corrugated webs in the world. The JV also proposed the cantilever erection by using a pair of special form travelers and also the climbing form system for high rise piers. The contract was awarded to the joint venture on January 2007.

The design and construction of the bridge took 6 years and the bridge was completed on May 2013. This paper shows some features of the bridge (**Fig.2**, **Fig.3**).

1. Design

(1) Design Policy

The preliminary design was carried out during the tender stage to decide bridge dimensions considering several constraints such as crossing roads, river, forest reservation areas, and high voltage power lines given as conditions of the contract. TAISEI-Oriental Shiraishi JV has selected the bridge formation as shown in **Fig.1** to match the conditions. In this stage, the JV also considered the methods of construction for foundations, substructures and superstructure including the equipment which can be adopted for the construction of the bridge as well as the geographical conditions. This means that the design of the bridge was carried out considering the construction stage. This is one of the merit of design–build system contract. Further, the JV considered the durability of the bridge to respond the requests by the Owner.

(2) Structural Design

The JV selected the steel corrugated web for the superstructure. The web structure has been widely used recently in Japan. This structure enables to reduce the weight of the superstructure compared to the concrete web system. This means that the dimensions of foundations and piers can be reduced. This is the greatest advantage of the web system and this is the reason that there are several bridges with the webs have been built in Japan where earthquakes occurs frequently. Cantilever slabs of the superstructure of this bridges are 5.4m wide because the superstructure is one box girder. The partially prestressed concrete ribs are designed for the slabs. For the piers, the JV adopted the reinforced concrete hollow structures which also can contribute reducing of the self-weight of piers, which lead to reduce the size of foundations. High strength reinforcing bars (SD 490) were used to resist the external forces. Large diameter bored pile foundations were selected considering the ground conditions.

2. Construction

(1) Construction of foundations

Bored pile foundations (Max. diameter 17m) construction was carried out using blasting charge because of the existence of very hard rocks. After the excavation of the ground, concrete was cast (**Fig.4**).

Fig.4 Foundation work

(2) Construction of Pier

The pier were constructed by using the self-climbing form system. It took 7days per a block which is 4.2m. The lateral reinforcing bars were assembled partially on the ground and lifted up by a tower crane, then installed. The vertical reinforcing bars (D51, SD490, L = 8m) were connected by the mechanical joint. By adopting the climbing form system, rapid and safe construction works were secured and high quality of the structure was also kept perfectly (**Fig.5**).

Fig.5 Pier construction by self-climbing form system

(3) Balanced Cantilever Construction

The superstructure was carried out by balanced cantilever method using traveler forms (**Fig.6**).
Special form travelers were used for rapid erection of the superstructure. The maximum segment length is 8.0m and the width of the superstructure is 21.65m.
The extra-large traveler forms which has 1200tm capacity were used mainly.
The sequence of the works was precisely determined in the design and the actual work followed the sequence.
Both inside and outside prestressing tendons were used.
Epoxy coated prestressing strands were adopted for outside cables.
The properties of concrete used for the superstructure are as follows:

Compressive strength	40N/mm^2
Slump	15cm
Max. aggregate size	25mm
Air content	4.5%
Cement: High Early Strength type	

The partially prestressed concrete ribs were built for cantilever slabs both side of the box girder. Pre-fabricated reinforcing bar cages were made for the ribs to reduce the reinforcing bars work of the portion.

Fig.6 Cantilever erection with extra-large traveler forms

3. Conclusion

The Aokigawa bridge was completed on May 2013. Many people living near the bridge celebrated the completion with the Owner, JV and several guests. This bridge will be loved and cherished by the local people as their own bridge.

Fig.7 KOI-NOBORI (carp streamers) on the bridge

概　要

新東名高速道路青木川橋は，愛知県岡崎市に位置する新東名高速道路の代表的な橋梁である。事業主である中日本高速道路株式会社にとっては初めてとなる設計施工一括方式の契約である。受注者は大成建設・オリエンタル白石特定建設工事共同企業体である。

入札時には，橋梁線形条件，各種の制約条件が示されただけで橋梁形式については応札者にての設計で決定された。大成建設・オリエンタル白石 JV は，保有資材やノーハウを有する施工法を取り入れ， 6 径間連続波形鋼板ウェブ一室箱桁構造を上部構造とし，大口径深礎，中空 RC 橋脚を基礎，下部工とする設計で応札し，2007年 1 月に契約，2013年 5 月に竣工した。