An Expressway Bridge with High Strength and Other Advanced Materials throughout the Structure — Uratakao Bridge —

高強度材料，新材料を随所に用いた高速道路橋
— 裏高尾橋 —


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Synopsis

The Uratakao Bridge is a four-span prestressed concrete-steel composite rigid frame continuous box girder bridge that links the Hachioji junction and the Takaosan Tunnel (**Fig. 1**). The expressway bridge has a center span with a length of 155.0m in the outbound bridge, largest at the time of construction among non-suspension corrugated steel-web bridges in Japan. High strength and other advanced materials were applied throughout the bridge such as high strength reinforcing bars, tendons with ultra-high strength strands and low-heat and low-shrinkage portland blast-furnace slag cement.

Fig. 1 Uratakao Bridge

Structural Data

Structure: Four-span prestressed concrete-steel composite rigid frame continuous box girder bridge
Bridge Length: Inbound lane: 405.5 m
Outbound lane: 438.0 m
Span: Inbound lane: 51.5 + 140.5 + 140.0 + 69.5 m, Outbound lane: 67.0 + 155.0 + 144.0 + 68.0 m
Width: Inbound lane: 9.75 to 17.723 m
Outbound lane: 9.75 to 21.055 m
Owner: Central Nippon Expressway Co., Ltd. Tokyo
Designer: Kajima/Hazama joint venture for specific construction work, and Miyaji Engineering Co., Ltd.
Contractor: Kajima/Hazama joint venture for specific construction work, and Miyaji Engineering Co., Ltd.
Construction Period: Mar. 2006 – Mar. 2012
Location: Tokyo, Japan

1. Introduction

The Uratakao Bridge is a four-span prestressed concrete-steel composite rigid frame continuous box girder bridge. It connects the Hachioji junction, which is the intersection of the Metropolitan Inter-city Expressway and the Chuo Expressway, and the Takaosan Tunnel (**Fig. 2**). The bridge is located at the edge of a quasi-national park including Mt. Takao, well known as a tourist spot, so that the external appearance of the bridge was required to be harmonized with surrounding scenery. Considerations were also required for the effects on environmental elements such as groundwater and air because of the topographical and geological formation characteristics. Against the background, the severe conditions were conquered and a peaceful landscape fit for the rich nature of Takao was created. To that end, the materials, structures and construction methods were comprehensively optimized by collective design and construction of super- and sub-structures; and the latest technologies were actively adopted.

2. Application of high strength reinforcement to bridge piers

Design of a bridge with ideal spans was difficult because of the restrictions on the installation of foundations. The cross sectional area was reduced by using high strength concrete (design strength: 40 MPa) and high strength reinforcement (USD685, yield stress: 685 MPa) in P1 and P2 piers. As a result, seismic resistance was ensured throughout the bridge, and the amounts of materials and equipment for piers and foundations and construction period were greatly reduced. Carbon dioxide (CO_2) emissions and environmental burdens such as vibration and noise due to construction were reduced by using smaller amounts of materials and equipment. At the same time, a risk of turbid water runoff into the Kobotoke River during the excavation of P1 foundation was greatly reduced. The bridge has relatively high piers and it was necessary to use high strength reinforcement not only in main reinforcing bars but also in lateral

Fig. 3 Structural test for adopting high strength reinforcement (verification of seismic resistance)

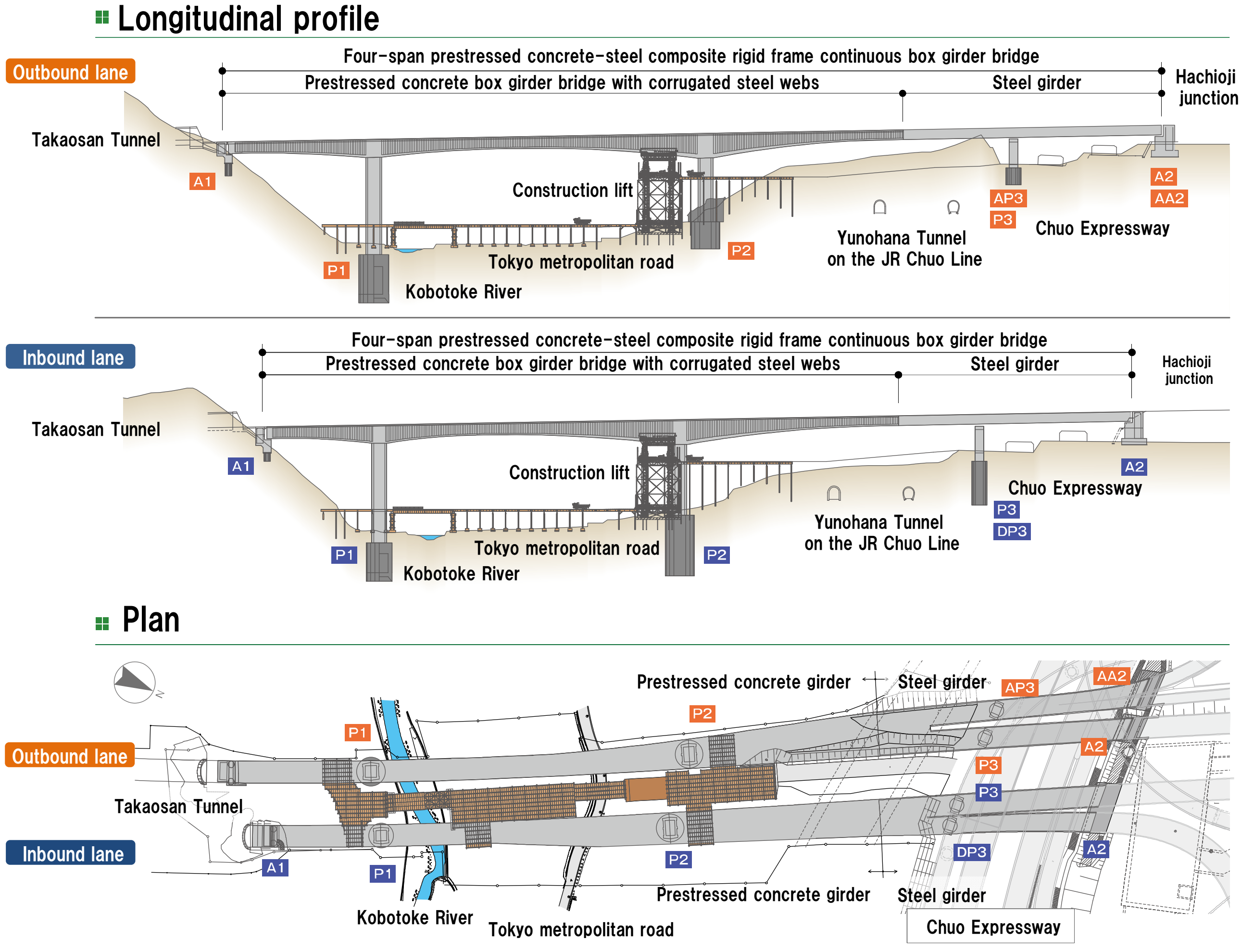

Fig. 2 Elevation and plan of Uratakao Bridge

reinforcing bars. Then, structural tests were conducted to verify applicability (**Fig. 3**).

3. Adoption of ultra-high strength strands in superstructure

The seismic performance of superstructure under level-2 earthquake motions was verified by nonlinear time-history analysis. As a result, it was found that the reinforcing bars in the inbound bridge were difficult to arrange. Thus, ultra-high strength strands, 28% stronger than conventional strands at the loading level, were partly adopted in internal and external tendons for the first time in an expressway bridge in Japan (**Fig. 4** and **5**).

4. Adoption of low-heat and low-shrinkage portland blast-furnace slag cement

Low-heat and low-shrinkage portland blast-furnace slag cement with low CO_2 emissions during manufacturing was adopted in piers, abutments, column heads, and barrier curbs. The objective was to control thermal stress cracking during construction to ensure durability. The material was adopted in a bridge on an expressway for the first time in Japan. Tests were therefore conducted before construction. The tests included those conducted while operating actual machines.

5. Large block erection of steel girders above an expressway

Steel girders were erected in block using large cranes in a section that crosses the Chuo Expressway to guarantee travel safety and reduce the frequency of traffic regulations. Large cranes were placed on unused ramp space adjacent to the Chuo Expressway. Blocks of girders were transported on a Unit Carrier on a timely basis, and lifted quickly and safely using hydraulic cylinder jacks. Bottom steel plates of composite slabs were installed preliminarily. Girders were erected in a span between P3 and A2 that crosses inbound and outbound lanes of the Chuo Expressway. The Uratakao Bridge is, however, composed of girders on the main road and ramp both in the inbound and outbound lanes. That means girders were erected in four spans. Girders were erected in more than one span when the road was fully closed to traffic during the night once. All the girders were completely erected after the traffic was controlled a total of four times (**Fig. 6**).

Fig. 4 Construction of superstructure

Fig. 6 Erection of steel girders in block

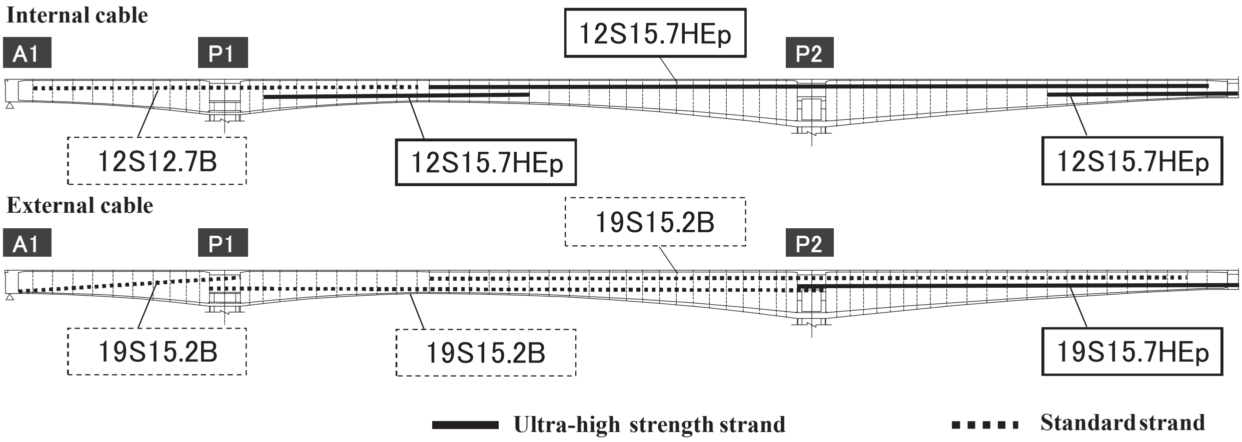

Fig. 5 Adoption of ultra-high strength strands

6. Consideration of landscape

The bridge piers were made to look slimmed down by reducing the member cross section with the use of high strength materials and developing an appropriate surface shape. Traditional Japanese color, which is found in Mt. Takao regardless of the season, was adopted for the color of the corrugated steel webs. Thus, the image of the bridge was softened. The colors that would match the surrounding were selected for temporary equipment such as construction lift and temporary supports. As a result, a peaceful landscape was created that fitted into the rich nature of Takao (**Fig. 7** and **8**).

Fig. 7 Color of corrugated steel web and the bridge pier shape developed

Fig. 8 Color of construction lift

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概 要

裏高尾橋は，八王子ジャンクションと高尾山トンネルをつなぐ PC・鋼混合 4 径間連続ラーメン箱桁橋であり，下り線の中央支間155.0m は，PC 波形鋼板ウェブ箱桁橋として建設当時国内最大級の支間を有する高速道路橋である。高尾山麓の観光スポットに位置し，高尾の景観に調和する橋梁デザインが求められるとともに，地形・地層構成の特徴により地下水および大気などの環境影響に対する配慮が必要であった。また，小仏川およびその流域地下に広がる帯水層，JR 中央本線「湯の花トンネル」および中央道と交差するため，基礎の設置位置が限定されるなど，設計・施工の両面で厳しい制約条件を有していた。

本橋の建設にあたっては，上下部一括の設計施工により材料や構造，および施工方法を総合的に最適化し，最新技術を積極的に導入することによって，これらの厳しい制約条件を克服し，高尾の豊かな自然に溶け込む落ち着きのある景観創出を実現したものである。