Prestressed Concrete Composite Truss Extradosed Bridge
— Fudo Bridge —

PC 複合トラス・エクストラドーズド橋
— 不動大橋 —


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Keywords: composite truss bridge, extradosed bridge, panel point structure
DOI: 10.11474/JPCI.NR.2014.109

Synopsis

Fudo Bridge was constructed for the substitute road to span across the future lake as part of the Yamba Dam Project planned for implementation midpoint along the Agatsuma River (**Fig.1**). This bridge is the world's first prestressed concrete, hereinafter referred to as PC, composite truss extradosed bridge that integrates the structural technology of PC composite truss bridges and extradosed bridges[1] [2] [3].

Structural Data
Structure: PC composite truss extradosed bridge
Bridge Length: 590.0m
Span: 63.4m + 125.0m + 2@155.0m + 88.4m
Width: 13.5m (Typical Section)
18.5m (Tower Section)
Tower Height: 13.5m
Owner: Gunma Prefecture
Designer: CTI Engineering Co., Ltd.
Contractor: KAWADA Construction Co., Ltd.
Construction Period: Jul. 2007 – Sep. 2010
Location: Gunma Prefecture, Japan

1. Introduction
Fudo Bridge is a 5-span continuous rigid-frame PC composite truss extradosed bridge (**Fig.2, Fig.3**). In selecting the bridge type, we considered the symbolic nature of the bridge as a gateway for the New Kawarayu Hot Spring as well its integration with and visibility of the surrounding topography.

Fig.1 Fudo Bridge

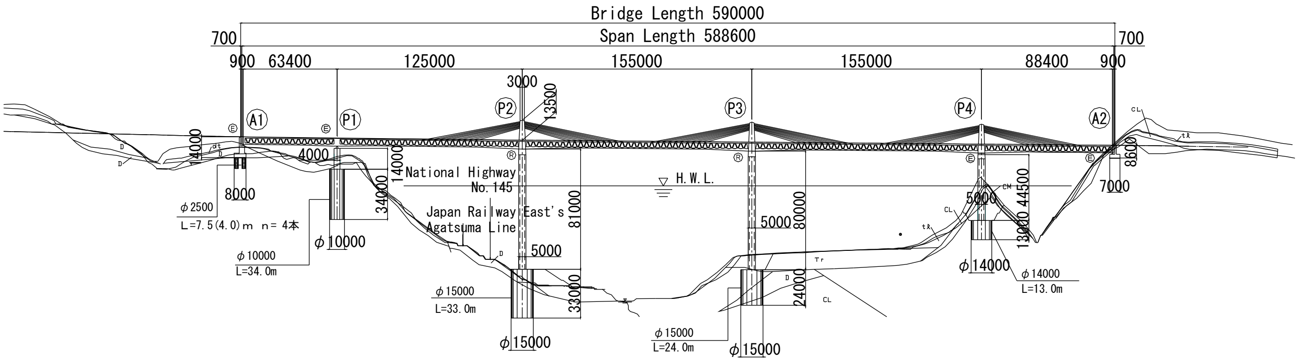

Fig.2 General drawing of Fudo Bridge

2. Design

(1) Structural Design

The general of the superstructure is shown in **Fig.4**. The superstructure is composed of upper and lower concrete slabs and steel pipe truss webs.

The truss structure is a Warren truss type with its panel points at 4.0m intervals. Stay cables are decentered at towers and fixed on the upper slab.

The type of stay cables at tower section is double fan type and 10 cables are aligned from top at both sides of each single tower.

Those stay cables are penetrating the towers and fixed at the cable holes of the tower by a saddle structure[4].

The conditions of bearing support at each substructure are varied. The rigid frame structure is applied at P2 and P3, the taller piers, and elastic suspension using isolation bearings is applied at A1, A2, P1 and P4, the abutments and shorter piers.

(2) Joint Structure

The center span is 155m long, and the panel points, where the deck and truss members cross, had to possess higher load-bearing capacity than conventional requirements. Accordingly, we proposed a new panel point structure (**Fig.5**) and verified its safety by FEM analysis and a variety of loading experiments (**Fig.6**).

(3) Seismic Design

In the experiment under assumptions of actual earthquake, non-linear time history response analysis was employed. As the height of taller piers exceeds 80m, attention was paid to the dead weight moment under significant deformation caused by the earthquake, and the fictitious force and lotic water pressure acting on the inside of the piers at underwater portion as well.

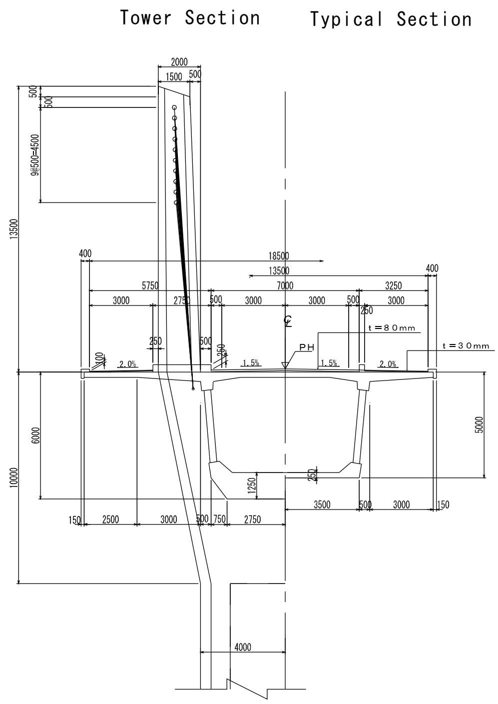

Fig.3 Cross section

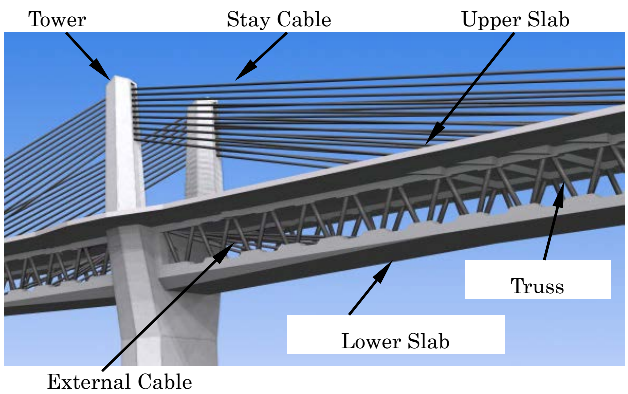

Fig.4 General of superstructure

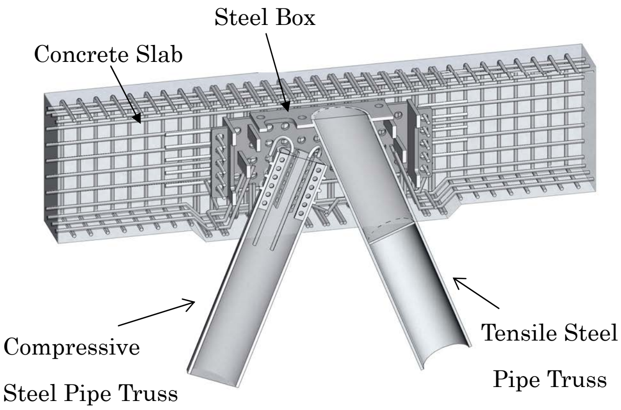

Fig.5 Structure of new panel point

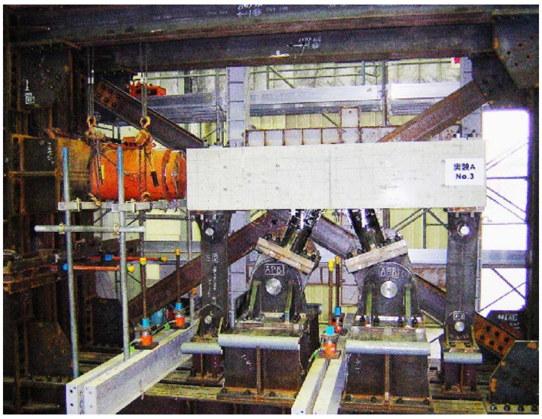

Fig.6 Loading test of new panel point

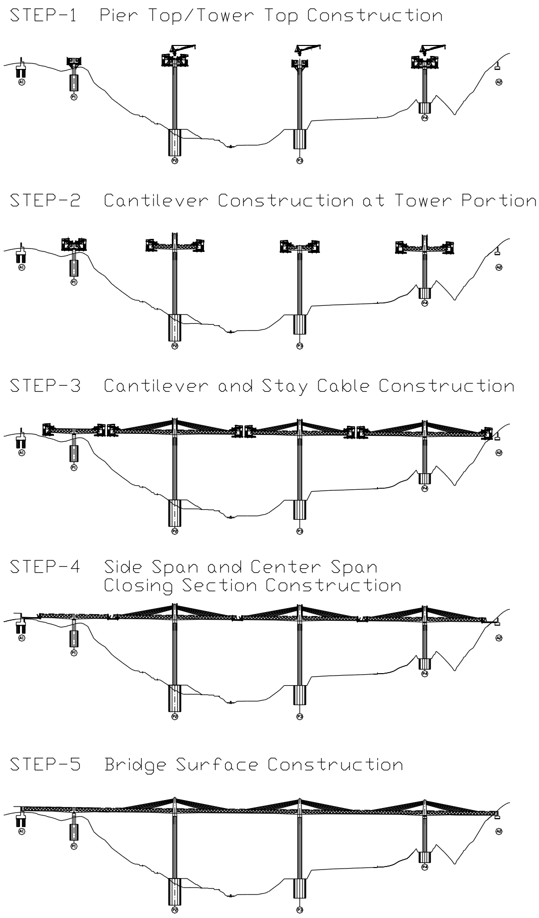

Fig.7 Construction steps of superstructure

Fig.8 Balanced cantilever construction

Fig.9 Fixed steel pipe truss

3. Construction

Construction steps of superstructure are shown in above **Fig.7**. As the structure spanning over National Highway No. 145 and East Japan Railway Campany's Agatsuma Line, efforts were made toward safety enhancement during construction by covering the entire undersides of form travelers (**Fig.8**).

The steel pipe truss members were fixed at the designed locations by utilizing turn buckles and other temporary equipment prior to the assembly with upper and lower concrete slabs (**Fig.9**).

Moreover, in order to meet the required short construction period, some tactics were used such as the reuse of column top falsework as the scaffolding for the form travelers, delivery of preassembled large-scaled falsework members, and prior onsite assembly of formworks and reinforcing bars.

Fig.10 Complete view

4. Conclusion

Construction on the column capitals and bases from segment P2 to P4, including the bridge towers, began in September 2008. 22 months later, the completion of the bridge was celebrated at a joining ceremony held in June 2010(**Fig.10, Fig.11, Fig.12**).

Fig.11 Floor of the bridge

Fig.12 Inside of the bridge

References

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概　要

不動大橋は，吾妻川中流に計画中の八ッ場ダム事業の一環として整備中の付替道路の橋梁である。橋長590.0mの５径間連続ラーメンの本橋は，「PC 複合トラス橋」と「エクストラドーズド橋」の技術を融合させた世界初の「PC 複合トラス・エクストラドーズド橋」である。

橋梁型式の選定に際しては，新川原湯温泉の入り口としてのシンボル性と，周辺地形との一体性・透明性を重視した。本橋の中央径間長は 155.0m で，床版とトラス材の交点である格点部には従来以上の耐荷力が要求された。そこで，新たな格点構造を提案し，FEM 解析と各種載荷実験によってその安全性を検証した。

平成20年９月に主塔を有する P2～ P4 脚頭部工に着手し，22ヶ月後の平成22年６月に橋梁本体の完成を祝う連結式式典がおこなわれた。