T-Shaped PC Girder Bridge Used Various Erection Methods — Kyushu Shinkansen Daini Chikadou Viaduct —

各種架設工法を用いた多径間 T 桁橋 — 九州新幹線 第 2 地下道架道橋 —


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Synopsis

Kyushu Shinkansen Daini Chikadou Viaduct (length is 1080 m) consists of 31 spans of PC T-shaped girders. To erect many PC girders efficiently and economically, movable scaffolding method is planned to be applied.
For construction of this bridge, movable scaffolding method is applied to 20 spans, unified to 35 m for movable scaffolding method. Other spans are erected by various methods suitable to each site condition.

Structural Data

Structure: 31-span T-shaped girder bridge
Bridge Length: 1 080.0m
Span: 17@35m＋45m＋25m＋11@35m＋30m
Width: 11.2～11.3m
Owner: Japan Railway Construction, Transport and Technology Agency
Designer: JR West Japan Consultants Co., Ltd. Fukken Co., Ltd.
Contractor: Fuji P.S - Nippon P.S - Nippon High Strength Concrete JV
Construction Period: Mar. 2006 – Mar. 2009
Location: Fukuoka Prefecture, Japan

1. Introduction

Kyushu Shinkansen Daini Chikadou Viaduct is located in the northern section of the Kyushu Shinkansen. The northern section, between Hakata Station and Shin-Yatsushiro Station, is the secondly opened section of the Kyushu Shinkansen, the high speed railway between Hakata station and Kagoshima-Chuo station.
The length of construction site of this bridge is 1,080 m. In upper 600 m section for Hakata, construction work in narrow site between Hakata Shinkansen Depot and major town road or residential area is necessary. Hakata Shinkansen Depot is the important high-speed-railway facility, in which regular maintenance of rolling stocks of the Sanyo Shinkansen is provided. The constant operation without any disturbance of shinkansen was required. The heavy traffic of the major town road do not permit the constant traffic restrictions. The photograph of the construction site is shown **Fig.1**.
Furthermore, because of the ascent of 35/1000 for Shin-Yatsushiro, the pier of the end of this site is 33 m high from the ground level. It is necessary the construction work at the high place.
Rigid-frame-type viaducts are applied generally, for shinkansen viaducts. In this site, considering the severe conditions of high formation level and close work to important facilities, girder-type viaduct, consist of T-shaped PC (prestressed concrete) girders, is selected. Because there are many girders in this site, adoption of span-by-span movable scaffolding (MS), or transfer timbering, method with MS machine is examined, considering economy and safety at erection. At the planning of layout of girders and piers, girder length is unified to 35 m as much as possible, to convert only one MS machine in this site. Finally 20 spans of girders are erected by MS method. Outline and erection method of this bridge is shown in **Fig.2**.

2. Erection by MS method

MS method is applied to 20-spans of girders in the section where uniformed 35-m-long girders are adopted and there is nothing interfering with the construction under the girders. In the middle of the section, 45-m-long girder, which MS method can not be applied to, is adopted above the prefectural road. For converting one MS machine without dismantling, land transportation and assembling during construction working, it is planned that firstly 45-m-long girder erected, and MS machine pass over the girder after that.

(1) Structure of the MS machine

The side view of the MS machine applied to this bridge is shown in **Fig.3** and the cross section is shown in **Fig.4**.

In **Fig.4**, opening state of truss supporting form, to move the scaffolding machine forward, is also shown. This construction site is close to Hakata Shinkansen Depot on left side and to major town road on right side. The position of hooking the truss supporting form is different in each side to keep distance from facilities on each side for safety when opening the truss.

(2) Standard construction cycle

Standard construction cycle of the MS method is shown in **Table-1**. Moving the MS machine takes 1.5 days, including opening and closing of the truss supporting form, because traffic regulation in Hakata Shinkansen Depot and in major town road on right side is needed.

The bearing shoes of Hakata side of a girder can be set only after one before girder has been constructed and R3 temporary pier is removed. 1 cycle is shortened from about 22 days of original construction plan to 18 days by labor saving such as using prefabricated steel reinforcement.

(3) Main cables of T-Shaped Girder

Each T-shaped girder erected by MS method has 6 main

Table-1 Standard construction cycle

(day)

	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18
Prestressing	■																	
Demolding		■	■															
Support Base Movement			■	■														
Girder Movement ・Installation				■	■													
Form Lifting・Adjustment					■	■	■											
Bearinng Work (The starting point side)					■	■	■											
Reinforcing Bar Prestressing Steel Assembly							■	■	■	■	■	■	■	■				
Form assembly (Cross Beam・Utility Pole Base)							■	■	■	■	■	■	■	■				
Concrete Placing															■			
Concrete Curing																■	■	■

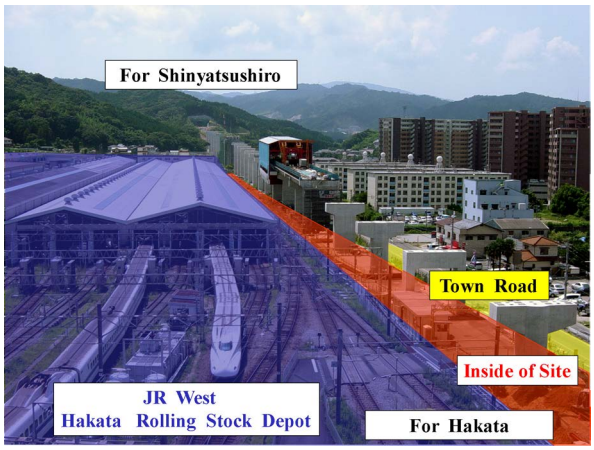

Fig.1 The site of Hakata side

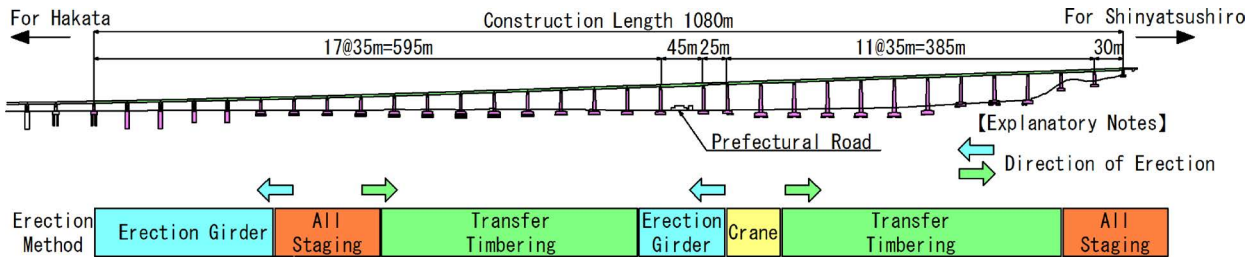

Fig.2 Outline of bridge

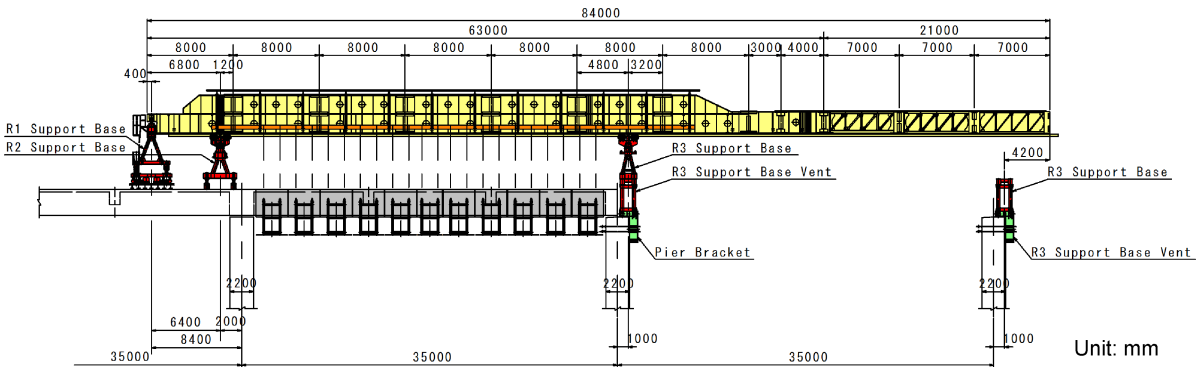

Fig.3 Side view of MS machine

cables (12S12.7: PC cable of 12 strands of φ12.7-mm) with dead end anchor Hakata side and jacking end anchor Shin-Yatsushiro side. For the girder whose Shin-Yatsushiro side girder erected before it is difficult to induce prestress at the end of main girder. Therefore, 6 cables, one end of which is jacking end on upper side of girder, are located as shown in **Fig.5**. 1 cable, both end of which is jacking end on upper side of girder, is added. Stress around anchor on upper side of girder is examined by FEM, therefore 9 cross-section cables (1S21.8: PC strand of φ21.8-mm) is added in the slab near an chors. To protect from water, waterproof coating and concrete are added over the top of slab around anchors.

3. Planning of Various Erection Method

In the section which did not adopt MS method, most suitable erection method for each section is planned considering of obstacle interfering under girder, safety in construction and workability. Outline of construction methods and reasons of selection are shown as follows.

(1) Erection Girder Method (The first-sixth span)

The section of Hakata side, the bank of Hakata Shinkansen Dept is located under constructing viaduct. Therefore, it is difficult to open truss supporting form for moving the MS and to assemble and dismantle ordinary frame timbering. Therefore erection girder method was applied to this area. The reason is that the selected erection method is less influenced from site condition under the girder.

Main girders are constructed on the girders of the 7th and 8th span, erected by ordinary frame timbering before.

The site of erection is shown in **Fig.6**.

(2) All Staging (The Seventh and Eighth span)

The yard to assemble the MS machine is necessary. Because the site between Hakata Shinkansen Dept and major town road is narrow, the MS machine should be assembled on erection girder or girder erected before. In consideration of economy and workability, 2 spans of girders are erected before, as the assembling yard for MS. 2 girders are erected by ordinary frame timbering method. The site is shown in **Fig.7**.

(3) Erection Girder Method of precast segments (The Eighteenth Span)

The 45-m-long girder on the prefectural road in the

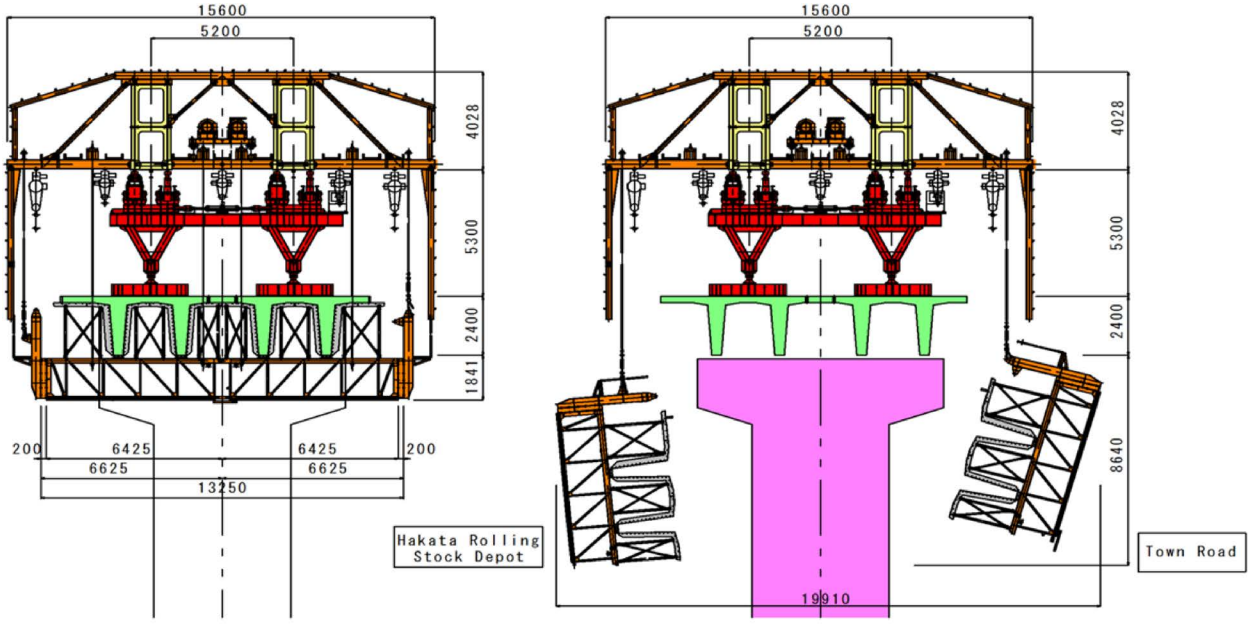

Fig.4 Cross section of MS machine

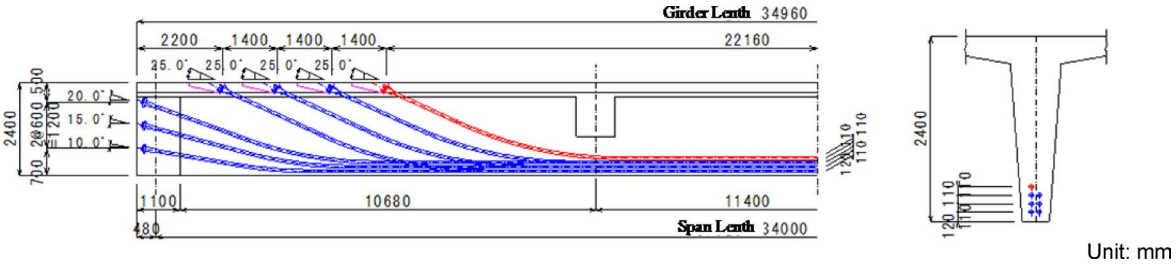

Fig.5 Upper anchorage of cable

middle of the section is too long to be constructed by MS method, and is required to be erected before MS machine pass over.
Because of many cables for electricity or telephone over the road, it is difficult to apply crane erection method. In addition, there is no space for yard to construct main girder near the site. Therefore the erection girder method with precast segment is applied. The precast segments are fabricated in a factory and assembled on the next two spans. In order to assemble the precast segments, PC T-shaped girders were previously erected on the first next span by crane, and a temporary erection girder was erected on the second next span. (Shown **Fig.8**)

(4) All Staging (The Last Span)

The last span, at the end of this site for Shin-Yatsushiro, it is difficult to open truss supporting form because of the slope near the tunnel entrance, and erection nose of MS machine is assumed to be interfered by the tunnel. In addition it is impossible to dismantle and carry out MS machine on steep slope. Therefore this span of girder was erected by ordinary frame timbering method, before erection of the neighboring girder by MS method.

4. Conclusion

This bridge is erected by various erection method suitable to the each site for safety and time saving, such as MS method. The overview of the bridge from Shin-Yatsushiro side is shown in Fig.9. Kyushu Shinkansen including this bridge started operation in spring of 2011.

Fig.6 Erection girder method

Fig.7 All staging

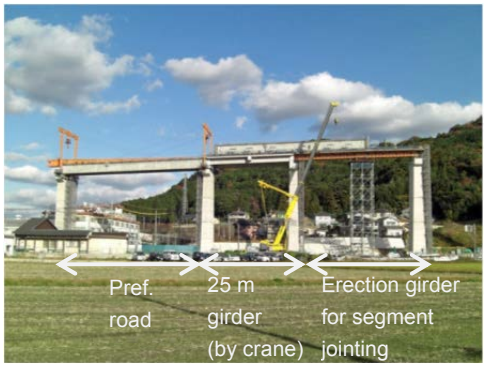

Fig.8 Erection over the pref. road

Fig.9 Overview after erected

概　要

九州新幹線，第 2 地下道架道橋工区では，延長1,080m にわたり，PC 桁による桁式高架橋が連続する。PC 桁の施工延長が長いため，経済性や工期の観点から，大型移動式支保工の導入を考慮し，可能な限り桁長35m の PCT 型桁で統一した。

31連の PCT 型桁のうち，桁長35m の20連は移動式支保工により架設し，交差，近接条件の関係で移動式支保工による施工が困難な箇所は，総足場施工や架設桁架設などの現地の条件に適合した工法で架設した。

移動式支保工で施工する区間の途中に，県道と交差する PCT 型桁 (45m) があり，現場の条件により架設桁架設とする必要があった。この箇所を先行施工することで，移動式支保工がその上を通過することができ，1 台の移動式支保工で組立・解体を伴う運搬をすることなく施工することができた。