A Symbol of the Friendship between Japan and Cambodia
— Tsubasa Bridge —

日柬友好のシンボル
— つばさ橋 —


*

**

***

****

* Kenichi SAITO, P.E.（USA）: Sumitomo Mitsui Construction Co., LTD.
齋藤　謙一，技術士（建設部門）：三井住友建設（株）
** Nobuhiko MARUNI: Sumitomo Mitsui Construction Co., LTD.
丸二　信彦：三井住友建設（株）
*** Akiharu ISHII: Sumitomo Mitsui Construction Co., LTD.
石井　昌治：三井住友建設（株）
**** Naoki ARIKAWA: Sumitomo Mitsui Construction Co., LTD.
有川　直貴：三井住友建設（株）
Contact: ksaito@smcon.co.jp
Keywords: cable-stayed bridge, tie-down cable, jumping forms, balanced cantilever construction
DOI: 10.11474/JPCI.NR.2018.123

Synopsis
This project features a 640-m-long three-span continuous prestressed concrete (PC) cable-stayed bridge spanning the Mekong River at a point roughly 60km southeast of Phnom Penh, the capital of the Kingdom of Cambodia. The main bridge is connected to approach bridges (PCI composite girder bridges) on the east and west banks that have a combined length of 1,575m and a 3.2km approach road (fill section) running east and west. The total length of the constructed route is 5.4km. The main bridge is the first long cable-stayed bridge in Cambodia. If built in Japan, it would be the country's longest concrete cable-stayed bridge.

Fig.1 Tsubasa Bridge

Structural Data
Structure: 3-span continuous cable-stayed bridge
Bridge Length: 640.0m
Span: 155m + 330m + 155m
Width: 16.98m
Tower Height: 121m
Owner: Ministry of Public Works and Transport
Designers: The Consortium of Chodai Co., Ltd. and Oriental Consultants Co., Ltd.
Contractor: Sumitomo Mitsui Construction Co., Ltd.
Construction Period: Dec. 2010 – Mar. 2015
Location: Kandal Province, Cambodia

1. Introduction
Tsubasa Bridge is a three-span continuous cable-stayed PC bridge with a 330-m-long main span. The main span is the longest in Cambodia.

2. Design
(1) Structural Design of Main Girder
On the cross section of the main girder, the edge girder was adopted considering its light weight and excellent workability for reinforcing-bar assembly and formwork. A precast reinforced concrete structure was adopted for the main-girder structure to reduce the girder height. The weight of the main girder was reduced further by reducing the girder height, enabling

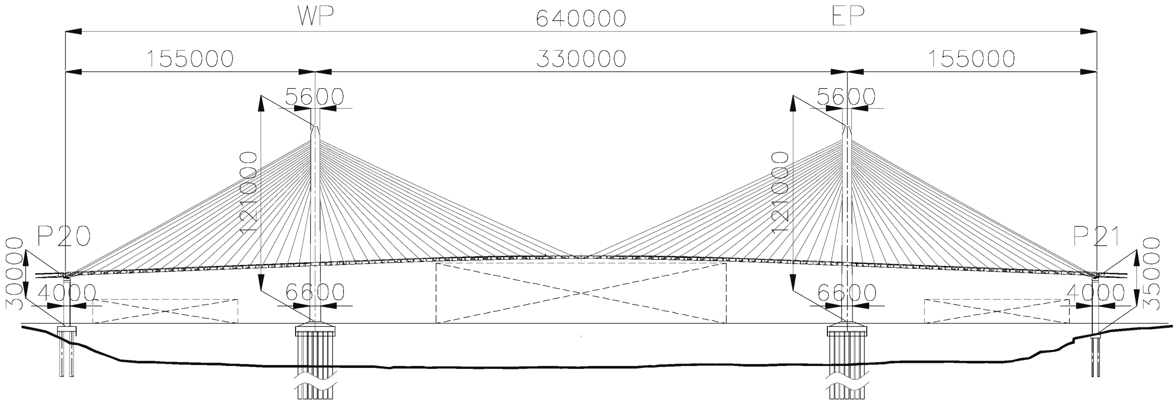


Fig.2 Structure of main bridge

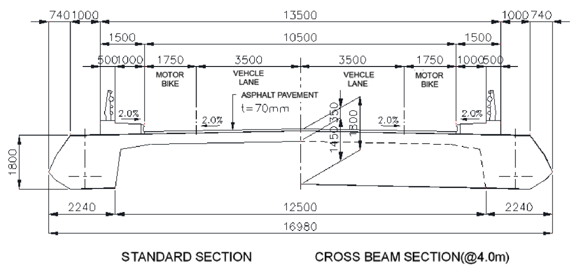


Fig.3 Girder cross section

reduction of the lateral wind load, which is a dominant factor in the design. The fairing shape was selected for its stable resistance to wind as a result of wind tunnel tests using a partial model of the main girder (**Fig.3**).

(2) Design of Stay Cables

The stay cables were assembled on site, facilitating transportation and installation. Triple antirust PC strands that were galvanized and coated with polyethylene were used for the stay cables, and an oil damper was installed as a measure against vibration. For the anchorage zones of the stay cables at the main tower, separated anchorages were adopted to reduce the distance between them and facilitate inspection. The anchorage zones were reinforced with PC bars and U-shaped PC cables, which was unprecedented in Japan.

(3) Design of Tie-down Cables

The bridge experiences a negative reaction at the edge supporting point upon dead and design loads. Measures were taken by adopting a counter weight at the edge of the main girder against a dead load and tie-down cables (rarely adopted in Japan) against the influences of a live load and temperature changes. The tie-down cables were anchored near the foundation of the bridge column to prevent tensile force in the column and angular variation caused by longitudinal displacement of the main girder.

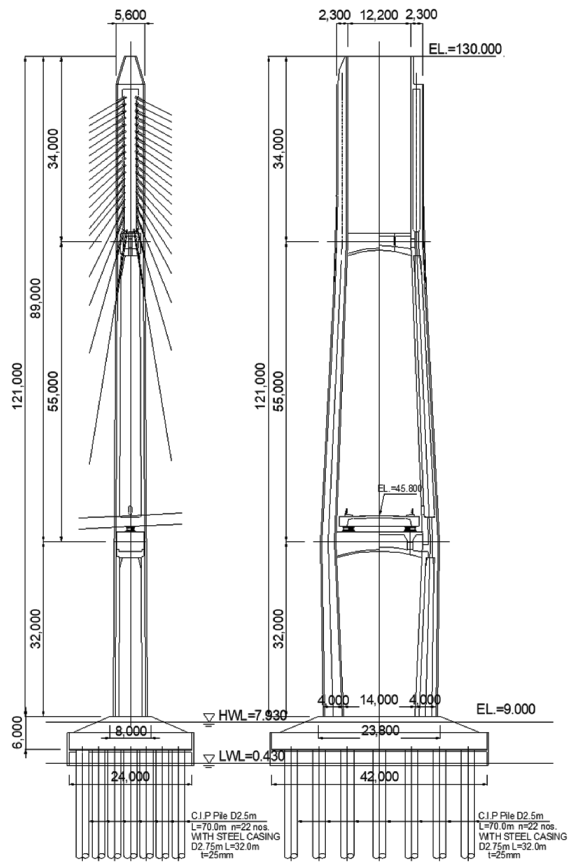


Fig.4 Structure of main tower

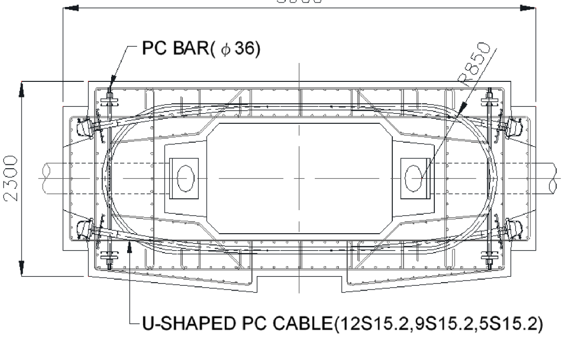
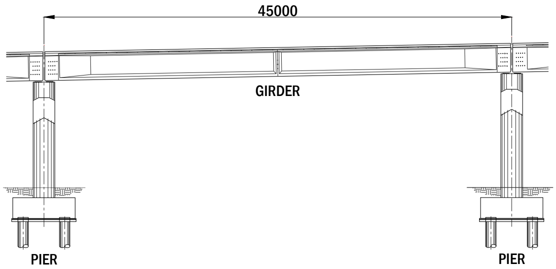
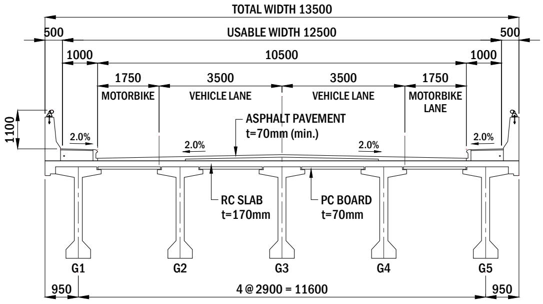


Fig.5 Tower cross section



Side view



Girder cross section

Fig.6 Structure of main bridge

(4) Approach Bridge

As an approach bridge, a five-span connection PC composite bridge with a span length of 45m was adopted given its economic efficiency, workability, and maintainability.

3. Construction

(1) Balanced Cantilever Construction

The main girders of the main bridge were constructed using cast-in-place balanced cantilever erection with under-supporting form travelers. These travelers were suspended temporarily at the front by permanent stay cables. This lessened the weight load of the travelers and made it possible to extend the construction segment length from the initial 4m to 8m, matching the arrangement interval of the stay cables. For the concrete form shoring work, to simplify the setting, adjustment, and stripping of the forms, the forms for the base plates and horizontal girders were fully integrated and lifted up and down using hydraulic jacks. By using this functional system, the concrete form shoring work was completed in the standard cycle of 10 days (daytime work only).

(2) Construction of Towers

The main towers were constructed by integrating the forms and scaffolds and using a tower crane to hoist them as a unit to the next lift. The main steel bars for each lift were assembled in the yard and then hung using a tower crane. The use of jumping forms and a prefabricated rebar cage resulted in less labor on site and reduced the construction cycle (day and night work) for the standard lift to eight days (**Figs.9**, **10**).

Fig.8 Balanced cantilever erection

Fig.7 Under-supporting form traveler

Fig.9 Jumping from

Fig.10 Prefabricated rebar cage

Fig.11 Opening ceremony

4. Conclusion

A "connection ceremony" was held on January 14, 2015 to connect the bridge girders at the center of the main bridge and was attended by Prime Minister Hun Sen and over 7,000 work personnel. At the event, the prime minister announced that the bridge would be named "Spien Tsubasa" (Cambodian for Tsubasa Bridge). Around the same time, new 500-riel notes were issued featuring an image of the new bridge, replacing the image of Kizuna Bridge (constructed with Japan ODA in 2001). Tsubasa Bridge opened on April 6, 2015.

We hope very much that the bridge will be a symbol of stronger friendship between Japan and Cambodia. The super-high-speed construction solution with special travelers and precast members is also a special feature of this bridge.

The inauguration ceremony was held with the attendance of the Imperial Family and the prime minister. The bridge has since won the Tanaka Prize of the Japan Society of Civil Engineers and awards from the Japan Prestressed Concrete Institute and the Japan Concrete Institute.

Fig.12 New 500-riel note

References

[1] Kitada, I., Maruni, N., Iijima, M., Ishii, A., *Construction of Neak Loeung Bridge (Tsubasa Bridge) –Cambodia's first long cable-stayed bridge connecting the Southern Economic Corridor*, Journal of Prestressed Concrete, May 2015. (in Japanese)

[2] Kitada, I., Maruni, N., Iijima, M., Kanasige, J., Ishii, A., Suzuki, M., *Construction of Tsubasa Bridge –Cambodia's first long cable-stayed bridge*, Bridge and Foundation Engineering, Oct. 2015. (in Japanese)

[3] Kitada, I., Maruni, N., Iijima, M., Suzuki, M., *Construction of Tsubasa Bridge (Neak Loeung Bridge) –Long span concrete bridge over the great river Mekong*, Journal of Concrete Engineering, Nov. 2015. (in Japanese)

概　要

ネアックルン橋（完成名：つばさ橋）は，カンボジア王国の首都プノンペンの南東60kmに位置し，南部経済回廊（ホーチミンープノンペンーバンコク）のメコン川渡 河地点に橋梁を日本の無償資金協力によって建設するプロジェクトである。本工事は，メコン川に架かる橋長640mの３径間連続PC斜張橋（メイン橋）を中心に，東西両岸1.5kmのアプローチ橋（PCI型合成桁橋）と東西3.2kmのアプローチ道路（盛土）から成る全長5.4kmと大規模で，特にメイン橋の中央径間330mは，コンクリート斜張橋としては日本国内でも最大級の規模となった。全幅17mのエッジガーダー断面を，下支え式の移動作業車にてブロック長8mの場所打ち片持架設工法で施工した。河川内に構築された高さ121mの２基の主塔は地域のランドマークとなっている。