# Construction of the Large-Scale Offshore Bridge in Vietnam by Span-by-Span Construction Method — Dinh Vu - Cat Hai Bridge —

## ベトナムにおけるスパンバイスパン工法を適用した大規模海上橋の施工 — ディンブー－カットハイ橋 —


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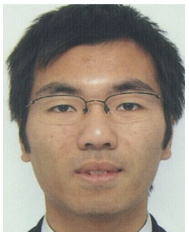
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## Synopsis

The authors would like to herein summarize and present the Span-by-span (hereinafter referred to as “SBS”), construction method applied in the aforementioned large-scale offshore bridge in Vietnam (**Fig.1**) which was financed by Japan ODA STEP loan[1].

The SBS construction method is the advanced technology to shorten the construction period for the prestressed concrete (hereinafter referred to as “PC”) box girder bridge by erecting the precast segments in one time at the bridge span of 60m. The segments of 3.2m height, 15.6m width, 80 ton weight are transported by trailer from the fabrication yard, and erected by two launching girders span by span by joining the segments after being lifted sequentially. The Feature of SBS construction method is superior in construction period, and to enable high quality by precast work at fabrication yard. Generally, this method is often applied to multiple span continuous concrete bridge with limited construction period and area. Application of this method in Vietnam is the first time, and the span 60m is sorted in the longest span class in the world.

**Fig.1 Approach bridge at Hai An side**

## Structural Data

*Structure*: 5-span continuous prestressed concrete box girder bridge, Total 75 spans, 19 normal girder segments/span
*Bridge Length*: 4,433.7m
*Span*: 59m + 3@60m + 59m
*Width*: 15.6m
*Girder height*: 3.2m
*Erection method*: Span-by-span
*Owner*: Socialist Republic of Vietnam, Ministry of Transport, Project Management Unit No.2
*Consultant*: Joint Venture of Oriental Consultants Global Co., Ltd, Japan Bridge & Structure Institute Inc,Nippon Koei Co., Ltd in association with TEDI, TIDICC and APECO
*Contractor*: Joint Venture of Sumitomo Mitsui Construction Co., Ltd, Truong Son Construction Corporation, Cienco4 Group Joint Stock Company
*Construction Period*: May. 2014 – May. 2017
*Location*: Located between Tan Vu and Lach Huyen, Hai Phong City, Vietnam

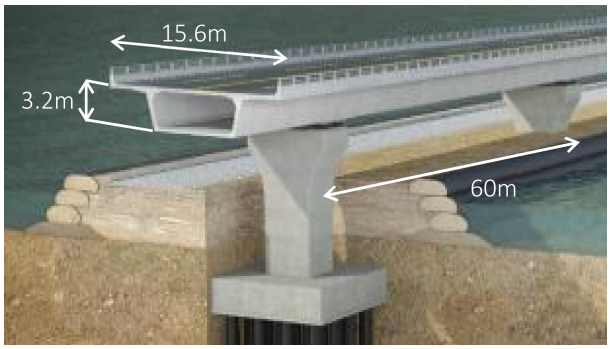



Fig.2 Structure of on land portion

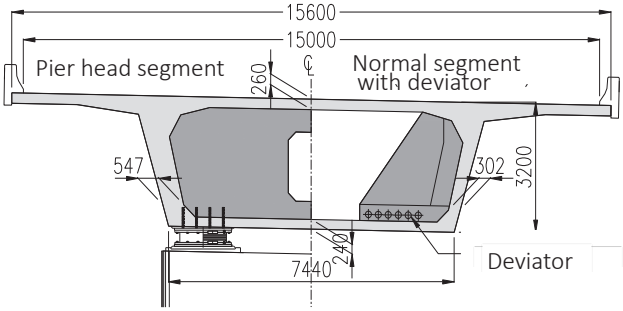



Fig.3 Typical cross section

## Introduction

The construction period for the Project is only 36 months. Its critical path exists in the 4.43km long Approach Bridge at Hai An side. Considering its tight schedule and the severe marine circumstance, SBS construction method was selected to shorten construction period and to enable high quality of precast segments at fabrication yard. Structure and typical cross section of Approach Bridge at Hai An side are shown in **Fig.2**, **3**.

## 1. SBS construction method

### (1) Precast segment fabrication yard

1,405 normal segments and 90 pier head segments having maximum weight of 80 ton are fabricated at the self-developed fabrication yard locating approximately 2km from the bridge by two fabrication lines of 550m length. The yard has the area of 9.9ha including three concrete batching plants, two rebar fabrication yards and a segment stock yard. Refer to **Fig.4**, **5**.

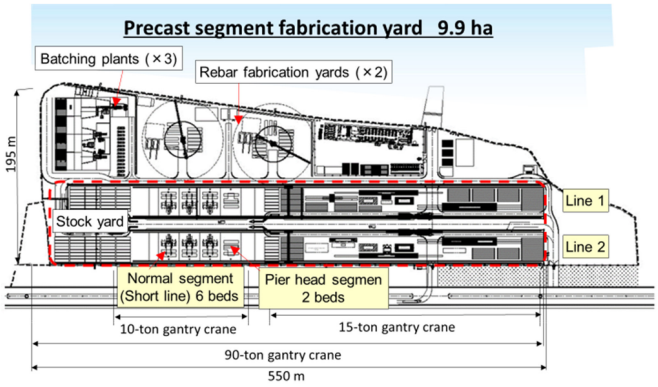



Fig.4 Layout of fabrication yard

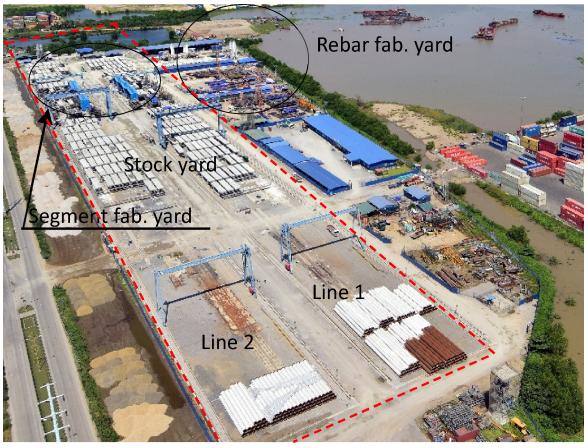
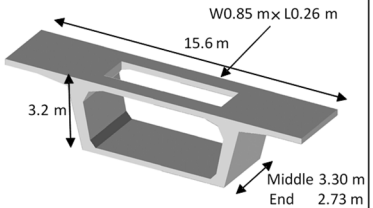
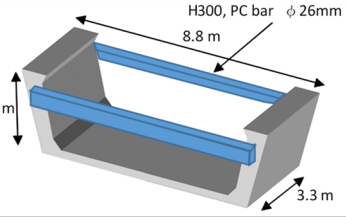
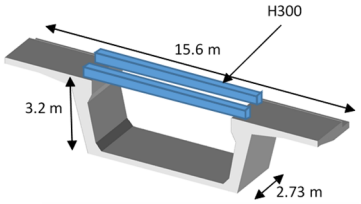



Fig.5 Aerial photo of fabrication yard

### (2) Casting and erecting pier head segment

Three types of pier heads were selected to reduce the weight[2] (**Table-1**). On land pier head segment with maximum weight of 80 ton is transported to site by special multi axis vehicle and installed by 250 ton crawler crane (**Fig.6**). Offshore pier head segment is partially precast to reduce the weight to 62 ton (end pier), 55 ton (middle pier) considering the balance/ stability of the crane and barge (**Fig.7**). Reinforcement of offshore pier head segment in order to prevent the deformation was decided by FEM analysis considering the erection and concrete casting stage. Casting concrete in place and prestressing PC cable complete 10 days erection cycle.

**Table-1 Precast pier head segment type**

| Name | On land Middle pier / End Pier | Offshore Middle Pier | Offshore End Pier |
|---|---|---|---|
| Structure |   |   |   |
| Characteristic | CIP: Cross beam, part of top slab<br>Weight: 80 ton<br>Reinforcement: Nil | CIP: Cross beam, top slab<br>Weight: 55 ton<br>Reinforcement: H300, PC bar ϕ 26mm | CIP: Cross beam, part of top slab<br>Weight: 62 ton<br>Reinforcement: H300 |

Note: CIP = Cast in place

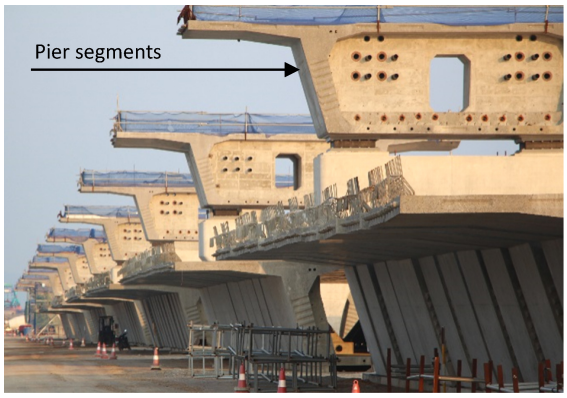



Fig.6 Erected on land pier segments

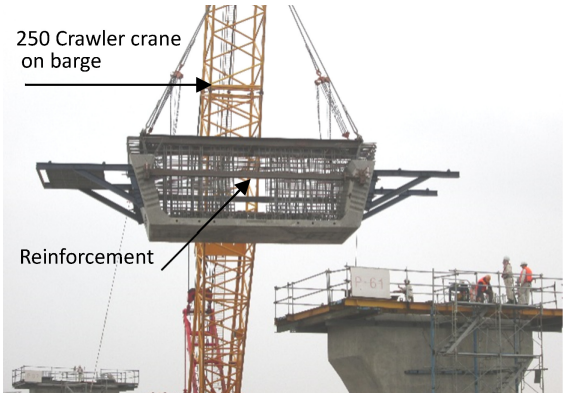



Fig.7 Erection of offshore middle pier

### (3) Normal segment fabrication

Normal segments are casted by short-line match casting method with six sets of specially fabricated formwork (**Fig.8**). The match cast segment is used as the formwork for the edge surface of the just cast segment to achieve the complete contact between two segments. Prefabricated rebar cage is installed in the formwork by crane to shorten the construction time. Fabrication cycle time for each segment is 1 or 2 days depending on the existence of deviator for external PC strand.

Curing shed is applied to minimize the weather impact to the concrete quality .

Fabrication accuracy of segment dimension/elevation is strictly controlled by using a special self-developed software taking into account the measured result of the relative difference between the top slab of the match cast segment/the just cast segment and the match cast segment‘s length.

Fig.8 Segment formwork

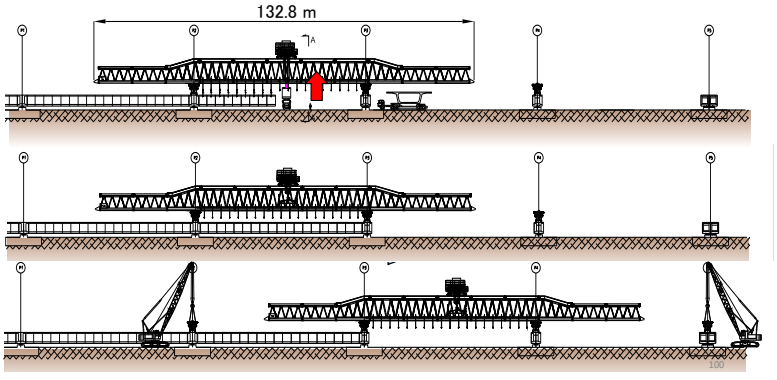
Special caution during fabrication stage and erection stage has been made to achieve ±10mm contractual tolerance of the bridge deck elevation after stitching work. Necessary camber has been calculated and reflected to decide the elevation of each segment to achieve 3mm tolerance at fabrication stage. Special digital level was used to assure the accuracy of 0.1mm.

3D thermal stress was analyzed to evaluate and verify almost no thermal effect to old girder segment due to hydration reaction of new girder segment. Tensioning of transverse PC strands is implemented after girder concrete reaches more than the design strength of 50Mpa to minimize the elasticity and creep deformation.

### (4) Normal segment erection

Erection sequence is described in **Fig.9**. Normal segment, having typical general view as **Fig.10**, is erected by two launching girders which have 7.8m height, 132.8m length, 960 ton total weight, 1,350 ton hanging ability, 90 ton movable winch (**Fig.11**).

For on land portion (A1 to P60), 14 of total 19 girder segments in total are transported, pre-placed at erection position by special multi axis trailer to shorten construction time. After moving launching girder to the position, five remaining segments are transported and all nineteen segments are hung up in order for applying epoxy resin on the segment contact surface and stitching work by using temporary PC bars (**Fig.12**) sequentially. Segment measurement and adjustment will be carried out to ensure the contractual




1. Transport 19 segments
   (on land: pre-place 14 segments)
2. Hang 19 segments
3. Epoxy resin, stitching
4. Adjustment

5. Cast in place gap concrete
6. PC cable installation and stressing

7. Advance lauching girder

Fig.9 Erection sequence of normal segment

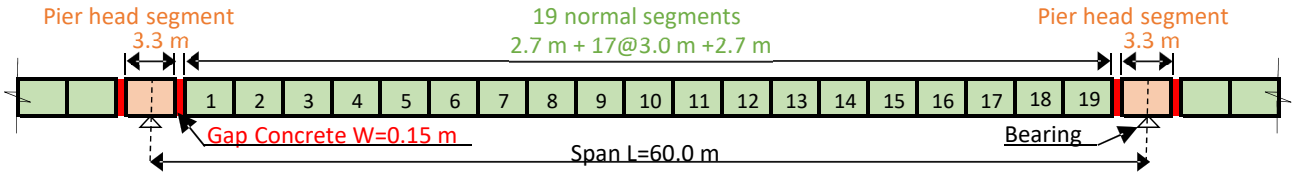



**Fig.10 Typical general view of one span**

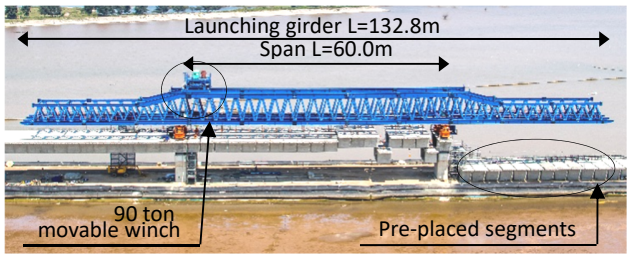



**Fig.11 Side view of launching girder**

tolerance, followed by casting expansive concrete to the gap concrete between normal segment and pier head segment. PC strands, manufactured and imported from Japan, with the greatest length of 120m are installed (**Fig.13**), followed by prestressing work of minimum number of the PC strands to advance the launching girder ahead to minimize the erection cycle. Remaining number is prestressed after advancing.

For offshore portion (P60 to P75), the construction sequence is similar, except segment transportation being executed by trailer on bridge deck and movable winch from behind the launching girder (**Fig.14**).

One span erection of on land portion and offshore portion is 7 days and 10 days, respectively. It enables the erection of 75 spans within 13 months.

## 2. Conclusion

SBS construction method is relatively effective and superior in term of quality control of precast segments, shortening project period for multiple span continuous concrete bridge with limited construction area.

## References

[1] Kurokawa, T. et al,: *Construction of Lach Huyen Bridge – Access Highway to International New Port–*, Bridge and Foundation Engineering, Vol.50, No.10, Kensetutosho, Tokyo, pp. 7-10, Oct. 2016. (in Japanese)

[2] Nishimura, K. et al,: *Construction of the Large-Scale Offshore Bridge in Vietnam by Using Precast Segment Method*, Japan Prestressed Concrete Institute 25th Symposium, JPCI, Tokyo, pp. 657-660, Oct. 2016. (in Japanese)

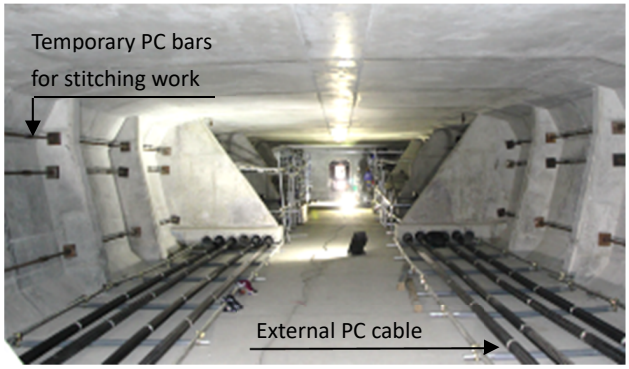



**Fig.12 External PC cable inside box girder**

**Fig.13 Installation of PC cable**

**Fig.14 Segment erection offshore portion**

## 概　要

ラックフェン国際港アクセス道路・橋梁工事は，ベトナム北部ハイフォン市で建設中の国際港と既存高速道路を連結するアクセス道路の建設工事である。総延長15.6km のうち海上部4.43km の上部工は工程短縮を目的として，ベトナム初となるプレキャストセグメントによるスパンバイスパン架設工法が適用された。しかし，本橋のセグメント架設工程は13ヶ月と非常に短いため，施工の合理化を図り同工法の急速施工能力を最大限に発揮する必要があった。本橋では，柱頭部のハーフプレキャスト化，スパンバイスパン架設作業において合理化を図り，セグメント架設を13ヶ月という短期間で終えることができた。