

AUTOMATION OF BRIDGE CONSTRUCTION BY PRECAST SPAN METHOD IN KOREA HIGH SPEED RAILWAY PROJECT

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ABSTRACT : Large portion of Kyung-bu high-speed railway in Korea was constructed in the form of bridges or tunnels. Most of bridges were designed to be prestressed continuous concrete box girder type. The precast span method was selected for the construction of prestressed concrete box girder bridges for its merits of good quality, fast construction speed, low construction cost and safety. Since it was the first attempt to apply the precast span method to a continuous bridge for high speed railway, many design and construction details were studied and implemented in the construction.

Keyword : High Speed Railway, Automation, Continuous Bridge, Precast Span Method

1. Introduction

It was inevitable to construct many bridges and tunnels in high-speed railway lines due to topographical characteristics of Korea. Out of 412km long Kyung-bu high-speed railway, 302km long section was designed in the form of either bridge or tunnel. Half of 19.5km long Hyundai's construction site (Section 2-2), shown in Figure 1, was also composed of bridges and tunnels.

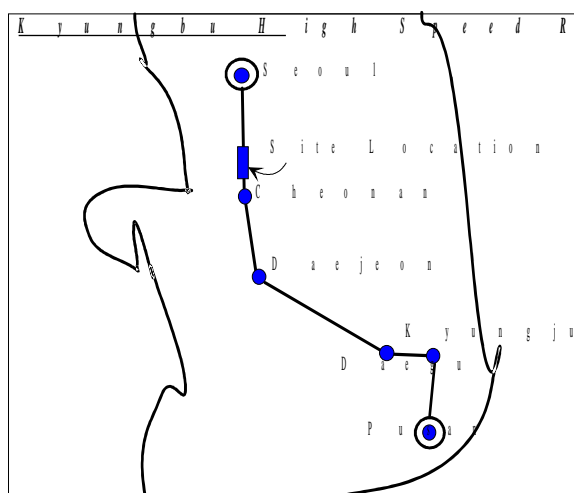


Fig. 1 Site Location

Most of bridges were designed to be prestressed concrete box girder type, considering economy and safety. For the construction of 3 prestressed concrete box girder bridges (69% of total bridge length in Section 2-2), the precast span method (PSM) was adopted instead of the original plan of using movable scaffolding system (MSS). The PSM was favored because of good quality of bridge section secured by factory manufacturing, fast construction speed (1.5~2 days per span in comparison with 25~30 days of the MSS), low construction cost with mechanized construction and the safety of field workers. The PSM was composed of three main processes : producing a segment of complete concrete box girder, transporting the segment to the site using heavy trailer, and placing the segment on predetermined piers using launching gantry.

So far, PSM has been applied for the construction of simple span bridges mainly. However, new application of PSM for continuous bridge construction has been made, considering advantages of a continuous bridge in dynamic behavior under moving high-speed train and maintenance cost. In this paper, design and construction of a continuous bridge construction using PSM will be described briefly.

2. Design & Analysis

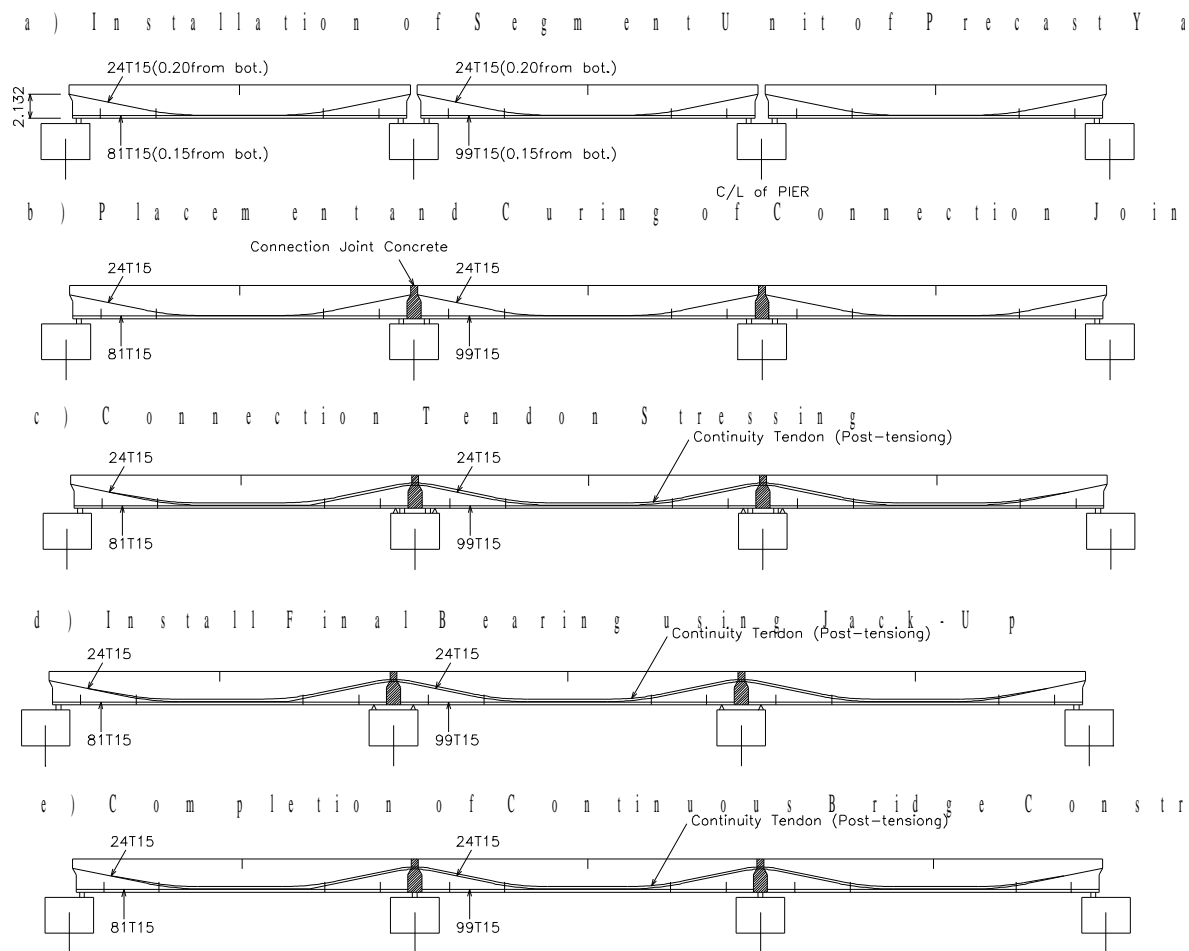


Fig.2 Continuation Process of Simple Span

Fig.3 Typical Cross Section

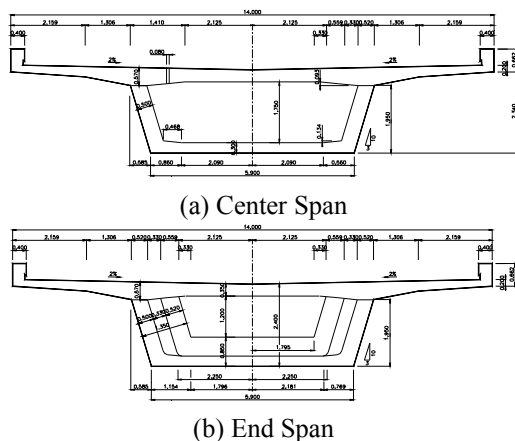
Regarding the construction of continuous bridges using PSM, the continuation process of simple spans, shown in Figure 2, was studied thoroughly before the construction. It was expected that the bridge would experience many changes in structural system, load conditions during each construction step and change in support conditions were considered carefully in design stage. The capacity and movement of bearings to be used were also studied in advance^{[2], [6]}.

Considering the erection device available and economical efficiency, the span length was determined to be 25m^[6]. Figure 3 shows typical cross sections of prestressed concrete box girder.

Since a high-speed train would run at the maximum speed of 350km/h, careful consideration was given to the dynamic behavior of bridge under moving high-speed train loads, and passenger comforts. Track-structure interaction analysis was also performed for the safety of high-speed train and the bridge^{[3], [4], [5]}.

3. Construction

The installation procedure of a prestressed concrete box girder segment is shown in Figure 4. After producing a segment of complete prestressed concrete box girder bridge (span length 25m and weight 600t) in factory, the segment was transported to the site using 110t heavy trailer and placed on predetermined piers using launching gantry (Figure 5). Figure 6 shows the construction view of these procedures.



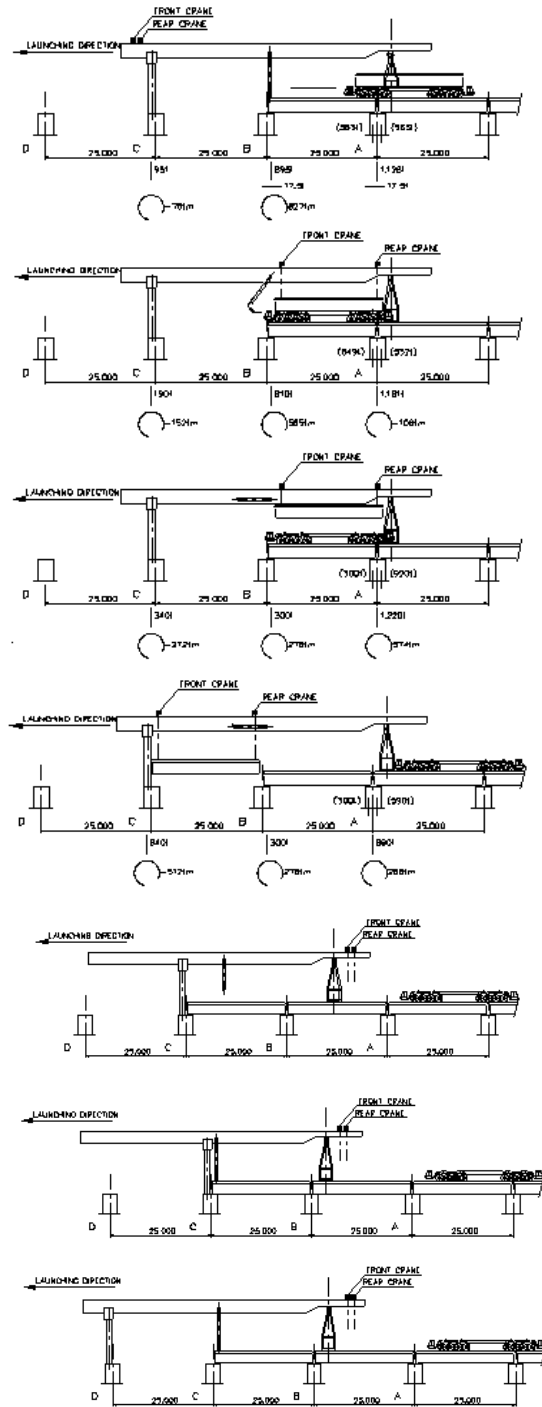


Fig. 4 Installation of PC Box Girder

Simple span sections were connected to a 3-span continuous bridge system by placing connection joint concrete, prestressing connection tendon and replacing temporary bearings with permanent bearings (Figure 2). Figure 7 and Figure 8 show the flow of the continuation process and the cross section of continuation details with sheath pipe. For each connection joint, three sheath couplers were used for connection of two pieces of sheath pipes, forming one row and three or four rows of sheath pipes were provided, as shown in Figure 8.

Post-tensioning was performed when the strength of the concrete reached 300kg/cm^2 . After post-tensioning, prudent control of elongation quantity was made.

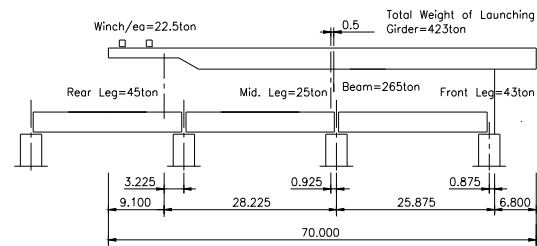


Fig. 5 Launching Gantry

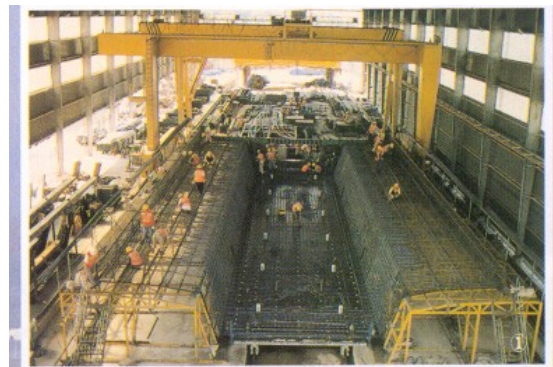


Fig. 6 Construction View

In early construction stages, many construction problems such as breakage of tendon, corrosion of tendon, hydration heat, temporary bearing material and damage of sheath pipe were encountered and solved^[6].

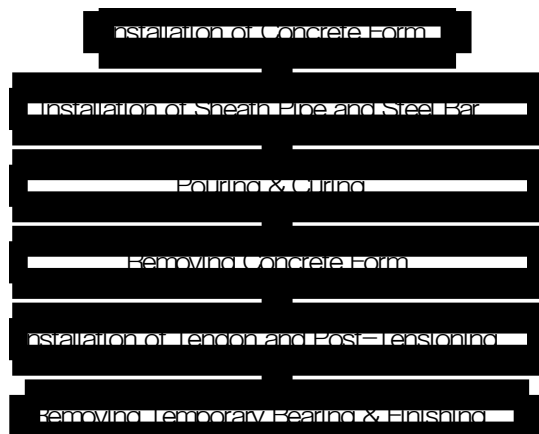


Fig. 7 Procedure of Continuation

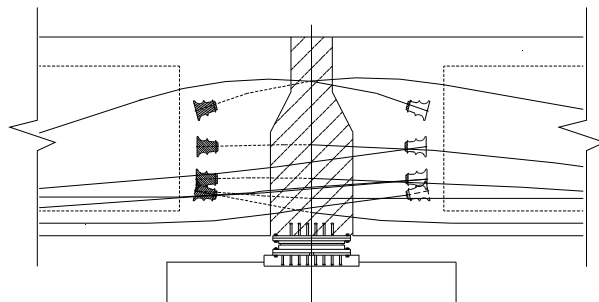


Fig.8 Cross Section of Continuation Segment

4. Conclusion

In this paper, design and construction of continuous bridges using the precast span method have been described briefly.

Design and construction details of structural system under different construction steps were investigated and implemented in the design drawings.

Since it was the first attempt to apply the precast span method to a continuous bridge for high speed railway, many design and construction details were studied and implemented in the construction.

By adopting the precast span method, good quality, fast construction speed, low construction cost and the safety were obtained with mechanized automation system.

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