Design and Construction for Durability and Maintainability of Reinforced Concrete Arch Bridge with Curved Girder

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Summary

The Agamatsu Bridge was designed as a concrete arch bridge with a curved stiffening girder since the bridge piers could not be placed on the river due to river flow impediment ratio constraints and the road alignment involved a horizontal curve. The bridge is a part of an important arterial road without an alternate route wherein improving the durability and maintainability are essential design considerations in order to minimize repair and renovation works. Hence, various schemes to improve durability and maintainability were utilized during the design and construction of the bridge, such as the use of a box girder with a ribbed deck slab to realize the fixed reinforced concrete (RC) arch structure with a curved girder.

Keywords: curved girder, fixed RC arch bridge, durability improvement, operation and maintenance, ribbed deck slab, New Melan System

1. Introduction

The Kakehashi Improvement Project wherein the Agamatsu Bridge is a part of was carried out for the purpose of re-routing the road to the opposite side of the river to prevent road closures in the event of rock falls or traffic accidents. The bridge is a design-build project integrating sub-and superstructure work with the theme of *100-Year Bridge in Harmony with Nature*. The bridge reported in this paper is a concrete arch bridge with a curved stiffening girder, it gives particular consideration to durability, maintainability, and aesthetics within the landscape (Figure 1).

2. Bridge Description, Design and Construction

The general drawing of the bridge is shown in Figure 2. It has a length of 199 m, arch span of 155 m, road horizontal alignment of R = 335 m. The road has an overall width of 13.0 m, and a 9.5 m roadway width + 2.0 m sidewalk at the standard sections.

Fig. 1: Completed bridge

An arch bridge was considered in this project due to the difficulty of constructing the bridge piers on the river mainly because of river flow impediment ratio limitation. The bridge was implemented as a structurally efficient arch bridge with a curved girder by using horizontal-ribbed deck slab structure for the stiffening girder and PC box girder with high torsional rigidity to account for torsional moments which also reduced the of number vertical members used. The use of high strength concrete and a slender arch rib on the one hand made the structure flexible and enhanced the seismic resistance of the bridge. Also, the bridge implements spread foundations.

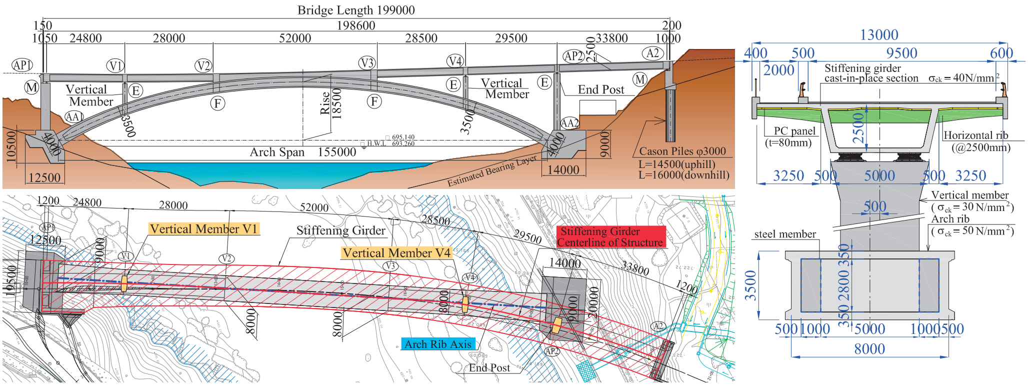

Fig. 2 : General drawing of the entire bridge

Excavation was carried out using an open excavation with the use of retaining walls. Non-explosive methods were used to minimize traffic impacts. Afterwards, the arch abutments were built and cable cranes were erected. A steel member was used over the entire arch rib because the number of back stay anchors was limited by constraints on construction. Construction of the arch rib was carried out using the New Melan System. In this system, the steel member is left inside the concrete arch rib as a box girder cross section and is used as an internal formwork. Vertical members were constructed after erecting the arch rib, after which, supporting falsework was assembled on top of the arch rib and the stiffening girder was constructed (Figure 3). Construction was easier by implementing this method because the falsework for the cantilever slab was not necessary.

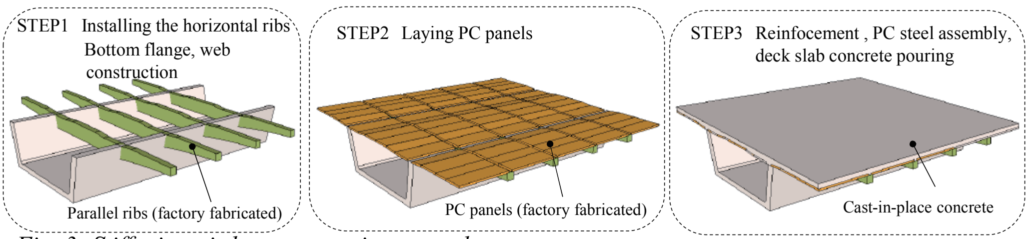

Fig. 3: Stiffening girder construction procedure

3. Durability and Maintainability Improvement Measures

To improve the durability of the bridge and to account for freezing deteriorations, all structural members were constructed with high strength concrete. For fatigue control, the stiffening girder is constructed as a prestressed concrete (PC) structure and the deck slab is a PC composite. For maintenance measures, an inspection corridor system for the bridge was built (inspection corridor, girder interior lighting, manhole, etc.), which takes into account the ease of inspection over the entire bridge span through provision of accessibility, inspection spaces, and interior visibility (Figure 4).

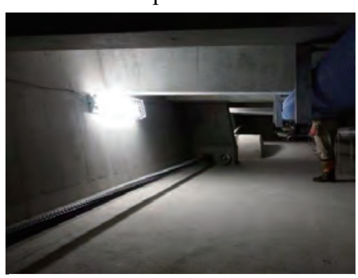

Figure 4: Lighting inside deck girder

4. Conclusion

The bridge is a concrete arch bridge with a curved stiffening girder, a type of bridge that is rare worldwide. To realize this, various schemes were utilized to improve the durability and maintainability, such as the use of a box girder with a ribbed deck slab. Many measures, some of which are not covered by this paper were also implemented to improve the durability and maintainability such as quality control, prevention of initial defects, and steps were taken to prevent deterioration.