Zeitschrift: IABSE structures = Constructions AIPC = IVBH Bauwerke

Band: 7 (1983)

Heft: C-28: Recent structures: Part II

Artikel: Usagawa Bridge on the Chugoku Expressway (Japan)

Autor: Mino, S.

DOI: https://doi.org/10.5169/seals-18291

17. Usagawa Bridge on the Chugoku Expressway (Japan)

Owner:	*Japan Highway Public Corporation*
Designer:	*Chiyoda Engineering Consultant, Tokyo and a detail design for construction stages carried out by Bridge Design Section, Sumitomo Construction Co., Ltd., Tokyo*
Contractor:	*Sumitomo Construction Co., Ltd., Tokyo in association with Nissan Construction Co., Ltd., Tokyo*
Dimensions:	*Overall bridge length: 332.5 m* *Arch span length: 204 m* *Full deck width: 21.9 m including dual 9.25 m wide two-lane carriageways* *Upper deck span length: from 16.5 m to 18.5 m*
Quantities of materials used:	*44,000 m³ concrete* *2,400 t steel (SD30) for reinforcement* *610 t steel (SBPD 95/110) for prestressing* *1,100 t steel (SM 58) for a temporary arch* *120 t steel (SS 41) for pylon* *36 t steel (SEEE F160) for rock archors*
Works' duration:	*from October, 1979 to November, 1982*
Traffic opened:	*1983*

Introduction

The Usagawa Bridge was built over the Usa Valley, 80 m deep, and in the surroundings of the construction site can be seen a series of mountain peaks, some 1,000 m above the sea level, which belong to a national park as a ridge of the Chugoku Mountains. Thus, in addition to economy and ease of construction, taking into consideration especially keeping an appearance of the bridge in harmony with the surrounding scenery, Nihon Doro Kodan selected a reinforced concrete arch construction with dual, post-tensioned upperdecks as a structural type of the bridge.

The Usagawa Bridge, the largest concrete arch bridge ever built in Japan, will boast of a record span even in the world as an arch having an asymmetric profile.

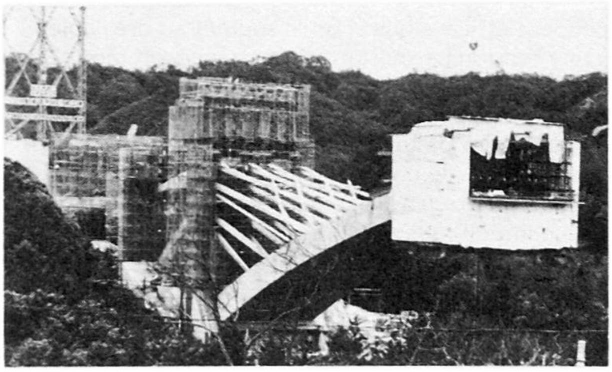


Fig. 1 Cantilever erection using temporary stay cables stretched from main columns

Design

The bridge has a unique asymmetric profile that the arch rise is 38.7 m at one side whereas it is 20.7 m on the other, the arch axis being flat shaped hyperbolic curves. A 17.8 m wide three-cell box sectioned arch ring has a depth tapering from 3.6 m at the crown, where it is monolithic with upperdecks to maintain the largest possible arch rise, up to 4.4 m at the springings, where it is rigidly connected with massive concrete footings founded into the hard granite. These cross sections are so arranged as to satisfy the requirements for the earthquake condition in addition to the service load conditions. To minimize the dead weight imposed on the arch ring, prestressed concrete voided slab construction with average continuous spans of 18 m is adopted as the upperdeck structure. The characteristic cylinder strength of the concrete of the arch ring is to be 400 kg/cm² (40 N/mm²), as temporary prestressing is introduced in the arch ring to control the flexural tensile cracks which may occur during cantilever erection and may reduce the flexural rigidity of the structure against buckling. Ground anchors drilled into the rock are used to resist uplifting reactions due to cantilever erection.

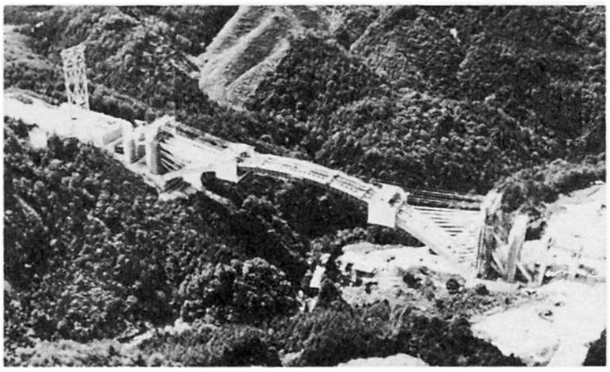
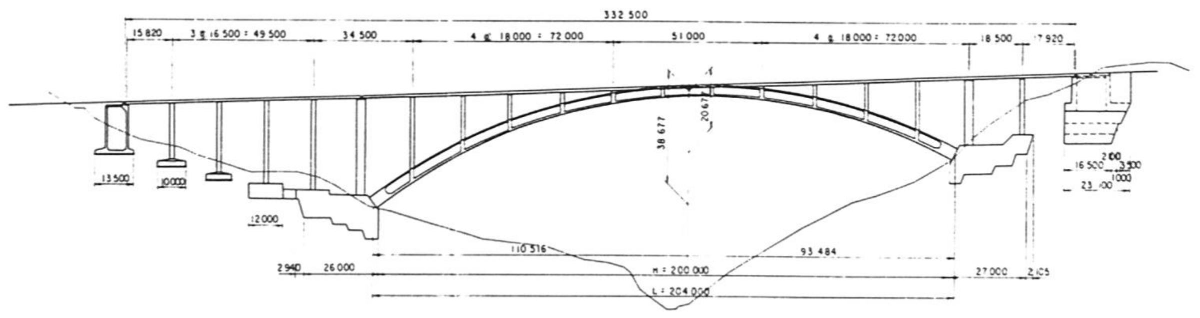


Fig. 2 Construction over a steel girder arch



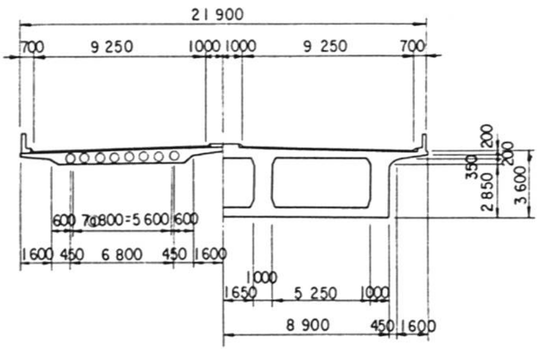


Fig. 3 General view of the bridge

Construction

An arch ring, a crucial structural member of the bridge, was built at two stages. First, from both banks, it was built in a manner of cast-in-situ cantilever erection up to the midpoints of the half-arches, that is, so-called L/4 points using temporary post-tensioning tendons, as well as temporary stay cables stretched from main columns and steel pylons. Secondly, having established two quarter arches, in a way of wrapping up with concrete a steel girder arch which by that time had been erected between the two L/4 points to stabilize the structure during construction. Travelling forms were used at both stages and to save time the segmental length was made longer (6 m each) at the latter stage where the steel arch helped the travelling form have more capacity. Having erected a whole arch ring and removed travelling forms, pylons, stay cables and post-tensioning tendons, verticals and upperdecks were constructed. And then, after road surfacing, the bridge was completed.

(S. Mino)

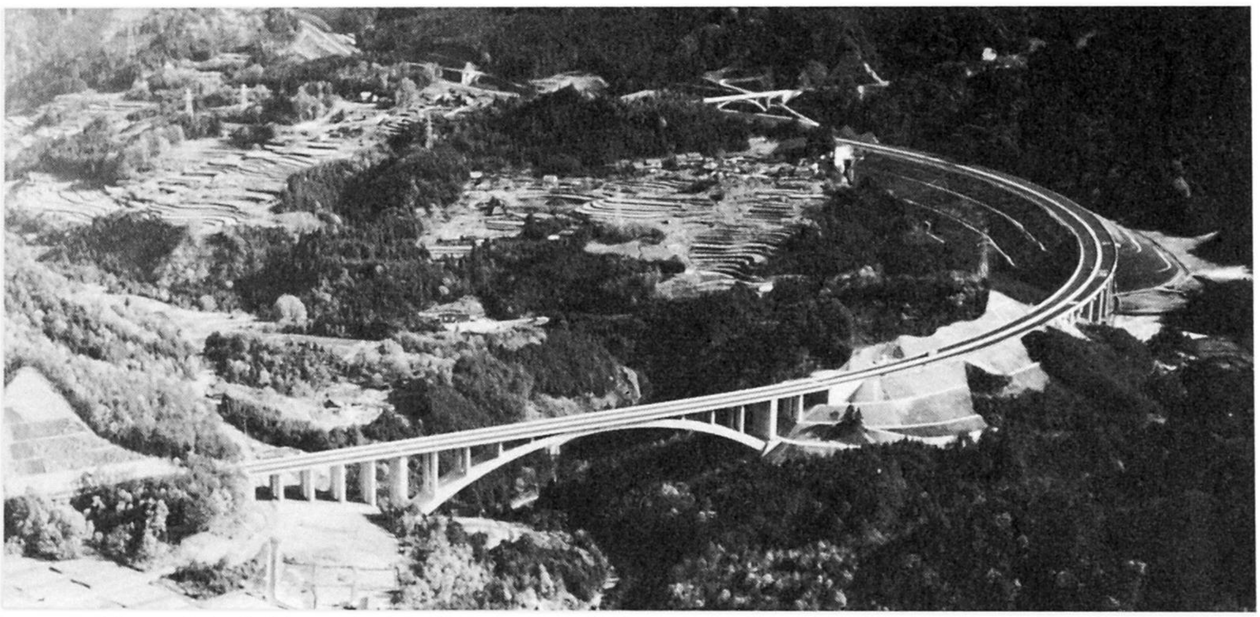


Fig. 4 View of the bridge completed