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5. Denny Creek Bridge (Washington, USA)

Owner: *State of Washington*

Designers:

Superstructure: *Dyckerhoff & Widmann, Inc., now DSI*

Substructure: *Department of Highways, State of Washington*

Contractor: *Hensel Phelps Constr. Co., Colorado*

Service Date: *1980*

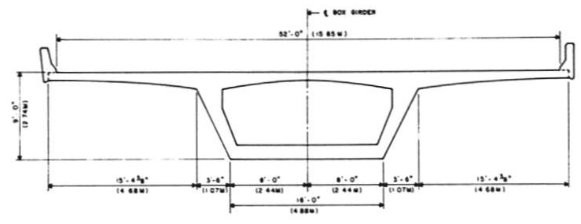

Fig. 2 Transverse section

Introduction

The Denny Creek Bridge is located in the Cascade mountains east of the city of Seattle. It carries the westbound traffic of the Interstate 90 across the Denny Creek through a beautiful resort region where protection of the environment is extremely important. The bridge carries three lanes of traffic and has a total length of about 1,100 meters.

Tendering

The bridge was tendered in May 1976. To assure competitive bidding the Highway Department has contracted two design consultants, Dyckerhoff & Widmann (D&W) New York City, and ABAM Engineers, to each carry out an alternate design, in addition to a design which was done by the State of Washington. The D&W design calls for a cast-in-place posttensioned single-cell box girder with long cantilever slabs at each side of the box. The ABAM design calls for a precast posttensioned bulb-T girder. The original stage design has trapezoidal precast box girder resting on a hammer head pier table with cast-in-place deck slabs.

Because of the serious concern of the environmental impact, the state allowed a $300 000 premium favoring the D&W alternative based on aesthetical reasons.

The low bidder was Hensel Phelps Construction Company bidding the D&W design at $11 399 000 which is about $1 million below the estimate.

Design

The bridge has twenty spans ranging from 43.8 meters to the typical spans of 51.3 meters. Because of the environment in this area it was specified that the superstructure must be constructed without falsework.

The superstructure runs closely along the slope of the mountain. Avalanche loading has to be considered in the design. To avoid a possible direct hit by the avalanche D&W's design chosed to use a middle box girder to allow more clearance for the avalanche to pass under the superstructure. This also results in a aesthetically very pleasing cross section with long cantilever slabs. The superstructure is designed for HS-20 loading and a snow load of 2.5 m. Sufficient drainage is provided in the cantilever slab to handle the water from the melting snow. The height of the piers ranges from about 6 meters to 55 meters.

Small holes are placed in the webs at about one meter centers to facilitate ventilation to reduce temperature difference between the inside and the outside faces of the box girder.

Taking advantage of the relatively solid cross section which is required for the long cantilever slabs the designer suggested to build the superstructure in three stages. The first stage is the U-shaped girder consists of the bottom slab and the webs. This stage can be built by means of a launching truss. By arranging the posttensioning tendons properly this U-shaped girder is capable of supporting, without the launching truss, its own weight plus the formwork and the dead load of the second stage which is the middle part of the deck slab. The cantilever slabs is to be built by means of forms supported by an after-runner. Posttensioning of tendons shall be arranged in such a way as required by the stages of construction. This method allows the use of a relatively light launching

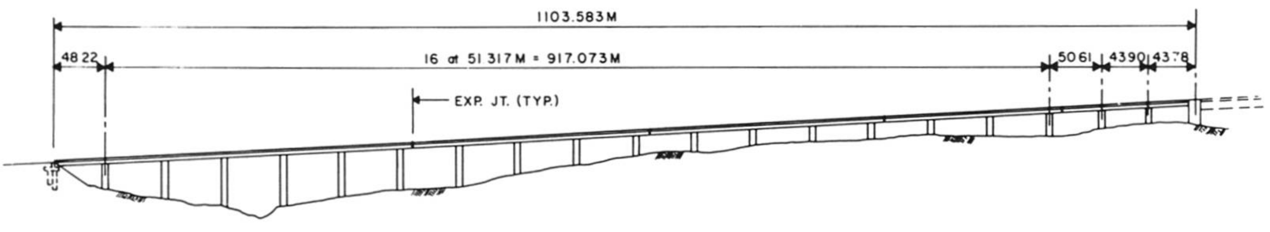

Fig. 1 Elevation

truss which has to support only the construction load of the U-shaped section plus some minor construction loadings. However, the contractor is not required to follow this suggestion although in the final construction the scheme used by the contractor was almost the same as suggested.

The superstructure has four intermediate expansion joints in addition to the joints at the abutments. To facilitate the stage construction these expansion joints are located approximately twelve meters from the piers in the direction of construction to coincide with the construction joints. The deck is transversely posttensioned to eliminate tensile stresses under service loadings. The deck is to receive a 46 mm asphalt overlay.

The piers are typically 4.88 by 3.05 meters rectangular hollow columns supported by 3.66 meter diameter shafts. In the avalanche area a triangular nose is added at the uphill edge to protect the pier columns. In order not to disturb the environment the shafts have to be excavated. No blasting or heavy drilling is allowed for this purpose.

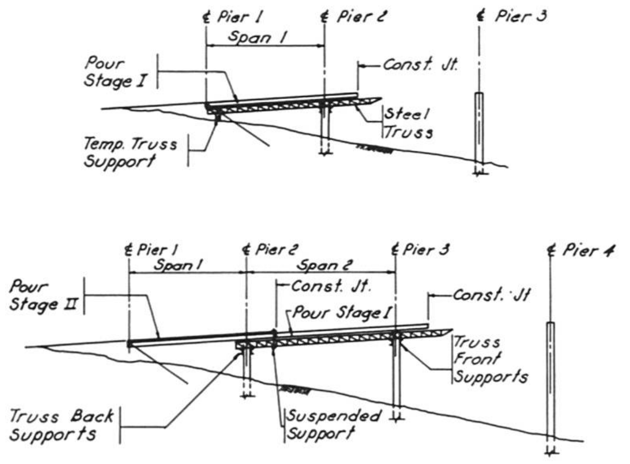

Fig. 3 Truss position
a) initial b) after moving

Construction

In the actual construction, the contractor selected an overhead truss to build the U-shaped stage one girder. Strand tendons were used for both longitudinal and transverse posttensioning. Part of the longitudinal tendons were coupled at the construction joints to make continuous tendons. After posttensioning the required tendon of the Stage 1 girder the overhead truss was moved ahead to the next span.

This construction makes it possible to divide the construction activities in these three separate stages. This division is especially advantageous in United States because of the separation of different trade unions. As the workers can only be assigned to do a specific task of the construction, contractors have to plan in such a way that the worker in each trade of the labor force will be utilized at all times. The stage construction can facilitate such a work schedule by staggering the construction operations in each of the construction stages.

The construction was successfully carried out and the bridge was opened to traffic in 1980.

(Man-chung Tang)

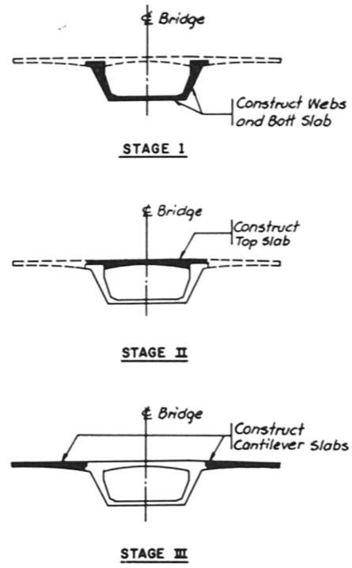

Fig. 4 Pouring sequence
(truss and form work not shown)

Fig. 5 Denny Creek Bridge