Zeitschrift: IABSE structures = Constructions AIPC = IVBH Bauwerke

Band: 8 (1984)

Heft: C-32: Recent structures

Artikel: Steel arch bridge, Kuan-Du (Taiwan, China)

Autor: Loh, E. / Seim, Ch. / Tai, J.

DOI: https://doi.org/10.5169/seals-18844

2. Steel Arch Bridge, Kuan-Du (Taiwan, China)

Overall Construction and Supervision:	*Taiwan Highway Bureau*
Design:	*T. Y. Lin International, Inc. & China Eng. Consult. Inc.*
Contractors:	*Tan Eng Iron Works Co.*
Technical Consultant:	*Harumoto Iron Works Co.*
Steel Supplier:	*Taiwan Steel Corporation*
Completion:	*1983*

Layout and Overall Design Features

In order to accelerate the development of the adjacent towns, the four-lane 19 m wide Kuan-Du Bridge was buildt over the Tamsi River about 15 kilometers north of the City of Taipei (Fig. 1).

Various aesthetic, navigational and structural considerations made the choice of bridge design an important one. The beautiful scenery around the site demanded a structure which would enhance rather than detract from the beauty of the environment. Navigational requirements called for a vertical clearance of 15 meters for a distance of at least 100 meters at the main channel, which is on one side of the river. Additionally, because of the shifting nature of the channel, similar clearances were desiderable for the other river spans. Thus the number of piers for the main span was limited to three or four.

Foundation conditions, which vary along the bridge centerline, also demanded a flexible solution. Therefore, three open caisson piers were built, using two caissons per pier with 6.5-meter diameters and depths of 16.7 to 26.2 meters, while the remaining main piers were founded on 76.2 cm steel pipe piles with depths of 44 to 56 meters.

Additional aesthetic and structural features of the main crossing design are described below (Fig. 2):

a) The center span of 165 meters is flanked by shorter spans of 143 meters plus two 4-meter approach deck spans, resulting in a 5-span structure that appears as a graceful 3-span arch.

b) The center-span and side-span arch rises differ but are matched with the span lengths' variation in order to yield equal arch thrusts at the piers. The same criterion of thrust-balancing is applied to the 44-meter approach spans. As a result, there are no unbalanced arch thrusts for any of the five spans.

c) The arch ribs are designed to essentially resist axial load, and to carry little bending moment. Thus, they are very slender and graceful. Practically all bending moments are resisted by the two deck girders located in the same vertical plane as the ribs. These main deck girders also serve as horizontal ties for the arch. Since these girders lie along the plane of the roadway, their depth is blended into the deck, posing no obstructive appearance.

d) No diagonal cross-bracing was used above the deck, leaving a clean arch superstructure having only the horizontal strut bracing necessary to stabilize the arch ribs. Thus a neat appearance is presented, particularly when driving through the bridge.

e) The vertical hangers, spaced 11-meters apart, are exposed twin 4.13 cm diameter galvanized strands, emphasizing the airy feeling of the slender arches, without obscuring their elegant simplicity. These hangers are connected with turnbuckles at the ends. Redundancy is supplied by designing the hangers to hold even if one of the twin strands were to break.

f) For a smooth appearance of the steel members, all sections were welded in the shop or on the shore. Therefore, the only bolting required was at the intersection of the deck and the arch ribs.

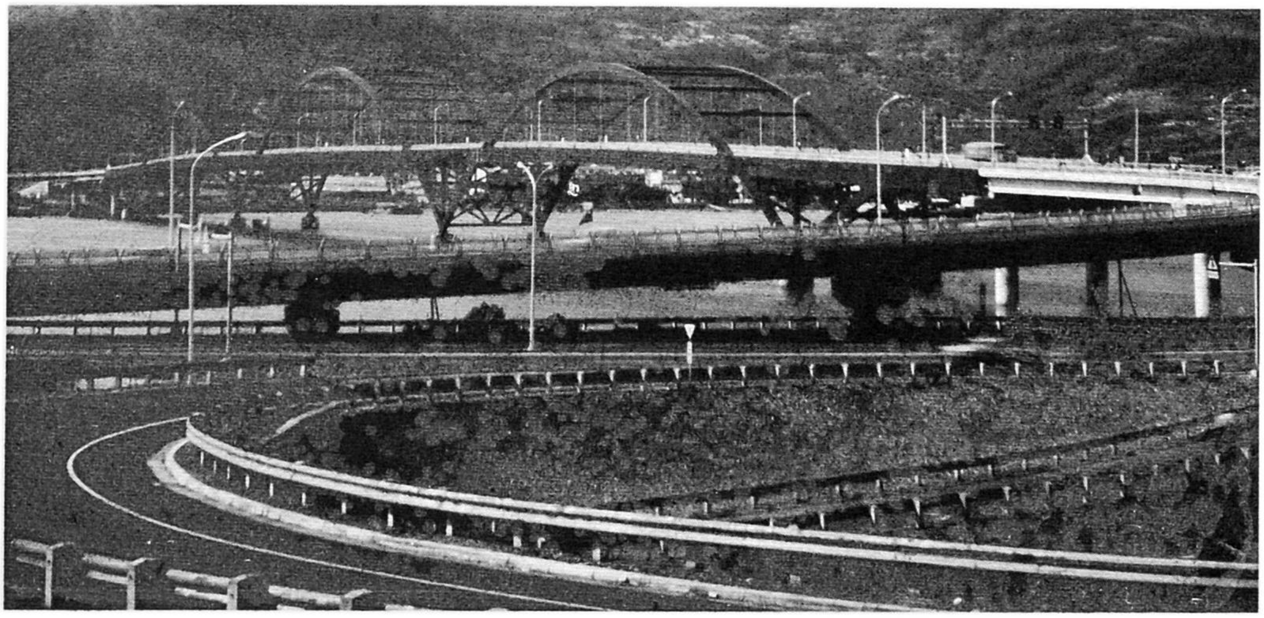


Fig. 1

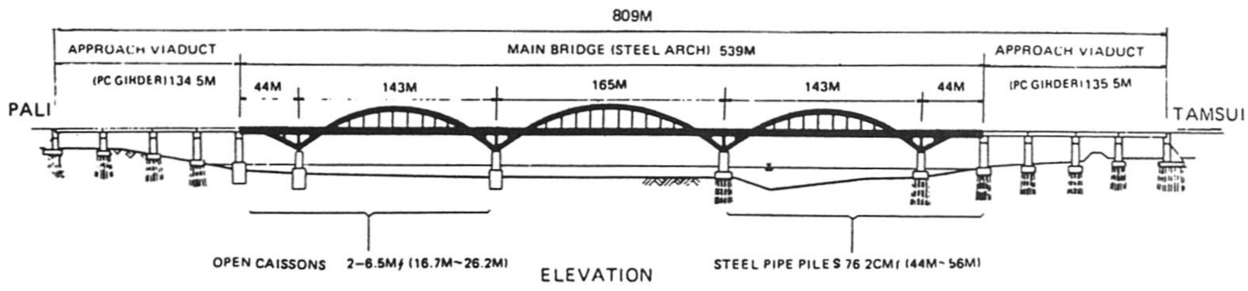
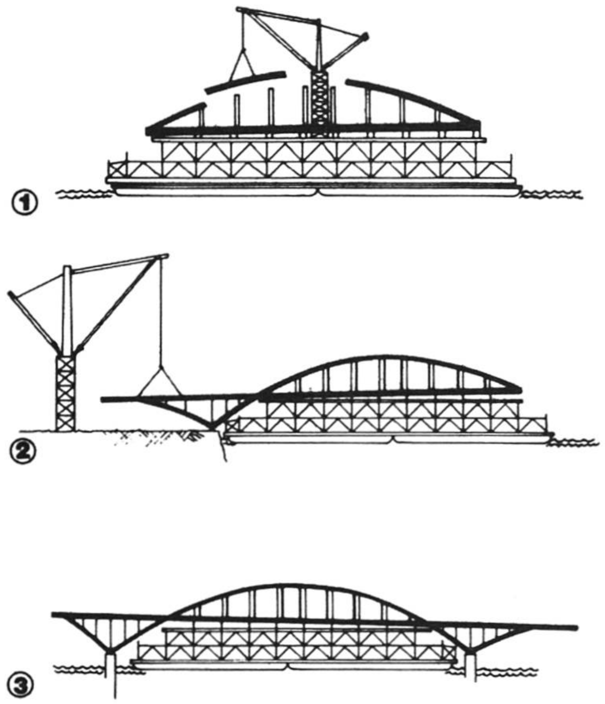


Fig. 2

Design details

Both the arch ribs and the tie girders are designed of welded rectangular box sections with an inside, uniform width of 75 cm and depths of 135 and 270 cm respectively. These box sections are resistant to buckling, simple to fabricate, and easy to maintain. To simplify welding procedures, a maximum steel thickness of 5 cm was specified. All main members were designed for full-face automatic welding, therefore, thermal deformation was minimized. Additionally, canvas covers were used during job site welds to control temperature and humidity. Finally, all welds were fully examined by radiography.



Arch *(1)* is assembled on barge anchored parallel to shore. Barge then rotates to align arch *(2)* for bolting to triangular-shaped base section fabricated on land. Fully assembled segment then moves into river for setting *(3)* on bridge piers.

Fig. 3

Erection

Without using falsework in the water, this 539-meters, 5-span arch bridge was erected in just three segments and floated into place by barges. Assembly of the segments took place in a combined land and water-based operation.

The bridge construction scheme called for installing six temporary bents in the river at the intersections of the arches and deck girders. The Contractor decided to dispense with the bents. Instead, he rented two 6000-ton water-ballasted barges and used them as a base on which to build the arches using shop-fabricated components. Anchoring the barges end-to-end and parallel to the shore permitted landbased cranes to assemble the spans. Temporary struts rising vertically from the tie girders supported the arch members during this assembly.

The triangular-shaped base sections of the arches, lying below deck elevation were assembled on shore, perpendicular to the river bank. Once they were ready the barges were rotated 90 degrees from their parallel position thus putting the arches sections aboard them into alignment with the triangular section which was then high strength bolted into place (Fig. 3).

Placement

The barges were towed to the bridge site during high tide with their elevation being controlled by water-ballasting. As the tide went down, the structure was lowered into position.

Had the bridge been lifted in place by a floating crane, the rent of a 1500 to 2000 ton class floating crane, which would have had to come from Japan, would have far exceeded the estimated cost for erection. In addition, a large scale dredging would have been necessary, adding extra costs. Thus, the Contractor's plan was not only ingeneous but economical.

The first 209-meter assembly with two triangular sections (one at each end) was erected on its piers February, 1983. The Contractor placed the 165 m. center span, consisting of an arch and one triangular section in June. The third arch span was erected in September. Each of the three segments weighed from 1500 to 2000 tons. The bridge was completed by the end of October 1983.

(E. Loh, Ch. Seim, J. Tai, T. Y. Lin)