Salient details of some cable-stayed bridges

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The paper briefly reviews four interesting cable-stayed bridges in Europe, USA and Mexico, which illustrate the grace of this type of bridges as well as their suitability for a range of spans previously considered the domain of suspension bridges. For the sake of brevity, only the essential features are described, and no attempt is made to describe the detailed design and construction features.

Brotonne Bridge, France

Brotonne Bridge, Figure 1, situated between Rouen and Tancarville is a cablestayed, prestressed concrete bridge. The conditions prevailing at site demanded a structure without piers in the navigational span, and a navigational clearance of 50m above the maximum high-water level to allow the free passage of ships to the port of Rouen.

The structure includes a cablestayed bridge with a prestressed concrete deck of three spans : 143.50m-320.00m-143.50m. The main span of 320m created a world record for concrete structures. While the left bank approach has eight spans of 38.90m and one span of 58.60m, the right bank viaduct has

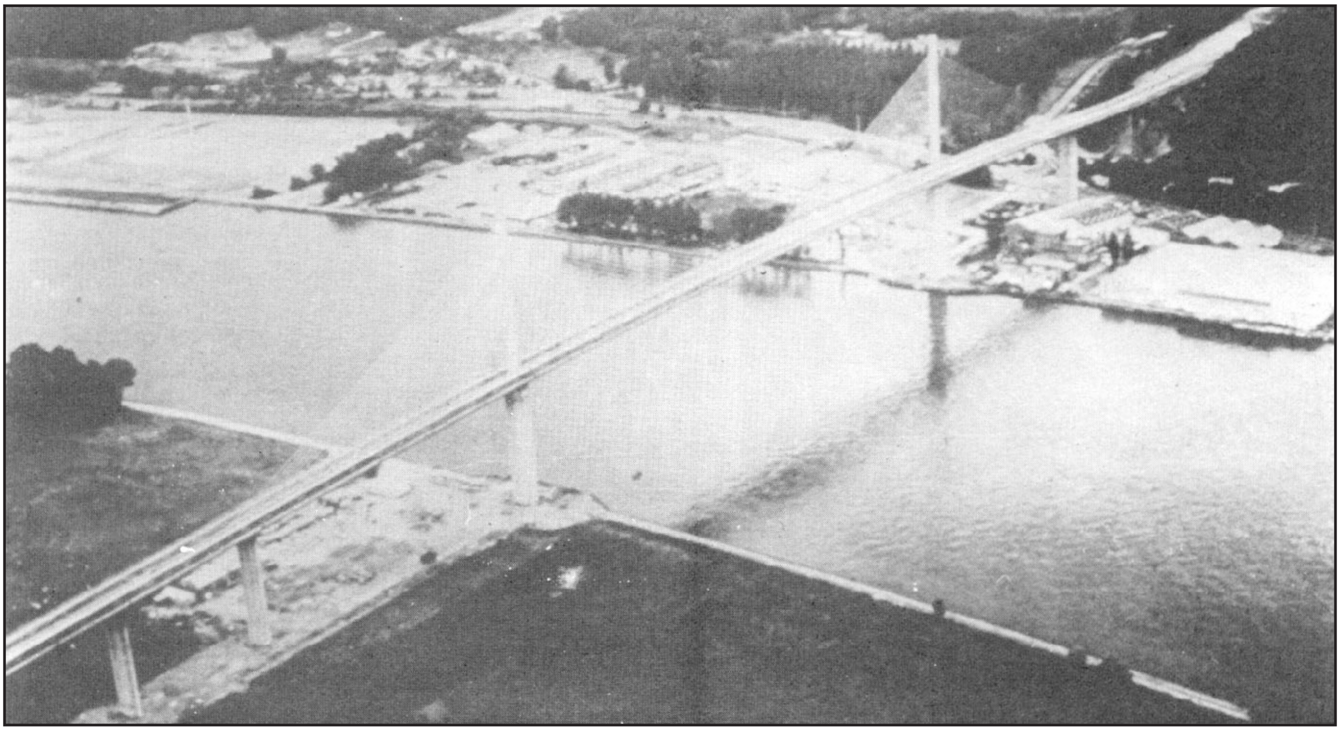

Figure 1. Brotonne Bridge over the river Seine in France. The central 320-m long span of the bridge is supported by stay-cables

three spans of 70.00m, 55.50m and 39.00m. The structure rests on neoprene bearings or neoflon sliding bearings.

The main part of the structure is a cable-stayed bridge having 12 stays for each half of the bridge, situated in a single plane along the bridge axis and comprising of cables from 39 T 15 to 60 T 15. The cable lengths varied from 84m to 340m. Each group of stays is supported by a pier having a height of 50m between ground level and underside of the deck, and by a tower, 70.5-m high above the deck. The total height of each pylon is 124.50m.

The stays are supported at the tower on pipes cast in concrete at every 1.8m. The first pipe is located at a height of 21m above the deck. The cables are housed in thick-walled tubes, which have an internal diameter of 160mm and are filled with cement grout to protect the steel. The foundations are at a depth of 35m and consist of a concrete casing having 12.4-m external diameter and 800-mm thickness.

The piers, constructed with the aid of sliding formwork, have a hollow polygonal section inscribed in a circle of 10-m radius.

The towers, constructed with the aid of climbing formwork, are of hollow section varying from 4.80m x 2.60m at the base to 2.84m x 2.60m at the top. The towers are rigidly fixed to the deck and their loads are transmitted to the piers through a solid base cast monolithically with the deck.

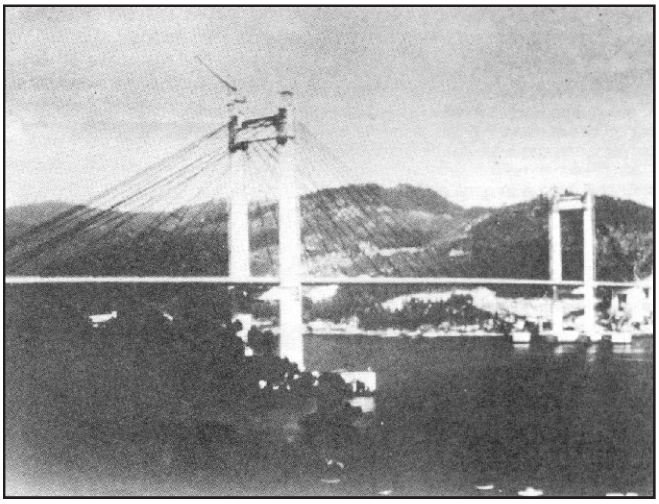

Figure 3. Rande Bridge, Spain. The main cable-stayed span has 400-m length, with two portal-shaped reinforced concrete towers

Pasco-Kennewick Bridge, USA

Pasco-Kennewick Bridge, Figure 2, completed in 1978, was the first cablestayed bridge with segmental concrete superstructure to be constructed in the United States. The overall length of the structure is 763m. The central cablestayed

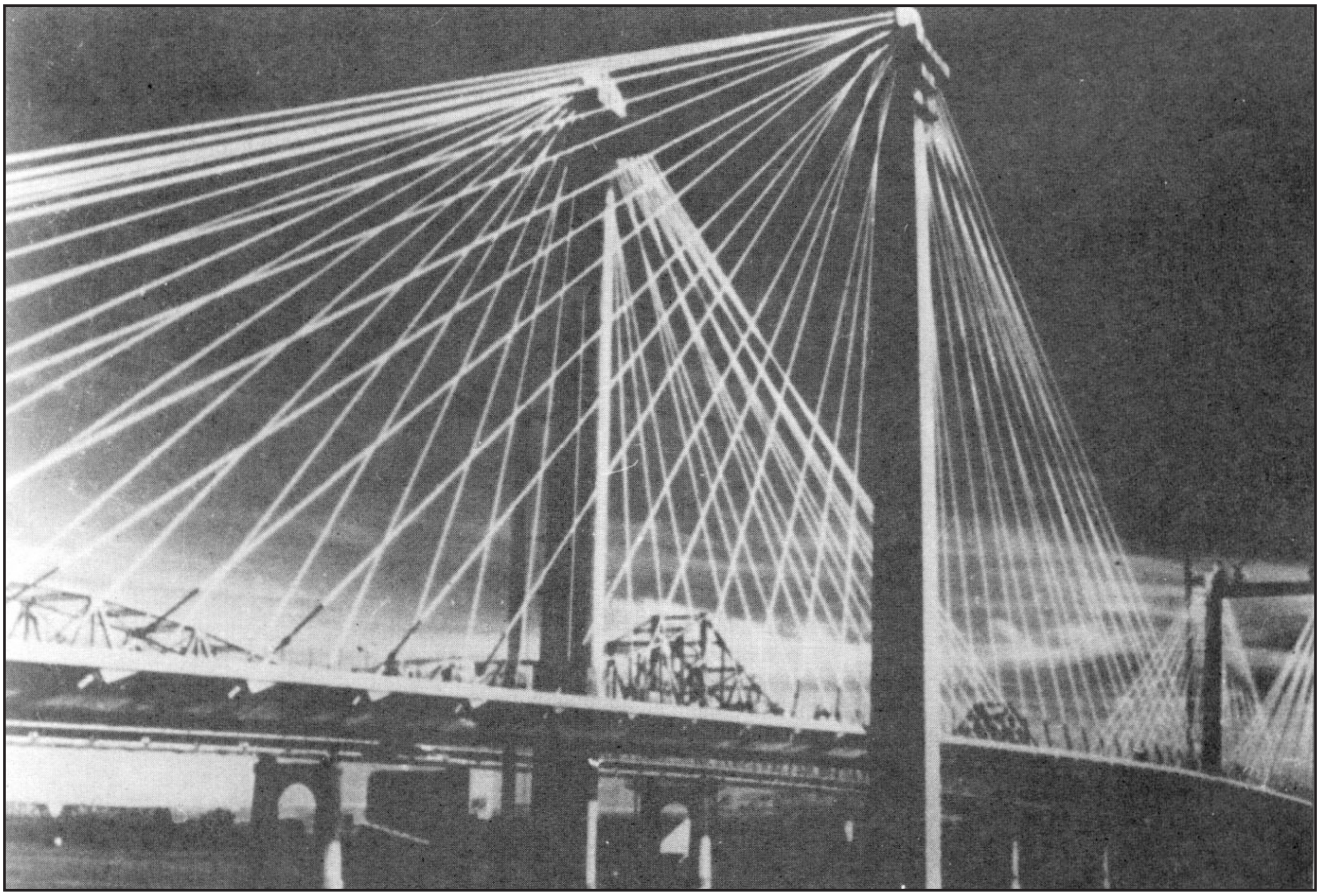

Figure 2. Pasco-Kennewick Bridge across the Columbia River in the USA. It has a central cable-stayed span of 299m, with stayed flanking spans of 124m

span is 299m and the stayed flanking spans are 124m. The Pasco approach is a single span of 38.4m, while the Kennewick approach has one span of 37.8m, and 3 spans of 45.1m each. The girder is of uniform crosssection, 2-m deep along its entire length and 24.3-m wide.

The bridge is not symmetrical. The pylon on Pasco side is approximately 1.8m shorter than that on Kennewick side. Therefore, the cable-stayed pairs are not of equal length.

There is no attachment of the girder at the pylons, except for vertical neoprene-teflon bearings to accommodate transverse load. The girder is supported only by the stay-cables.

Vertical bearings are also located at the approach piers and abutments. The natural frequency of the girder where it will respond to dynamic acceleration of earthquakes is 2 cycles/sec. If this situation occurs, the vertical restraint at the Pasco abutment is designed to fall in direct shear, thus changing the frequency to 0.1 cycle/sec, rendering the system insensitive to dynamic excitation.

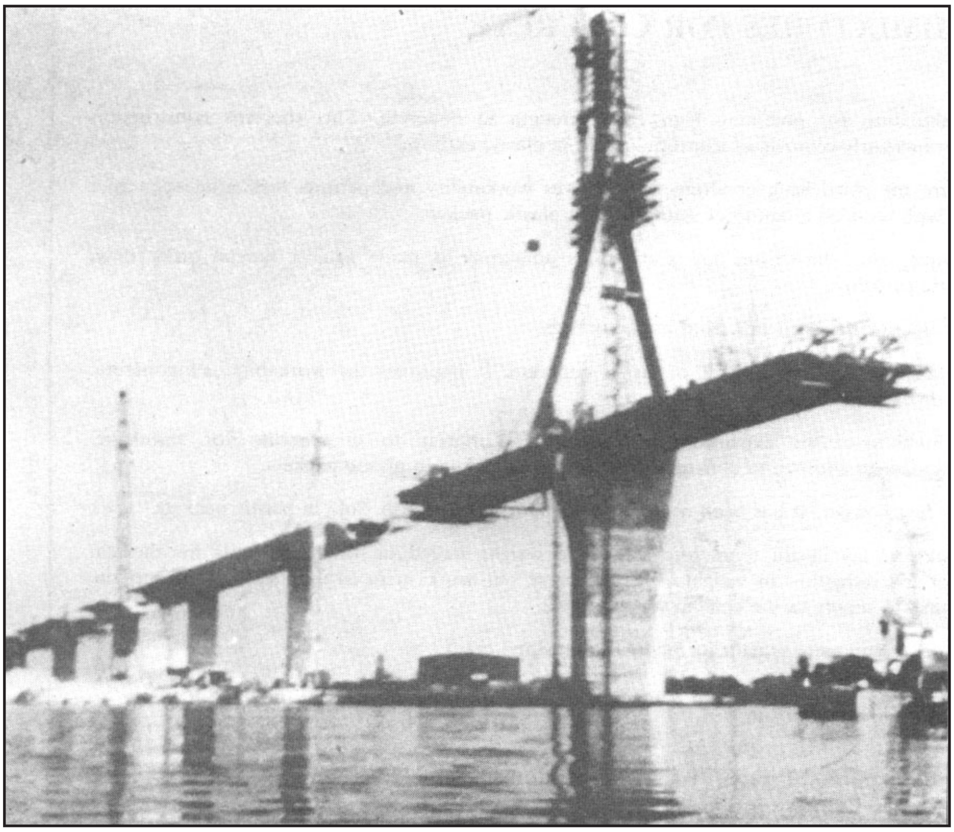

Figure 4. Coatzacoalcos Bridge, Mexico. The location of the bridge on a pronounced curve of the river and its exposure to cyclones, earthquakes and aggressive environment necessitated special studies

Rande Bridge, Spain

Rande Bridge, Spain, illustrated in Figure 3, has a length of 1,570m, the main structure being in three spans of 148m, 400m and 148m. The main structure is cable-stayed with two portal shaped reinforced concrete towers supporting a steel deck. There is also an access viaduct on the north side. It is 106-m long and comprises of three continuous spans of two prestressed concrete box girders. On the south side, the access viaduct is 753-m long and is made up of 17 spans with double box girders.

The piers of Rande Bridge are in reinforced concrete and the deck is in steel, erected by cantilever construction method. The stays are prestressed concrete cables enclosed in polythene tubes to ensure adequate protection against corrosion.

Coatzacoalcos Bridge, Mexico

This bridge, illustrated in Figure 4, forms an important link between the southeast and central parts of Mexico, and is part of a diversion which is built to direct a part of the heavy traffic (8,000 vehicles/hour) around the town of Coatzacoalcos. It is at present the biggest bridge in Mexico, and is classified amongst the ten biggest cable-stayed bridges in the world. It is located on a very pronounced curve in the river and the area is exposed to cyclones, earthquakes, and aggressive marine and industrial environment. The span of the bridge and the nature of the site necessitated special studies for the distribution of lateral spans, seismic and fatigue effects, anchorages of cables, and wind effects.

The .total length of the bridge is 1,170m, of which 472m consists of the approach viaduct. The 698-m long main structure consists of 7 spans of 30m, 49m, 112m, 288m, 112m, 60m and 49m. It is a stayed structure, whose suspension is by 17 stays anchored in the deck, passing through pylons. The pylons stand 97-m high above the river. The deck of prestressed concrete crosses the pylons at 35m above the water level, leaving enough space for navigation.

The foundation of pylons consists of 18 piles, 2.50-m diameter and 30-m deep.

The bridge required 25,000m^3 of concrete, 3,500t of steel for the reinforced concrete works, 670t of high tensile steel for prestressing, of which 400t was for the cable stays.

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