Analysis and Design of Peljesac Bridge in Croatia

Jure RADIC
Professor
University of Zagreb
Zagreb, Croatia
Jradic@grad.hr

Professor Jure Radic, born in 1953, received his PhD at Faculty of Civil Engineering, University of Zagreb in 1987. He is full professor at the Structural Department of Civil Engineering Faculty.

Zlatko SAVOR
Assistant Professor
University of Zagreb
Zagreb, Croatia
savor@grad.hr

Zlatko Savor, born in 1945, received his PhD at Faculty of Civil Engineering, University of Zagreb in 2005. He is assistant professor and Head of the Structural Department of Civil Engineering Faculty.

Gordana HRELJA
Civil Engineer
University of Zagreb.
Zagreb, Croatia
hgoga@grad.hr

Gordana Hrelja, born 1972, received her civil engineering degree in 1998 from the Univ. of Zagreb. She is research assistant at Structural Department of Civil Engineering Faculty.

Summary

The construction of a new 2.4km long bridge, crossing the sea strait between the Croatian Mainland and the Pelješac Peninsula to provide the fixed road link between the whole of Croatia, has just begun. The bridge location is in a highly seismic zone with the design ground acceleration of 0.41g and on extremely bad soil. Extensive off-shore site investigations were carried out, including continuous shear wave survey and geotechnical explorations from a specially equipped drill ship, to obtain soil parameters for the design of bridge foundations. A site-specific seismic study was undertaken based on the seismic source zone characterization and attenuation relationships for the south of Croatia. The four lane road bridge consists of two approach bridges and the main cable stayed bridge with continuous steel trapezoidal box superstructure.

Keywords: design, cable stayed steel bridge, steel superstructure, soil parameters, seismicity, deep foundations

1. Introduction

The southern part of Croatia, including the city of Dubrovnik, is currently separated from the rest of Croatia by a small coastal stretch belonging to the state of Bosnia and Herzegovina. The idea of fixed road link to connect the whole of Croatia, without having to cross state borders,twice has been studied for more than a decade.

The new bridge crossing the sea strait between the Croatian Mainland and the Pelješac Peninsula shall fulfil this purpose and also further the development of the Pelješac Peninsula and adjacent islands.

The seabed at the bridge alignment is almost level at -27.0m elevation, with the stratigraphic pattern a series of sub-horizontal layers and irregular top of the rock along the bridge. Extensive off-shore site investigations were carried out, including continuous shear wave survey and geotechnical explorations from a specially equipped drill ship, to obtain soil parameters for the design of bridge foundation. The stratigraphy at the bridge site can be described as follows:

- 0.0-6.0m, very soft to soft high plasticity clay
- 6.0-60.0m, medium stiff to stiff high plasticity clays and silts
- 60.0m to bedrock, very stiff to hard clays, locally cemented
- lime-stone bedrock with variable degree of weathering and fissuring.

The depth to bedrock is variable along the bridge alignment, found at between 75.0m and 102.0m depth in the central portion of the crossing and at 39.0m close to the Mainland coast. Coring from two boreholes revealed sound rock close to coast and highly fractured rock with clay filled joints in the central strait portions. The bridge site lies in a zone of large seismicity in the vicinity of active seismic faults, with seven significant earthquakes of magnitude M>6 within 100 km of the site, occurring in the past century.

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The bridge site is also open to high winds with maximum average 10-minute wind speeds of 33.4m/s and wind gust speeds of 47.1m/s, both for the return period of 50 years and most unfavorable SE wind direction according to estimates by the Croatian Meteorological Service.

Hence, the main challenges for the bridge design were high bridge alignment at approximately +90.0m elevation, adverse soil conditions and high seismicity of the site. Because of these constraints, it was evident that the total bridge dead weight and especially the dead weight of the superstructure had to be reduced as much as possible, which was accomplished by adopting a steel superstructure. Also relatively long spans were utilized to limit the number of expensive foundations.

Over 10 bridge types, including beams, trusses, arches and cable-stayed bridges, were studied at the preliminary design stage. After a beam type bridge was chosen for the main design, new demands on the navigation clearance were asked for by the neighboring country. The navigation channel was to be at least 400m wide with vertical clearance of 55m. This request limited the choice to cable stayed bridge alternatives and finally the cable stayed bridge with the main span of 568m and the steel box type superstructure was chosen for main design.

2. Bridge specifics

The four lane roadway width is 2x8.0=16.0m, with two lanes in each direction separated by a 3.0m wide median strip, so that the total width between safety barriers amounts to 20.0m. Survey walkways 1.11m wide, are positioned outside safety barriers, resulting in overall bridge width of 23.0m between cornices. Semicircular cornices 1.05m deep and 0.81m wide, which also function as wind deflectors, are installed at transverse bridge edges.

The ground plan alignment from the beginning of the bridge on the Mainland on the length of 275.0m is in the curve of R=450.0m radius, followed by the transition curve of 75.0m length, then in a straight line to the bridge end on the Pelješac Peninsula. The vertical grade line alignment changes along the bridge from concave curve R=8,000.0m to constant upward slope of 2.98%, followed by the convex curve R=11,000.0m, then downward slope of 2.98% and finally to concave curve of R=8,000.0m radius. The double slope transverse roadway gradient is 2.5% in the straight line bridge alignment, changing to single slope transverse gradient of maximum 5.8% in the horizontal curve at abutment U1.

The superstructure is a continuous trapezoidal steel box over 17 spans, with the overall length of L=72.0+96.0+5x120.0+150.0+568.0+150.0+5x120.0+96.0+72.0=2,404.0 m. (Fig. 1).

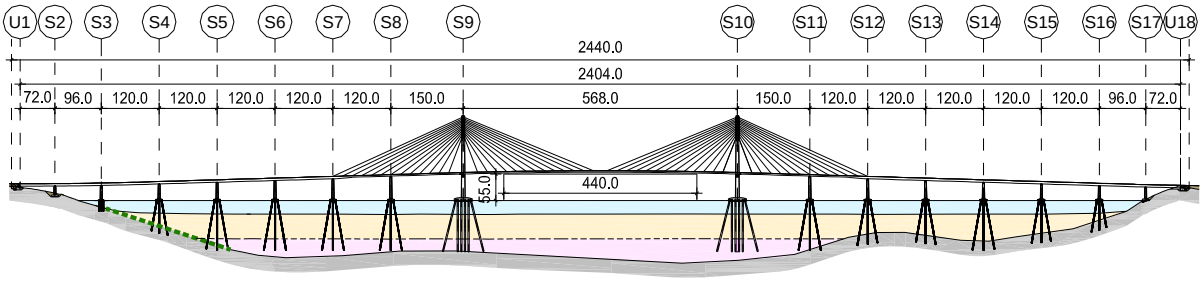

Fig. 1: Longitudinal layout of the bridge

3. Conclusion

The key design challenges were high bridge alignment at about +90.0 m elevation, adverse soil conditions, high seismicity of the site and stringent ecological requirements. At present, the main span of 568m would be the 3rd longest span for cable stayed bridges in Europe. The construction of the Mainland-Pelješac Peninsula bridge started a few months ago, the abutments are finished and construction of coastal piers is in progress. It is the longest bridge in Europe, currently under construction.