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Evolution of Design Trends in Cable-Stayed Bridges

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Abstract

Cable-stayed bridge design is quite different now from what it used to be 25 years ago. Technology applied to analysis, materials fabrication and construction has driven the designers to face very different problems along these years. The present paper explains how this evolution is seen from the experience of designing many such bridges including the well known Ebro and Barrios de Luna bridges.

The fields which will be addressed in this paper are aesthetics, general structural design, coding, structural analysis and cable technology. The final item will consist in giving an answer to the following question: are we marching to optimal design or to a free field open to new architectural or sculptural ideas?

The towers and the cable system are the most visible elements of the bridge and those which determine its aesthetical qualities. As engineers we tend to see both elements as two opposite poles since the towers are mainly compression struts and stays are tension elements. Can we forget this duality when designing a bridge? How the different tower shapes (single pole, H, A, inverted Y, diamond, etc.) fulfill the structural role which is assigned to them?

Structural or bridge codes did not consider the cable-stayed bridge as different as to deserve special treatment. Is it so nowadays? Safety problems as related to limit states is an important item since a very strict application of structural codes may drive to unsolvable design problems. Fatigue and vibration problems have to be dealed in a specific way since many such problems are only found in cable-stayed bridges.

Structural analysis has also changed dramatically in the last twenty years. General static analysis of the bridge used to be the object of most discussions: step by step analysis of erection procedure, geometrical non linearity, creep and shrinkage effects were the big issues. Today more specific problems are being throughly analyzed: aeroelastic effects, local stress problems, cable anchorages. The availability of sophisticated computer codes allows the analysis of ultimate limit states by taking into account the properties of steel and concrete at this stage. Are the codes prepared for such kind of analysis?

Cable technology has also changed some design ideas. Fatigue and stress-corrosion problems used to be a big issue and an argument against cable-stayed bridges. Today these problems may be considered as almost solved. Cables are playing an important role in the visual impact of the bridge. Then we begin to worry on external colors of the cables. Nevertheless cable vibration is still a problem although solution to it is well advanced.

Finally some of our present views about cable-stayed bridge design are presented. They refer to the applications of the extradosed concept as a way to extend the range of applicability of cable-stayed bridges and to the ever increasing role of prefabrication to solve construction problems. Some of our most recent projects are presented (fig. 1 and 2).

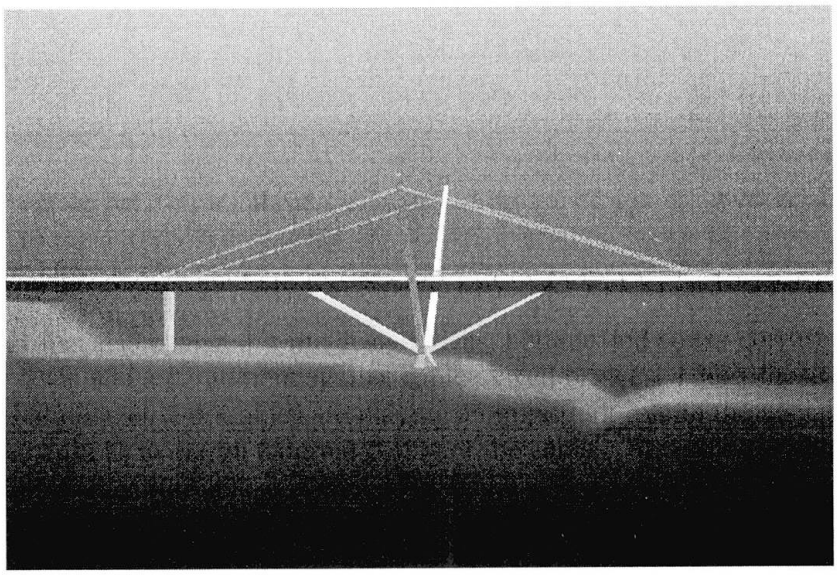

Fig. 1. Bocairente bridge, Spain, 1999

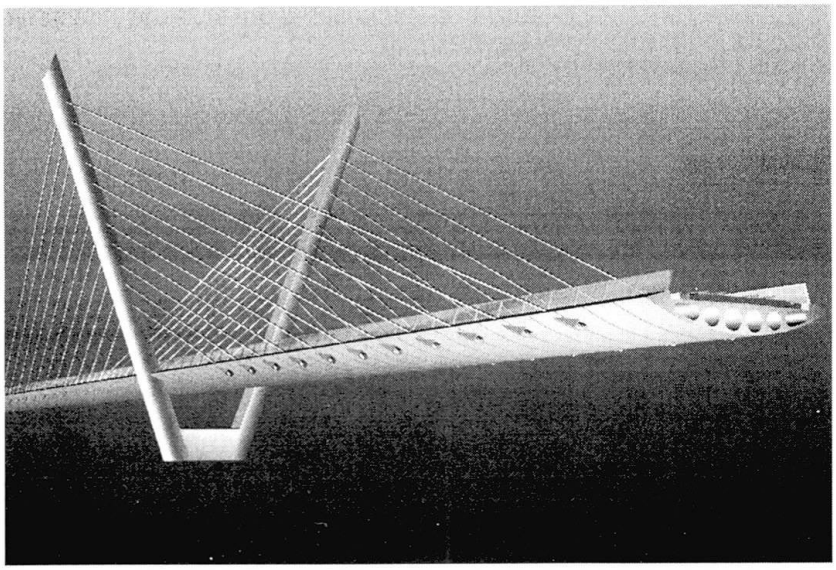

Fig. 2. Proposal for a new Ebro bridge.

This paper tries to give a comprehensive perspective of the evolution of cable-stayed bridge design on the basis of our long experience in this field and on the analysis of the most recent designs.