High Rigidity Suspension Bridges

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Abstract

High rigidity suspension bridges, with hybrid suspension system, made of parabolic cables and stay cables, have been widely used in the nineteenth century, at the beginning of modern suspension bridges history. The Brooklyn Bridge is an outstanding example of this kind of structures. At the present time, high rigidity suspension bridges are less successful than in the past, as cable stayed bridges are usually considered as the most efficient typology for crossing up to about 1100 meters, and suspended bridges for wider spans, up to 2,000 meters or more. Recently, the construction of Third Bosphorus Bridge has proven that the hybrid suspension system is still a competitive solution. The aim of this paper is to show the interest of high rigidity suspension bridges for 2000 meters crossing in comparison with traditional suspension bridges.

Keywords: long span bridges; cable stays; suspension cables.

1 Introduction

The aim of this paper is to present the interest of high rigidity suspension bridges, with hybrid suspension system made of parabolic cables and stay cables, for very long main spans, up to 2,000 m and more.

Hybrid suspension was used at the beginning of modern suspended bridges history, by pioneers like Albert Gisclard and Ferdinand Arnodin in France, respectively for the Jargeau bridge on the river Loire and for the Rouen transporter bridge on the river Seine, and by John August and Washington Roebling in the US, for the Brooklyn Bridge in New York. Stay cables were used essentially to stiffen the girder close to the pylons, where the rigidity of the main suspension is faint. Same design has recently been applied by Michel Virlogeux and T Ingénierie to the Third Bosphorous Bridge [1], a mixed roadway and railway crossing.

Today it's commonly admitted that cable stayed bridges are effective for spans up to 1,200 m, and suspension bridges for greater spans. Theoretically, with regards to cables weight, it is preferable to bear a beam with stay cables rather than with parabolic cables, because the quantity of steel is lower in the first case. Nevertheless, for long spans exceeding 1,200m some technical and economic disadvantages appear for stay cables systems, as pylons height, stay cable effectiveness, lateral wind forces on stay cables and pylons, weight of the deck, so that parabolic systems are preferred.

On the basis of these assumptions, hybrid suspension bridges can be considered as being the logical hyphen between the two suspension typologies, preserving the advantages of the stay cables to bear the sides of the deck and those of the parabolic cables to bear its middle.

2 A 2,000 m main span crossing

In this paper we consider a 2,023m main span bridge, bearing six traffic lanes and two lateral service sidewalks. Very long suspension bridges can be designed with 3 possible steel cross sections: