Aerodynamic Challenges and Solutions of Ultra Long Span Cable Stayed Bridges

Ngai YEUNG
Associate
Arup
Hong Kong
ngai.yeung@arup.com

Matt CARTER
Associate Director
Arup
Hong Kong
matt.carter@arup.com

Jung-hwi NOH
Senior Researcher
GS Engineering &
Construction Corp., Korea
jhnoh1@gsconst.co.kr

Sang-hoon LEE
Senior Researcher
GS Engineering &
Construction Corp., Korea
leesh07@gsconst.co.kr

Summary

This paper introduces the aerodynamic challenges of ultra long span cable stayed bridges with a main span exceeding 1,200m and provides technical solutions based on the specimen design of a 1,400m main span partially earth anchored cable stayed bridge. An innovative tie cable technology is introduced which makes the construction feasible and allows a 30% reduction in the steel deck quantities compared to a bridge built by the traditional cantilever method.

Keywords: cable stayed bridge; aerodynamics; long span; stay cable damping

1. Introduction

With the rapid increase in span length of cable stayed bridges over the last four decades the question now being investigated by a number of researchers is what would be the practical span limit for this type of bridge construction?

Because the suspension bridge form already offers a well established alternative to the cable stayed bridge for spans up to 2,000m or more, the challenge for an ultra-long span cable stayed bridge with span greater than 1,200 m is not only technical but also economical. Such a bridge will only be built if a cable stayed span of that size is competitive against a suspension bridge. Aerodynamic forces acting on an ultra-long span cable stayed bridge are decisive in determining not only technical feasibility but also the construction cost.

A partially earth anchored system has been proposed as a way of reducing the cost of ultra long span cable stayed bridges by significantly reducing deck quantities. However, a key unresolved issue is how such a bridge might be constructed.

This paper presents the aerodynamic challenges for ultra-long span cable stayed bridges and based on the Specimen Design of a 1,400m main span partially earth anchored cable stayed bridge presents proposed solutions. An innovative tie cable technology is introduced which makes the construction feasible and allows a 30% reduction in the steel deck quantities compared to a bridge built by traditional cantilever technology.

The paper also shows how the tension force generated within the deck of a partially earth anchored cable stay bridge has an important and beneficial geometrically non-linear effect in resisting wind forces acting on the global system of the bridge. Practical means of damping stay cables with lengths in excess of 700m are also discussed.

2. Key Issues and Aerodynamic Challenges

Cable stayed bridges with spans greater than 1,200 m will only be built if there are locations where such spans are needed, if a cable stayed bridge of such a span is technically feasible, and if a cable stayed span of that size is competitive against a suspension bridge.

https://doi.org/10.2749/222137912805110817