



Aerodynamic Challenges of Major Chinese Bridges

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Summary

This paper presents recent advances in aerodynamic studies of flutter instability, vortex induced vibration, and stay cable vibration, undertaken to address the most formidable challenges of long-span bridge design. Aerodynamic stabilization for long-span suspension bridges is introduced, followed by an aerodynamic feasibility study of a 5 000 m-span suspension bridge. It seems that the intrinsic limit of span length due to aerodynamic stability is about 1 500 m for a traditional suspension bridge, but either a widely slotted deck or a narrowly slotted deck with vertical and horizontal stabilizers could provide a 5 000 m suspension bridge with high enough critical flutter speed. Since cable-stayed bridges have good intrinsic aerodynamic stability, rain-wind induced vibration and mitigation are discussed as the primary concern encountered in the design of most long-span cable-stayed bridges. It is possible to increase the span length of cable-stayed bridges in the near future while ensuring aerodynamic stability. Compared to suspension bridges and cable-stayed bridges, arch bridges have relatively shorter span and higher stiffness. Consequently, only one of the ten longest-span arch bridges, namely Shanghai's Lupu Bridge, suffers vortex-induced vibration as described in the paper. An increase in span length of arch bridges should not be influenced by aerodynamic requirements.

Keywords: Suspension bridge, cable-stayed bridge, arch bridge, flutter stability, vortex-shedding vibration, rain-wind induced vibration

1. Introduction

Since the implementation of China's reform and open-door policy in 1978, the country's economy has soared for the past three decades with 9% average annual growth rate of Gross Domestic Product. This has created a great demand for development of transportation infrastructure, in particular the country's highway system. During the golden period of highway construction that began in 1988, unprecedented development of highway bridge construction has been experienced in the country. By the end of 2008, the total number of highway bridges will increase to 550 000, for a total length of 21 000 km. Both figures