Research on the Structural System of Super 1000m Cable-Stayed Bridges

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Summary

Trial designs of three different cable-stayed bridges, namely traditional fully self-anchored cable-stayed bridge (CSB), partially earth-anchored cable-stayed bridge (PEACSB) and cable-stayed-suspension bridge (CSSB), are carried out based on the same design criterion with the mid-span of 1400m. Results show that all three structures are feasible. Based on numerical calculation, effects of several structural parameters on static performance are presented. The three structures are compared regarding mechanical performance and cost. Results show that PEACSB and CSSB are favourable. As an application, in the design competition of the Second Humen Bridge, PEACSB and CSSB are applied to two navigation channels, respectively. Main ideas and outlines of the two schemes are presented. Finally, the prospect of the research on structural system of super 1000m cable-stayed bridges is discussed.

Keywords: super 1000m; cable-stayed bridge (CSB); structural system; partially earth-anchored cable-stayed bridge (PEACSB); cable-stayed-suspension bridge (CSSB); Second Humen Bridge

1. Introduction

The concept of modern cable-stayed bridge (CSB) was brought out by F. Dischinger in 1938. The first modern CSB was the Stromsund Bridge (1956). After more than half a century's development, the Sutong Bridge opened to traffic in 2008, which means that the CSB has been put forward into the super 1000m era. It can be safely said that the CSB will defeat the suspension bridge in even larger span range.

In the research of super 1000m CSB, the authors have been keeping eyes on three questions [1]. (1) Whether or not even larger CSB can be accomplished using present materials? (2) Which kind of structural system of CSB can be used in even larger span range? (3) Are there any new structural systems that can substitute traditional systems? Some viewpoints and achievements are given out in this paper.

2. Trial design of super 1000m CSB

2.1 Trial design

In order to answer the first question, trial designs of CSB with span of 1200m, 1400m and 1600m are carried out. [2] In terms of the technical standards of Sutong Bridge [3], the design condition is as follows. The side span and auxiliary piers are arbitrary. Clearance of the main span should be larger than 65m. The bridge carries eight traffic lanes in two directions. The design wind velocity V_{s10} is assumed to be 40.5m/s in the finished state. Considering the present materials used in China, the steel grades Q345qD (yield stress=345MPa, allowable stress=190MPa under normal static load, and 280MPa under ultimate wind load) is used in girder. The towers adopt concrete degree C60 (allowable nominal stress=19.25MPa). The allowable stress and stress amplitude of cables are 708, 250MPa, respectively.

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