Construction Sequence Simulation for Partial Cable Stayed Truss Bridge with Single Pylon

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Summary

Qiansimen Bridge, a part of Liangjiang Bridge in Chongqing city in China, is currently under construction by the Chinese contractor CCCC, Second Harbor Engineering Company Ltd. The bridge has been designed by T.Y. Lin International (China) as partially cable stayed bridge with steel truss girders and a single reinforced concrete pylon. The opening of the bridge is planned for July 2014. Each steel truss segment has a length of 16 m and forms an extremely heavy element of the bridge, which cannot be fabricated and erected in one piece. Stay cable forces vary between 10 000 and 15 000 kN during erection phase and in final state. Proper layout and adjustment of cable forces throughout the construction schedule is usually a tedious process. This paper presents an ingenious numerical simulation of the bridge construction sequence, where the erection process is accurately followed up by appropriate techniques. Result of the simulation is an optimized construction sequence of the steel truss, which on the one hand leads to a reasonable stress distribution in the truss elements and on the other hand allows for saving construction costs by avoiding multiple adjustments of stay cable forces during the construction process.

Keywords: partially cable stayed bridge; steel truss; single pylon; construction sequence; numerical simulation; cable force.

1. Introduction

The design of long span cable stayed bridges can become tedious when an appropriate strategy for the stay cable tensioning procedure needs to be found. The design concept for achieving the appropriate tensioning procedure in stay cable bridges is often based on finding the forces in the individual cables that give rise to certain allowable structural displacements, moments or stress distributions in the girder and the pylons at the end of construction. The stressing forces and the sequence of stressing for all the cables need to be optimised to meet these pre-defined requirements as close as possible. A further challenge is related to geometrically non-linear behaviour of the structure and simulation of erection procedure.

Finding a reasonable final state is indeed a critical design problem. There exist different methods of final state finding. Influence matrix method has been used for Qiansimen Bridge. Due to the large stiffness of main steel truss girder and large cable forces the construction stages had to be considered carefully and in detail. Traditional methods with tensioning each cable several times can cause instability of anchorage, and large forces in steel girder can prohibit the closure of the bridge. To avoid this, each stay cable has to be tensioned only once. By using this method also construction steps have been simplified. The efficiency of erection was improved and verified on-site. The project can be used as reference for further similar erection procedures.

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