Parametric Study on Safety Factor for Cable Slip in Four-span Suspension Bridges

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Summary

Multi-span suspension bridges have many advantages with respect to constructability, cost and aesthetic aspect, compared to 3-span suspension bridges, because the number of anchorages can be reduced. However, there are not enough design experiences for such bridge type so that various studies for multi-span suspension bridge must be carried out. Especially, the slip between cable and saddle on the top of middle pylon is one of the most important factors in the design phase.

In this paper, parametric analyses were performed to examine the variation of safety factor for cable slip according to design variables, such as sag ratio, stiffness of middle pylon and girder for 4-span suspension bridge. Eventually, the followings were obtained.

As the sag ratio or the stiffness of middle pylon decreases, the safety factor for cable slip increased. When the self-weight of stiffening girder increased, the safety factor also increased.

Keywords: multi-span suspension bridges; cable slip; stiffness of middle pylon.

1. Introduction

Multi-span continuous suspension bridge has more than two consecutive main spans of equal length and relatively short side spans at the ends. It has advantage that needs no central anchor block, compared with conventional multi-span suspension bridge, two three-span bridges placed end to end. Especially, in the place such as deep strait that requires very long span bridge, we might consider multi-span continuous suspension bridge (might be called as MCSB below) from the various perspectives of economy, constructability and etc.

For example, when multi-span continuous suspension bridge might be required to cross deep strait over several kilometers, the spanning plan must be made for the bridge to have longer span to reduce the cost of foundations. [3] But actually, including the San Francisco-Oakland Bay Bridge in USA, several multi-span suspension bridges, the Bisan Seto Bridges, and the Kurushima Kaikyo Bridge in Japan, have been built using sharing anchor block. [6]

In the preparatory investigations for the San Francisco-Oakland Bay Bridge (as shown in figure 1), MCSB has problems in relation to the flexibility of the structure itself. And it had been concluded that the cable, girder, and pylon of MCSB have to be stiffened to complement that problem. The displacements due to the flexibility, which is required to achieve equilibrium under live load acting in one span only of the two main spans would become so large that it could not acceptable. Certainly, these large displacements in huge civil structures are not preferred since that causes not only static or dynamic stability problems but also another serviceability problem such as fatigue and etc. Therefore, the stiffening methods for the cable, girder, and pylon of MCSB are required to complement its relatively weak stiffness. The various alternatives for MCSB are compared with conventional three-span suspension bridge and the possibility of MCSB is introduced in [6].

Fig. 1: San Francisco-Oakland Bay Bridge

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