Iterative Buckling Analysis for Steel Tower Members in Cable-Stayed Bridges

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Summary

A new method of iterative buckling analysis is proposed for obtaining the effective length of steel tower members in cable-stayed bridges. The concept of a fictitious axial force, which is derived from the relation between the individual buckling limit of each member and the overall buckling of the bridge, is introduced to overcome the problem associated with system buckling analysis. After presenting the proposed method, it is applied to an example cable-stayed bridge with different girder depths. The results demonstrate that the proposed method not only provides reasonable outcomes by correcting the inaccuracies seen in system buckling analysis, but is also convenient for practical applications.

Keywords: Iterative buckling analysis; Effective length; Fictitious axial force; Cable-stayed bridges; Stability.

1. Introduction

In general, girder and tower members of cable-stayed bridges may be regarded as a beam-column because they are subjected to both the axial force and the bending moment under the design loads. Therefore, it is probable that the stability of individual members is theoretically assessed by checking the beam-column interaction equations prescribed in design specifications. When applying the interaction equations, we need to calculate the effective length of individual members in order to determine axial compressive strength and the moment magnification factor.

Regarding the methods obtaining the effective length of individual members of steel structures, a wide range of analytical approaches has been suggested in the engineering literature including the alignment chart method, Story-based method, Methods of means and the equivalent methods with idealized springs for flexible connections [1-3]. Unfortunately, these analytical approaches cannot be applied to a cable-stayed bridge in that the primary focus of these methods is on the steel frames and there are several distinguishing assumptions, which are appropriate only for the steel frames, in the process of the methods. Although the behaviour of steel tower is similar to that of steel frames, it has been little known about the analytical approach for obtaining the effective length of tower members in a cable-stayed bridge.

Under existing circumstances, it seems that the most reasonable alternative is to use system buckling approach based on a numerical eigenvalue computation. Some trials to calculate the effective length of tower members in a cable-stayed bridge have been performed by several researchers [4, 5]. They utilized the Euler buckling equation with system buckling analysis and finite element models of bridges, and showed that the effective length of individual members of a cable-stayed bridge can be possibly evaluated by numerical approach. Nevertheless, the use of the Euler buckling equation with system buckling analysis for steel structures used by them has an

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