Dimensionless Free Vibration Analysis of Suspension Bridges Considering Hanger Extensibility and Various Girder Types

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Summary

In this paper, free vibration analyses with an improved continuum model for three-span suspension bridges are performed to study the effects of hanger extensibility on free vertical vibrations. The improved model can consider extensible hangers as well as various girder types such as hinged, continuous, and floating girders. To derive the equations of motion for this model, the coupled differential equations for the vertical deflections of the main cable and girder are presented. The Galerkin's method with the shape functions for the main cable and girder is introduced into the differential equations, and it leads the equations to a matrix form. The natural frequencies of a three-span suspension bridge are evaluated from the equations with the six dimensionless parameters. In the parametric analyses, the effect of the hanger extensibility is observed.

Keywords: Suspension bridge; Free vibration; Continuum model; Extensible hanger; Girder type.

1. Introduction

A continuum model based on the deflection theory is useful in a preliminary design of a suspension bridge because it does not need an initial equilibrium state analysis and can identify key design parameters. However, most of the conventional continuum models assume inextensible hangers while hangers are actually extensible. In addition, the conventional models cannot consider a floating girder. Therefore, this paper presents an improved continuum model for three-span suspension bridges with extensible hangers and three girder types such as hinged, continuous, and floating girders. Dimensionless free vibration analyses using the improved model are then performed to study the effects of hanger extensibility on free vertical vibrations of the bridges.

2. Improved continuum model

Fig. 1 shows a suspended girder considered in this study. In Fig. 1, m_c and m_g are the uniform masses of the main cable and girder, respectively; g is the gravitational acceleration; E_c and A_c are the elastic modulus and the cross-sectional area of the main cable, respectively; E_h and A_h are the elastic modulus and the cross-sectional area of the hangers, respectively; E_g and I_g are the elastic modulus and the moment of inertia of

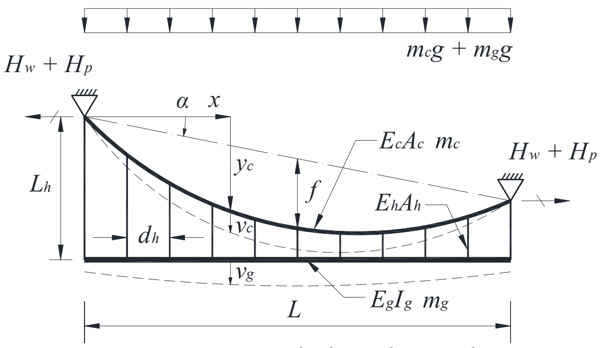

Fig. 1: Suspended girder with extensible hangers

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