Lateral Torsional Buckling of Long Span Suspension Bridge: Geometrically Nonlinear Analysis Under Wind Load

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Abstract: There are plans of constructing bridges longer span like Messina strait bridge. This trend causes the necessity of discussing on the problems of instability analysis such as lateral-torsional buckling. However, lateral torsional buckling analysis of long span bridge is not sufficiently taken yet. For that reason, we apply the Abaqus/Standard to solve the high nonlinear problem. The analysis object is Akashi-kaikyo Bridge which is the longest bridge in the world. This paper presents how to analyze the lateral-torsional buckling of long span bridge applying wind load.

Keywords: Lateral Torsional Buckling, Suspension Bridge, Aerodynamics

1.   Introduction

By now, a lot of long span suspension bridges have built and their lengths keep growing. As a result, their girder stiffness is relatively reduced and their strengths for wind force are also decreasing. Therefore, numerous flutter analysis and experiments were executed. On the other hand, it is as well as important to investigate the lateral torsional buckling strengths of suspension bridges, but the investigations have never been made for decades. Certainly, we just use Hirai-Okauchi formulation that was proposed around 60's to confirm the stability against the problem. It contains a theoretical equation and ideal boundary conditions so the application of the formulation is limited. Therefore, the need of modern examination of lateral torsional buckling of suspension bridge is increasing. A long span suspension bridge shows quite nonlinear behavior and shows nonlinearity when its initial condition and wind load are applied. Therefore it needs some techniques. We present the way of modeling bridges using the structural elements and making initial conditions under gravity. After this we present how to analyze the lateral-torsional buckling of long span bridge applying wind load. The wind load is calculated by the static coefficient of wind force. Finally, the result is showed and the conclusion is presented.

The main background of this problem and the procedure of the analysis are introduced in this chapter. The main topic of this analysis is a lateral torsional buckling and large deformation analysis of suspension bridge.

2.   Hirai-Okauchi formulation

Lateral torsional buckling is critical for structures and can lead suddenly collapse of them. Previous research was conducted by Hirai(Hirai 1942) and Okauchi (Okauchi 1967). The main theory of their theory is showed as follows.

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