Multimode flutter analysis of Chacao bridge

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Abstract

The Chacao bridge is a two span suspension bridge located in the southern part of Chile. It has continuous aerodynamic steel girder of 2754m with uneven main spans of 1155m and 1055m. To determine the onset velocity of flutter both section model tests and multimodal modal flutter analysis is employed. The multimodal analysis is based on measured aerodynamic derivatives and results from the global FEM model. The analysis shows that several modes are jointly active at flutter onset speed, and the combined flutter mode include contributions from both spans. The stability criteria for the bridge was defined as 63.8m/s. Multimodal analysis at angle of attack of 0^o, $+3^o$ and -3^o shows that the bridge fulfil this requirement. As a verification of the analysis a 1:250 scale model of the complete bridge were tested in the wind tunnel. This test verifies that the structure has sufficient safety towards flutter.

Keywords: Long span suspension bridge, multimodal flutter, aerodynamic.

1 Introduction

The Chacao bridge is a two span asymmetrical suspension bridge located in Chile. The overall length is 2754m and it consists of a continuous aerodynamic main girder with two main spans of 1155m and 1055m. The difference in main span is due to a shallow area used for foundation for the central pylon. The three pylons are of different heights to alleviate the uneven load effects due to the uneven main span length, see Figure 1. The bridge carries four lanes of traffic and the overall width of girder is 23,8m and the height of the girder is 3,27m, see Figure 2. The bridge is situated in a seismic active region with both subduction and crustal earthquakes, and thus, this is the most critical load for the structure. For long span bridges wind is also a major contributor to the forces acting on the structure. To secure sufficient safety towards high winds the stability limit for the structure has to be determined. This is done by wind tunnel tests on a section model, and by multi-modal flutter analysis based on aerodynamic derivatives measured in the wind tunnel. A verification of the findings were performed by testing a full aeroelastic 1:250 model of the bridge in the wind tunnel.

In addition to these tests several other wind tunnel tests were performed. A model of the local topography was used to study local wind effects. Sectional models of the deck and pylon cross section were used to derive load coefficients to be applied in the design, and aeroelastic models were tested for the freestanding pylons.

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