Izmit Bay Suspension Bridge- Response of Active Mass Damper Using Finite Element Analysis

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Abstract

This paper presents the design of anti-vibration system to mitigate vibrations of steel towers of IZMIT Bay Bridge in Turkey during service condition, and comparison results for both with/without anti-vibration systems using finite element analysis.

Keywords: IZMIT Bay Suspension Bridge, Steel tower, Mass damper, Vortex-induced vibration

1 Introduction

IZMIT Bay Bridge, consisting three continuous spans having a total length of 566+1550+566= 2682m, has opened to traffic in June 2016. Bridge girders are orthotropic steel box girder having a width of 30.1m and a depth of 4.75m, and both sides of girders have 2.9m walkway used for maintenance cars. The main cable of the bridge comprises 110 nos. of prefabricated parallel wire strands each having 127 wires with a diameter of 5.91mm.

The tower is 236.4m steel structure having closed box section legs inclined by about 1:80. Two rectangular box sections connect the towers, one in the middle and one at the top. Due to high seismic demand and short construction period, the tower is fabricated by high strength steel [1].

2 Anti-vibration system

Active mass dampers (AMD) used inside the steel towers are the main contributor to tower's overall damping.

In general, suspension bridges' steel towers are vulnerable against vibrations affected by wind or vortex induced vibrations (VIV) which are mostly sinusoidal, and this situation becomes more critical when the tower height or slenderness increases. According to the wind tunnel test, the maximum tower amplitude is obtained around 0.63m on bridge axis against VIV. On the other hand, the maximum amplitude allowed for Izmit Bay Bridge tower is 0.15m for in-service condition against VIV, and to achieve this target, each tower leg has two AMD (one has 10-ton moving mass). So, in total the bridge has eight AMD. The location of AMD is 160m high from the bottom of the tower, where the tower amplitudes maximum for the first bending mode shape on bridge axis.

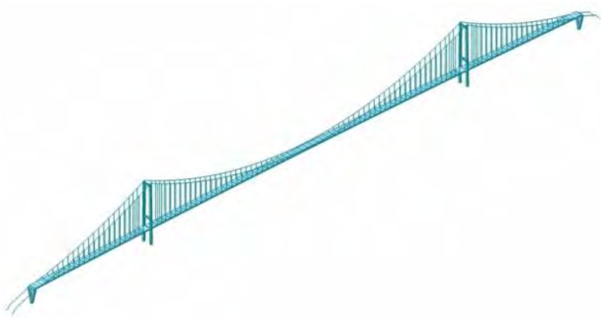

Figure 1. 3D model of Bridge in FEA

Excitation of structures by vortex shedding can be modelled as a generalised one degree of freedom Van der Pol oscillator [2].