Seismic Mitigation of the ASCE Cable-stayed Bridge

Marco DOMANESCHI
Research Associate
DIS, Politecnico di Milano
Milano, Italy
domaneschi@stru.polimi.it

Marco Domaneschi, born 1972, received his MSc and PhD degree from the University of Pavia.

Luca MARTINELLI
Assistant Professor
DIS, Politecnico di Milano
Milano, Italy
luca.martinelli@polimi.it

Luca Martinelli, born 1965, received his civil engineering degree and his PhD from Politecnico di Milano.

Summary

The ASCE benchmark on cable-stayed bridges has gathered, in the last years, the interest of many specialists in the field of the structural control and the dynamic response of long span bridges.

Starting from the structural model of the benchmark original statement, a refined version is developed in a commercial finite element environment (ANSYS) so as to include new aspects in the simulation of the stay cables dynamics, with respect to the coupled motion with the main girder, in the implementation of the seismic excitation and in the soil-structure interaction.

Analyses are carried out in the time domain for several realizations of acceleration in a multiple support framework.

Finally, a new passive device, adopting the Bouc-Wen model as its constitutive law, is implemented on the refined bridge version both for a comparison with the ANSYS hysteretic element and for a better simulation of the control devices. This new device is coded in an external Fortran program and details on the implementations and testing are given in a parallel paper of this Conference.

Keywords: Bridge, earthquake, realizations, passive, control, simulations, Bouc-Wen, model.

1. Introduction

Starting from the original framework of the benchmark, this work deepens the results of previous investigations [1-5]. A refined model of the bridge is studied using the ANSYS commercial finite element code [6] which has proven capable for the implementation of structural control systems [7].

Since the original benchmark was carried out in MATLAB; the files with the nodes and elements information are converted in the new analysis framework. The advances can be resumed in a better description of the cables dynamics and in a more realistic simulation of the seismic input. This last aspect is pursued explicitly considering the spatial variability of the seismic input for several seismic realizations, so as to comprise a statistical approach to the bridge response.

The hysteretic devices are simulated by two different type of elements: the first one is already existing in Ansys. The second one is here developed as an external program, with respect to the ANSYS environment, which implements the Bouc-Wen model [8]. In a parallel paper this implementation is deeply tested for its applications in structural control systems.

2. The bridge structure

2.1 Geometry

The bridge proposed in the control benchmark [2] is a fan-type cable stayed bridge: the Bill Emerson Memorial Bridge, located near Cape Girardeau (USA), spanning the Mississippi River (Figure 1).

https://doi.org/10.2749/222137810796024655