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Time Domain Buffeting Analysis of the Messina Bridge - Benchmark Study -

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ABSTRACT

Time domain buffeting analysis on the Messina bridge is conducted. For modeling of the structure and wind environments, the benchmark problem developed by Prof. Diana (2001) is used. The structural model of the Messina bridge has been updated several times, and the eigen analysis results of Dr. Hatanaka (2012) which is based on the model developed by Prof. Miyata (2003) of Yokohama National University (YNU) is used for the dynamic analysis. For the simulation of random fluctuating wind forces, the spectral representation method (Shinozuka, 1991) is used. Time domain buffeting analysis results are compared with the frequency domain analysis results of Dr. Hatanaka (2012) and Prof. Diana (2001). The analysis result shows a good agreement with other results of the benchmark study.

1. Introduction

Recently several long span bridge projects have been planned, proposed, and developed. Messina bridge is the longest bridge project proposed ever and it has a main span of 3,300m length. Even the events related with wind and seismic are the critical ones for the design and analysis of this kind of long span bridges, the mitigation of large displacements at the connections is another challenging problem. To handle this problem more effectively, not only the method of structural design, but also the utilization of mechanical devices should be considered. Especially, Stretto di Messina S.p.A (2009) describes that the events with wind and running train is the one of the most important scenario, it should be carefully investigated to design long span bridges. Time domain analysis can be an effective method for the thorough analysis of the

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bridge with various mechanical devices under wind and running train. As the first stage of the thorough analysis, time domain buffeting analysis is conducted. This study will be expanded to the vehicle-bridge interaction analysis and compared with the results of the previous study by Prof. Diana (2009).

2. Modeling of Structure and Wind Environment

In this study, the information and data of the benchmark problem developed by Prof. Daiana (2001) is used. Especially the eigen analysis results conducted by Dr. Hatanaka (2012) which is based on the model developed by Prof. Miyata (2003) of Yokohama National University (YNU) is used for the dynamic analysis.

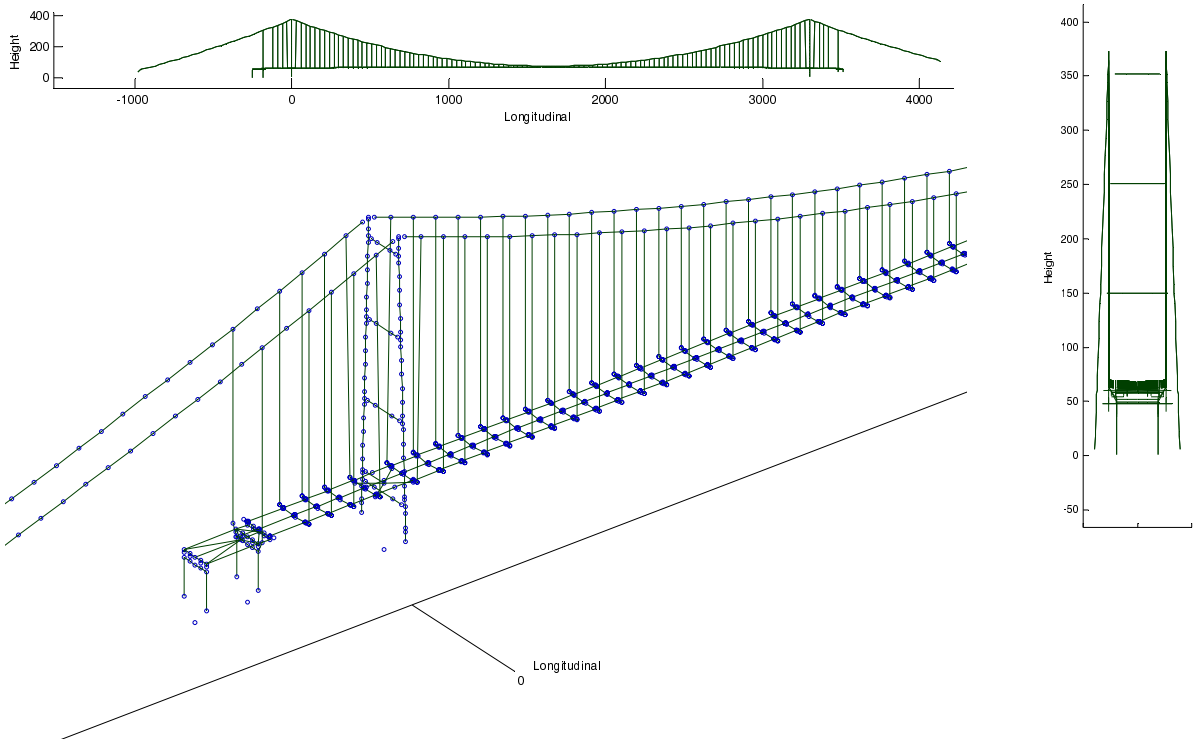
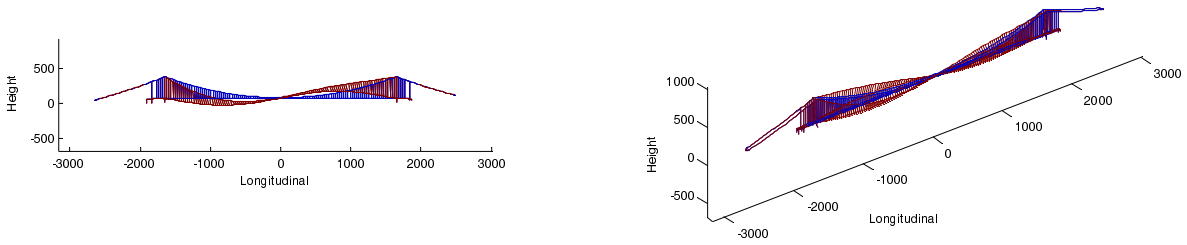
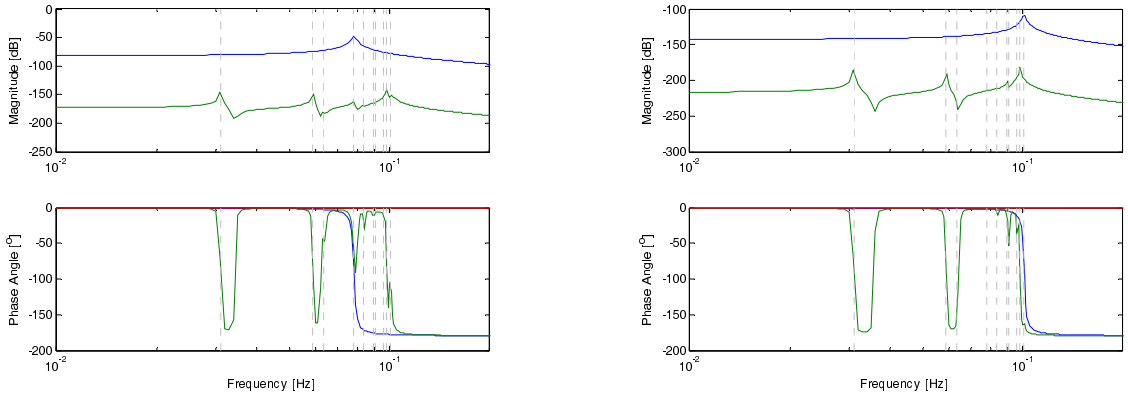


Fig. 1 Structural Model of the Messina Bridge (Diana, 2001 & 2009)



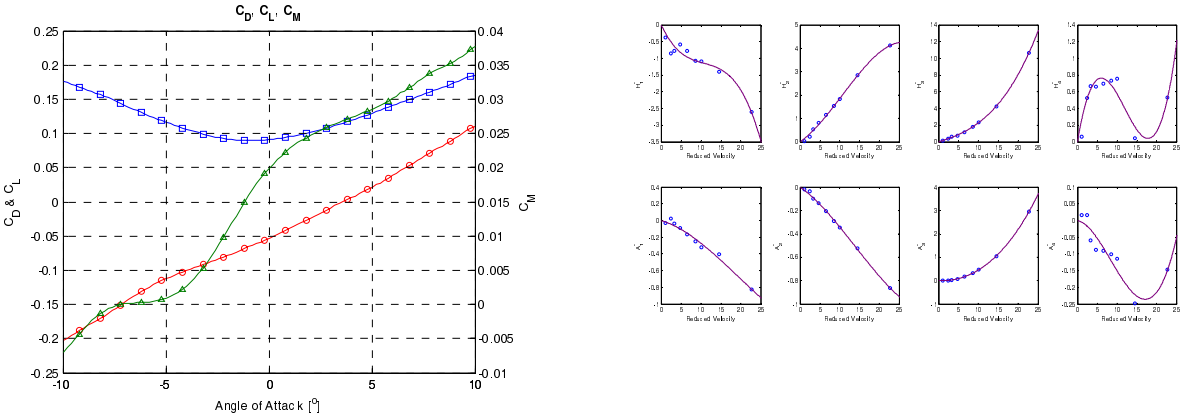
(a) Mode 3 (b) Mode 6

Fig. 2 Mode Shapes of the Bridge (Hatanaka, 2012)



(a) Heaving (b) Rolling

Fig. 3 Frequency Response Functions at the Center of the Bridge



(a) Static Wind Force Coefficients (b) Flutter Derivatives

Fig. 4 Wind Force Coefficients (Diana, 2001)

3. Time Domain Simulation

For the simulation of random fluctuating wind forces, the spectral representation method (Shinozuka, 1991) is used. Since the structural model has a lot of degrees of freedom, it is not realistic to generate the wind velocity data for each nodes, the equation of the generalized buffeting force is derived and randomly simulated.

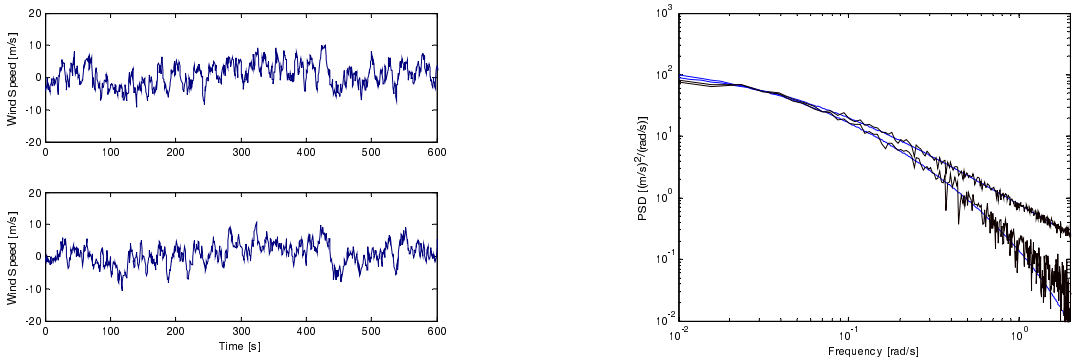


Fig. 5 Simulated Generalized Wind Force and PSD (Power Spectral Density)

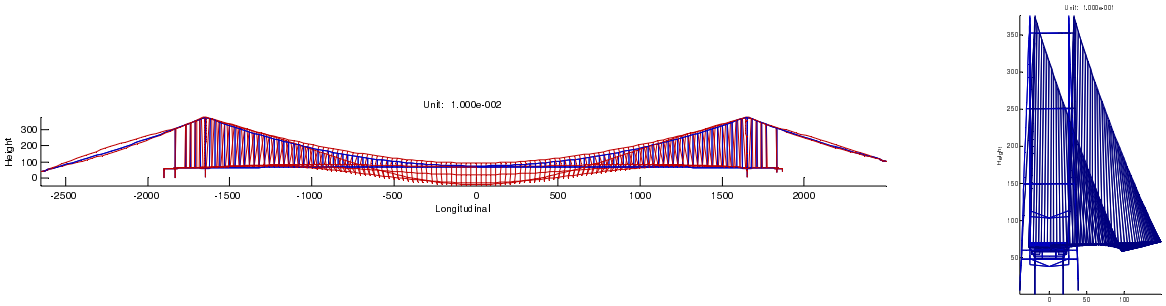


Fig. 6 Gust Response of the Messina Bridge

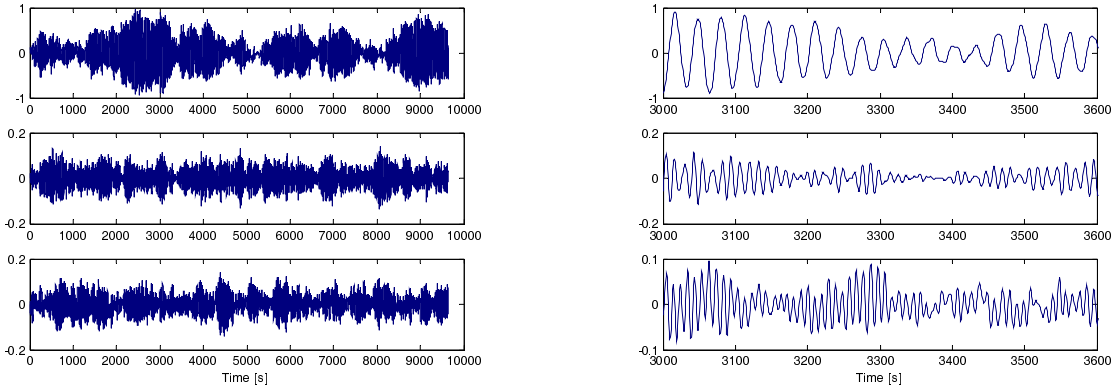


Fig. 6 Time History at the Center of the Deck

4. Concluding Remarks

Time domain buffeting analysis of the Messina bridge was conducted. To handle the large number of degrees of freedom, generalized buffeting force is derived. Simulation result shows the good agreement with the other results of the benchmark study.

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