GAČR 13-34405J: The aero-elastic stability of the cable supported bridge deck under simultaneous action of wind and traffic

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With nowadays trends of elongation of span length in bridge structures, they are becoming more and more sensitive to wind loads. Therefore analysis of their aero-elastic stability is of great concern. These structures have low natural frequencies and low damping, which makes them highly susceptible to the wind excitation.

Flutter is a dynamic instability phenomenon, which is influenced by the flow and vortex separation around the deck leading to the deformation of the structure and consequently to the existence of motion-induced forces, ultimately leading to the modifications of the flow around the deck.

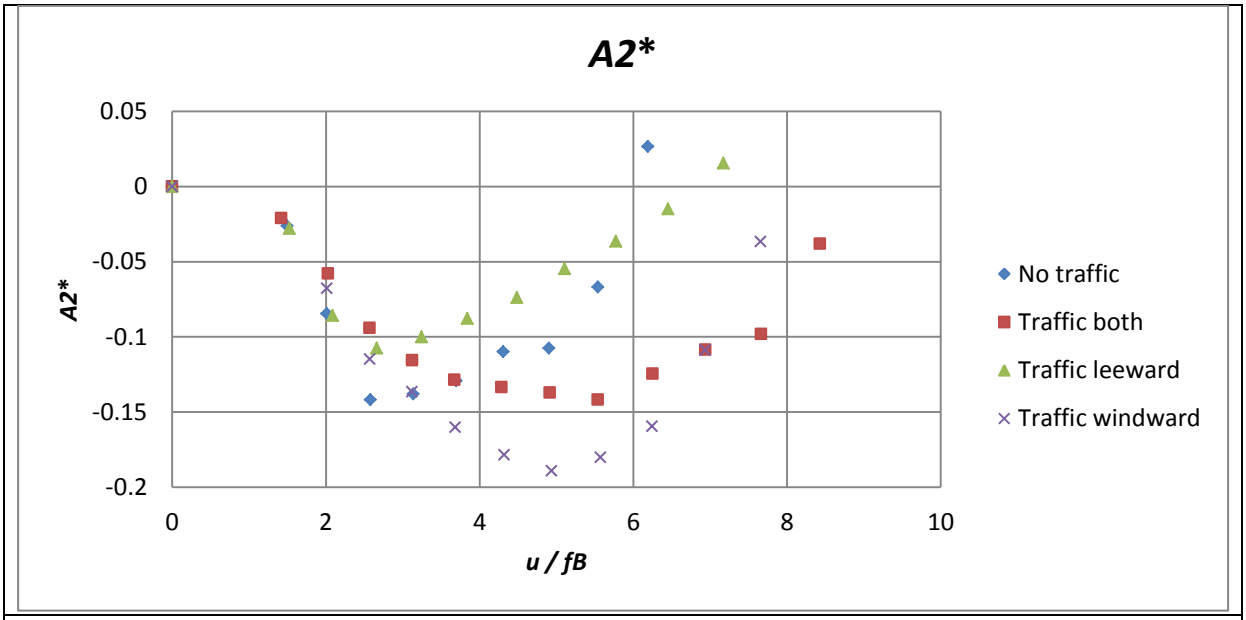
The project is focused on the instability of bridges under the combined action of wind and traffic. Our group is focused on the evaluation of the flutter instabilities and the measurement of the response of a bridge in the wind with simulated steady traffic. A particular example of the bridge in Taipei is selected.

Left-Experimental set-up. Right- Model of the traffic on the bridge

Experiments are carried out with a sectional bridge model placed on experimental stand with an option of the fine frequency tuning of the system. The measurement of the two degree-of-freedom motion response is carried out. In the scope of this experiments influence of steady traffic on the dynamic behaviour of bridge deck is examined. Models representing vehicles, i.e. cars and trucks, have been placed in 3 different setups - windward, leeward, and in both directions.

From the results we can observe significant trends in values of certain so-called flutter derivatives. For example, in the course of the derivative A2*, which is related to torsion instability, the values are going in negative direction for lower reduced velocities, hence the torsional damping is increasing under influence of aerodynamic damping. However, at

certain wind velocity, the value of A2* grows, and eventually becomes positive, which means that aerodynamic influence reduces the torsional damping and the instability driven by the torsion may appear. This derivative is associated with unsteady pitching moment characterizing 1DOF torsional flutter or 2DOF coupled flutter.



A2* derivative as a function of the reduced frequency

One can also observe a significant influence of traffic position on stability of bridge deck. It seems that deck without traffic is most susceptible to flutter instability, while the traffic windward is most stable one. Furthermore, deck without traffic experience the sudden loss of stability alike the case with the traffic. Also, A2* turns positive at the same reduced velocity for traffic in both directions and traffic positioned windward.