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Active Control of Bridges under Moving Loads

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INTRODUCTION

The influence of the dynamic vibration of bridges has been studied more widely and the application of control system can be implemented to the bridges to improve its performance under moving loads. By employing an active control system, the displacement of the bridge can be reduced, and thus help to achieve a longer span in bridge and enhance its serviceability.

DESIGN OF CONTROL SYSTEM

In this project, a closed-loop active control system is integrated into a model simply-supported bridge to reduce the displacement induced by moving loads. It can be achieved by imposing a force by means of hydraulically powered cables or struts in the opposite direction of the bridge that is travelling to compensate for the motion of the bridge. The traffic is modelled as a series of impulse loads moving in the same direction. The force imposed in the mid-span for control purposes can be derived through a designed controller with the data of displacement collected by the installed digital devices on the bridge. With the application of active control, the displacement and acceleration of the bridge at different time steps is controlled within certain limits by the controller.

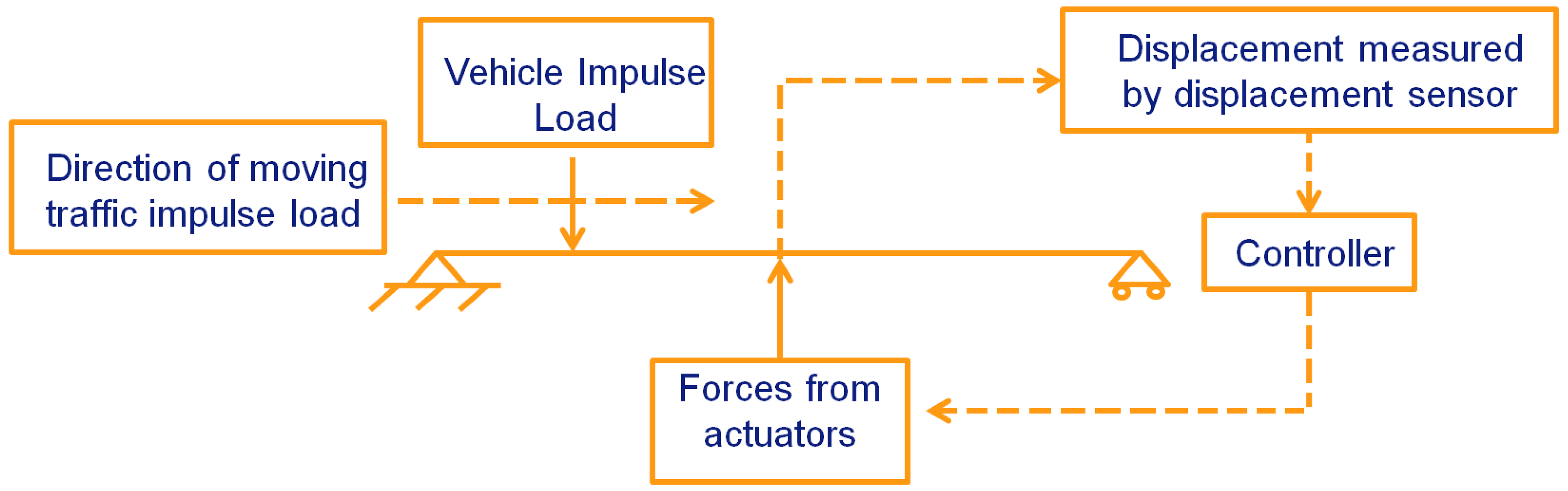

Figure 1. Illustration of the control system in this project.

BRIDGE COMPOSITION & FORCE ACTUATORS

While attached hydraulic actuators are suitable for existing structures, installed active tendons are more suitable for a new or refurbished bridge. Active tendon control is one of the options that can be easily integrated into a cable-stayed bridge. The computational compensation force is performed by the hydraulic actuators installed on the selected cables. It can provide a high static load of up to 400 tonnes as well as dynamics loads.

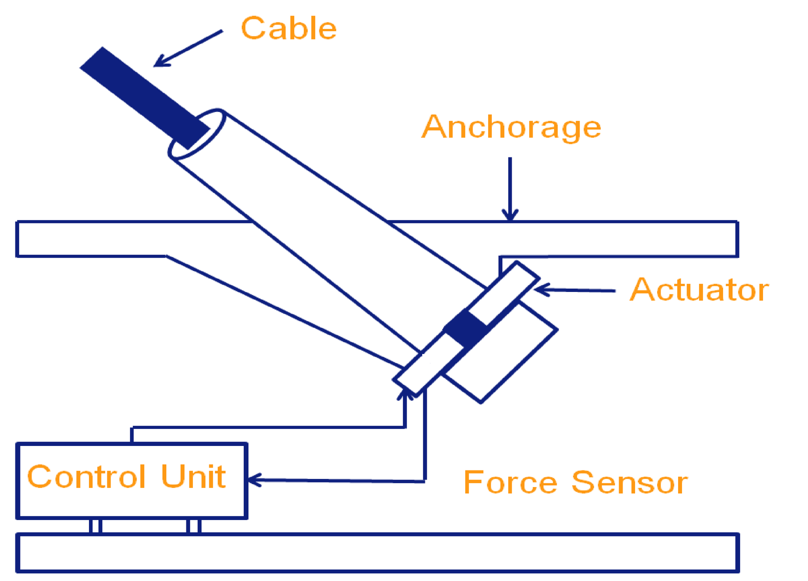

Figure 2. Detail composition of the system (Preumont,2011).

ACKNOWLEDGEMENTS

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REFERENCES

Preumont, A. (2011). *Vibration Control of Active Structures* (3 ed.). Springer.

METHEDOLOGY

In reality, there is a certain time lag between transmissions of data from sensors to the control system and then to the actuators. Thus, the control force derived based on current data does not reflect the actual control force that should be applied. A prediction of displacement based on previous data is applied to tackle this issue.

For the next time step, the effect of control force calculated from the previous time step is fed back to the start and added with the vibration of the bridge at the current time step due to previous loading.

Traffic Generation
•Exponential distribution of time interval

Integration of Control and Traffic generated responses

Displacement Monitoring
•At mid-span where displacement is maximum.

Displacement Prediction
•Based on half-period of previous data

Controller
•Calculate magnitude of control force

RESPONSE OF BRIDGE UNDER CONTROL

A valid control system is sensitive to the parameters used. An adequate selection of parameters can result a reduction of 10% of displacement at its maximum without increase its vibration range. For an unsuitable selection of parameters, the reduction of displacement can be more obvious while at the cost of increasing vibration.

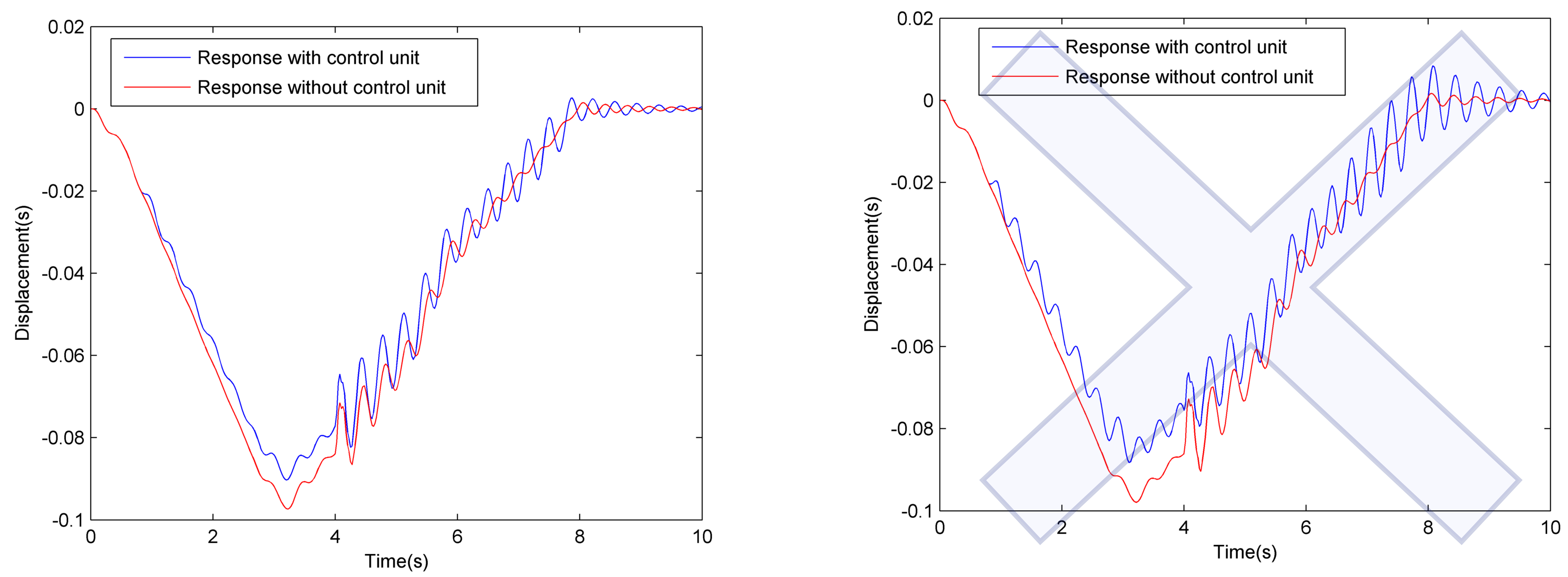

Figure 3. Comparison of Controlled and Uncontrolled displacements of the bridge at mid-span. a) Sufficient control b) Controlled displacement with overshooting in vibration

CONCLUSION

The control system is effective in controlling the maximum displacement while the system is quite sensitive to the different parameters. With the selection of proper parameters, an overall control of vibration within a certain range can be achieved without overshooting occurring.