MODEL REDUCTION OF LARGE STRUCTURAL SYSTEMS FOR ACTIVE VIBRATION CONTROL

By

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CERTIFICATE OF AUTHORSHIP/ORIGINALITY

I certify that the work in this thesis has not previously been submitted for a degree nor has it been submitted as part of requirements for a degree except as fully acknowledged within the text.

I also certify that the thesis has been written by me. Any help that I have received in my research work and the preparation of the thesis itself has been acknowledged. In addition, I certify that all information sources and literature used are indicated in the thesis.

John Boffa
(16/02/06)

PUBLICATIONS

Conference Papers:

Paper Title (1): **Study on Model Reduction of Large Structural Systems for Active Vibration Control.**

Authors: J.Boffa, N.Zhang and B.Samali.

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Paper Title (2): **Experimental Evaluation of Reduced Models of Large Structural Systems for Active Vibration Control.**

Authors: J.Boffa and N.Zhang.

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Paper Title (3): **Active Seismic Response Control of Tall Buildings Based on Reduced Order Model.**

Authors: H.Du, J.Boffa and N.Zhang.

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ABSTRACT

This thesis studies the applicability of the Dynamic model reduction method that is used for direct plant order reduction in the active vibration control of large and flexible structures. A comparison of the performances between the reduced models produced by the Dynamic model reduction method and those obtained by other common model reduction methods such as the Guyan method, and the Mode-displacement method have been carried out. By using a full analytical model of a twenty storey building as the reference, each three degrees of freedom model was compared by computer simulation. The open-loop frequency response simulation, open-loop earthquake simulation, and the closed-loop earthquake simulation were all used to initially evaluate the reduced models. The accuracy of the frequency responses was assessed with sinusoidal applied forces, and for the closed-loop dynamic analysis, an active mass damper at the top storey and a recorded earthquake excitation was used. When compared with the simulation results of the Guyan method, the Dynamic method has many advantages, especially in terms of its accuracy at the high frequency range. The Mode-displacement method produces reduced models that are good for dynamic analysis of open-loop systems, but it was found to be inconvenient for use in active control. Finally, the Dynamic model reduction method and Guyan method were compared using experimental test results. A 2.5m tall building model with 20 floors was used as the plant, with a linear motor installed at the top storey for the purposes of active-damping. Although the results of simulations would suggest that both models perform sufficiently, experimental testing proved that only the Dynamic model performs adequately for this specific application of active control. The problem associated with most model reduction methods, such as the Guyan, is that they are based on full-order models that were derived from the linear elastic theory. The versatility of the Dynamic model reduction method is such that it provides the option of obtaining system parameters directly from experiment, not just from theory. The experimental procedure ensures that the Dynamic model reduction method forms an accurate description of the real system dynamics. The applicability of this method for obtaining low-order plant models was demonstrated through real-time active control testing of the model structure, while it was subject to a sinusoidal excitation. The tests have shown that the Dynamic model reduction method can be used as an alternative approach for the model reduction of structural systems for the purpose of active vibration control.