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# Assessment of wind-induced vibration suppression and energy harvesting using facades

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## 1 Abstract

The new generation of super slender high-rise buildings first appeared in New York City. Due to inner-city concentration, it has become desirable to construct slender high-rise buildings, something which poses significant challenges in dealing with the susceptibility of such structures to the dynamic wind excitation. In this paper, innovative adaptable connections integrated with electromagnetic (EM) devices replace the conventional fixed connections between the main structure and its facades. Therefore, the wind excitation that previously acted directly on the main structure will be transmitted to the main structure through the adaptable facade so that the vibration of main structure can be reduced. Simultaneously, the vibrational kinetic energy of the moving facade will be partly transduced to electricity by EM devices. This concept will be parametrically investigated in the frequency domain using a two-degree-of-freedom (2DOF) system under harmonic excitation to find the most influential parameters for its vibration reduction and energy harvesting performance. The result shows that the vibration of main structure can be effectively reduced but it also brings the excessive facade vibration. For practical considerations, the excessive facade vibrational amplitude needs to be restricted within a certain range. Increasing the facade mass ratio and facade damping ratio can reduce facade vibration. However, for energy harvesting, the more severe the facade vibrates, the more energy can be possibly harvested. It has been mathematically strict proved that the maximum power point occurs when electrical damping ratio is equal to mechanical damping ratio. Further research is required for real application.

**Keywords:** facade system; wind-induced vibration; energy harvesting; isolation; high-rise building.

## 2 Introduction

High-rise buildings have been around for more than a century. Until now, they are still worldwide popular due to their significant economic benefits in dense urban land use [1]. Now, the trend of high-rise buildings is not only to pursuit higher, but also to be more slender, which is happening in Manhattan. Slender high-rise buildings with an aspect ratio of 1:10 to 1:20 are very susceptible to the dynamic wind excitation. Therefore, the design is governed primarily by wind loads. Large wind-induced vibration can cause discomfort to the occupants in the building and even damage the structures. Traditionally, tuned mass dampers (TMDs) are installed on top of tall buildings to reduce vibration, which has proven to be a reliable solution. However, for economic reasons, it may not be the best solution for slender high-rise buildings.

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