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Wind-induced vibration analysis of a standing glass structure by an advanced time-marching physics-informed neural network

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ABSTRACT

To predict the dynamic behavior of a standing glass structure under wind load and the effect of gravity, an advanced time-marching physics-informed neural network (AT-PINN) is presented. The AT-PINN approach can solve the vibration problem by training the neural network over successive time segments. To enhance the solution accuracy, the hard constraint of boundary conditions is incorporated in AT-PINN. The numerical examples show that the present approach effectively predicts the wind-induced vibration response of the standing glass structure during long-duration simulations. The implementation of the hard constraint technique can greatly improve solution accuracy and decrease computational costs.

1. INTRODUCTION

Glass facades are a popular choice in building construction. The large glass panels of tall buildings may undergo significant vibrations due to wind loads, resulting in safety hazards. Therefore, it is essential to examine how glass responds to wind-induced vibrations.

In light of the rapid advancements in artificial intelligence, certain deep learning techniques have been effectively applied in scientific computation. Physics-informed neural networks (PINNs) are particularly noteworthy among these methods, demonstrating significant potential and garnering considerable interest for solving partial differential equations (PDEs) (Cuomo et al. 2022, Yuan et al. 2022, Karniadakis et al. 2021, Raissi et al. 2019). Nevertheless, effectively solving PDEs in long-duration simulations remains a challenge for current PINNs. To accurately address vibration issues in long-duration simulations, we have introduced an advanced time-marching PINN (AT-PINN) approach (Chen et al. 2024). In this work, we introduce the hard

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