論文 / 著書情報
Article / Book Information

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Title(English)	Estimation of Wind Force Time-history on a Nonlinear Seismic Isolated Tall Building using Wind-Induced Responses
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Category(English)	Doctoral Thesis
種別(和文)	論文要旨
Type(English)	Summary

（博士課程）
Doctoral Program

論 文 要 旨

THESIS SUMMARY

系・コース： Department of, Graduate major in	建築学 系 都市・環境学 コース	申請学位（専攻分野）： Academic Degree Requested	博士 (Philosophy) Doctor of
学生氏名： Student's Name	SORIANO Razelle Dennise Agoba	審査員主査： Chief Examiner	佐藤　大樹　准教授

要旨（和文 2000 字程度）
Thesis Summary（approx.2000 Japanese Characters ）

Seismic isolation has been proven to effectively mitigate the impact of earthquakes on structures, and its reliability has led to its application even in tall buildings. However, as the height of these buildings increases, the isolation layer often exhibits nonlinear behavior under wind loading. This nonlinearity presents significant challenges in estimating wind forces, which are crucial for assessing the performance and safety of these structures under wind conditions. This nonlinear behavior necessitates time-history analysis to accurately capture the dynamic responses. Time-history analysis is particularly crucial for structures exhibiting nonlinearity, as it provides detailed insights into the interaction between wind forces and the structural system. Methods to perform time-history analysis include wind tunnel experiments and computational fluid dynamics (CFD) simulations, both of which offer valuable data for understanding wind-induced forces. However, their reliance on assumptions about structural and wind characteristics limits their accuracy under real-world conditions. To bridge this gap, the use of recorded structural responses offers a promising solution for validating and enhancing wind force estimation methods.

Several methods have been proposed to estimate wind forces on structures, including regularization techniques, Kalman filtering, and modal identification techniques. These methods, however, typically assume that structural parameters such as stiffness and damping are fully known—an assumption that is often impractical in real-world applications. Also, most of these methods can only estimate the fluctuating components of the wind forces. Some methods attempt to estimate both wind forces and structural parameters simultaneously but frequently rely on the availability of responses at all degrees of freedom or assume that these responses can be directly measured. This reliance introduces further challenges when full system identification is not feasible. Moreover, many existing methods are designed for linear structures, limiting their effectiveness in addressing the complexities of nonlinear systems, such as those with seismic isolation.

Modal analysis identifies the dynamic characteristics of the structure, providing essential insights into its response to wind forces. When combined with response estimation techniques, such as cubic spline interpolation and frequency domain integration, and system identification methods like Frequency Domain Decomposition (FDD), it becomes possible to reconstruct unmeasured responses and estimate unknown structural properties.

備考：論文要旨は、和文 2000 字と英文 300 語を 1 部ずつ提出するか、もしくは英文 800 語を 1 部提出してください。
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学生氏名： Student's Name	SORIANO Razelle Dennise Agoba	審査員主査： Chief Examiner	佐藤　大樹　准教授

要旨（英文 300 語程度）
Thesis Summary（approx.300 English Words ）

The Equivalent Input Disturbance (EID) method, an approach in control engineering, has been applied to linear base-isolated buildings for the purpose of wind estimation. This method offers the advantage of estimating both the mean and fluctuating components of the wind forces, unlike many traditional techniques. While nonlinear versions of EID have been introduced, these approaches have not yet been practically applied to nonlinear systems.

This research integrates modal analysis and the Equivalent Input Disturbance (EID) method to estimate wind forces in nonlinear, base-isolated buildings Combining these two methods addresses the challenges in wind force estimation by leveraging the strengths of both modal analysis and the EID method. By integrating response estimation and system identification techniques from modal analysis with the EID method applied to nonlinear systems, wind forces can be effectively estimated for base-isolated buildings, even in the presence of incomplete data and complex nonlinear behavior. This integration allows for accurate wind force estimation despite uncertainties in the system, providing a robust and reliable approach for addressing the challenges posed by limited or missing data in nonlinear, base-isolated buildings.

An overview of the thesis structure is as follows:

Chapter 1 provides the research background, objectives, and an overview of the thesis structure. It discusses the challenges of estimating wind forces on nonlinear, base-isolated buildings with incomplete data and sets the foundation for the integration of modal analysis and the EID method to address these challenges.

Chapter 2 discusses the estimation of wind forces using modal analysis in a linear model. This chapter introduces the fundamental theory behind modal analysis and its application to wind force estimation. It also presents response identification methods, including cubic spline interpolation and frequency domain integration, as well as modal parameter identification techniques such as system identification using the Frequency Domain Decomposition (FDD) method. Different scenarios involving complete and incomplete data are analyzed, highlighting the impact of various assumptions on estimation accuracy.

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要旨（英文 800 語程度）
Thesis Summary（approx.800 English Words ）

Chapter 3 focuses on wind force estimation using the Equivalent Input Disturbance (EID) method for linear models. The methodology for designing observer gain is detailed, and the approach is applied to both fixed-base and base-isolated building models. Results of wind force estimation for these models are presented and discussed.

Chapter 4 applies the Equivalent Input Disturbance for Nonlinear Systems (EID-NS) method to estimate wind forces in nonlinear models. The chapter examines the nonlinear characteristics of isolated systems and presents results for both base-isolated and middle-isolated buildings. It also explores how nonlinear behavior influences wind force estimation.

Chapter 5 addresses the estimation of wind forces in a nonlinear model with incomplete responses and structural parameters. The chapter integrates the EID-NS method with response identification techniques, such as cubic spline interpolation and frequency domain integration, to estimate unknown responses. It also examines the effects of incorporating these methods on the accuracy of wind force estimation.

Finally, **Chapter 6** concludes the thesis by summarizing the key findings and proposing future research directions to further enhance wind force estimation methods for nonlinear and base-isolated buildings.

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