論文 / 著書情報
Article / Book Information

題目(和文)	
Title(English)	Simple model for tall buildings with frequency-dependent viscoelastic damper in wind-resistant design
著者(和文)	張庭維
Author(English)	Ting-Wei Chang
出典(和文)	学位:博士(学術), 学位授与機関:東京工業大学, 報告番号:甲第12940号, 授与年月日:2024年9月20日, 学位の種別:課程博士, 審査員:佐藤 大樹,山中 浩明,盛川 仁,石原 直,山﨑 義弘
Citation(English)	Degree:Doctor (Academic), Conferring organization: Tokyo Institute of Technology, Report number:甲第12940号, Conferred date:2024/9/20, Degree Type:Course doctor, Examiner:,,,,
学位種別(和文)	博士論文
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 都市・環境学	系 コース	申請学位（専攻分野）： Academic Degree Requested	博士 Doctor of	(Philosophy)
学生氏名： Student's Name	CHANG Ting-Wei		審査員主査： Chief Examiner	佐藤　大樹　准教授	

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

The title of this doctoral dissertation is "Simple model for tall buildings with frequency-dependent viscoelastic damper in wind-resistant design". It consists of seven (7) chapters, and is mainly divided into three parts. Part 1 (Chapters 2 to 3) investigated the influence of the frequency dependency and wind-induced responses among the fractional derivative (FD) model and integer (ID) models. Part 2 (Chapters 4) verified the accuracy of the proposed rapid prediction method. Part 3 (Chapter 5 to 6) proposed a simple model for frequency-dependent VE-damped high-rise buildings subjected to wind excitation, proposing a design method for the VE damper based on the Japanese standard of wind loading with the simple model.

VE dampers effectively dissipate kinetic energy from earthquake and wind-induced structural vibrations but are highly sensitive to temperature, excitation frequency, and strain level. The FD model of the VE damper can express the response of the VE damper considering the feature of strain, temperature, and frequency dependency. However, the design wind loading considered only two parameters of the building, the natural frequency and damping ratio. To deal with the mentioned problem, this dissertation focuses on wind loading and the vital roles of frequency dependency in VE damper behavior.

Chapter 1 presents a brief history of VE damper application in mitigating structural vibrations, and the fundamentals of viscoelastic behavior. It also presents current modeling methods and studies on VE dampers that consider frequency dependency.

Chapter 2 builds up the analytical models of VE-damped systems of the FD model and ID models considering different frequency dependencies, and investigates the characteristics of different VE-damped systems under the steady-state responses. Based on the steady-state results, the significant influence on the behavior of VE dampers by low frequencies is found.

Chapter 3 investigates the wind-induced responses of the FD model and ID models of VE-damped systems subjected to along- and across-wind, respectively. It indicates that the along-wind displacement of ID systems with dampers of high storage stiffness has massive differences with the FD system due to low and wide-band frequencies dominating the behavior of the VE system significantly.

Chapter 4 proposes a prediction method based on the power spectral method and evaluates wind-induced responses of the VE-damped system with an FD model of the VE damper subjected to the respective along- and across-wind force. Results indicate high accuracy in the prediction of wind-induced responses of the VE-damped system considering its frequency dependency with frame damping concern.

Chapter 5 provides a global damping (GD) model based on the zero-crossing rate method to deal with the frequency dependency effect of the VE damper and the outstanding low frequencies of wind excitation. Results indicate the zero-crossing-rate-based global damping (ZR-GD) model has a high accuracy of maximum responses and standard deviation with the FD model, and offers an efficient way to model the wind-induced responses of the frequency-dependent VE-damped structures.

Chapter 6 provides a design method for the VE damper based on the AIJ loading recommendation with the zero-crossing-rate-based global damping (ZR-GD) model.

Chapter 7 gives the conclusions and recommendations for future works.

This dissertation contributes to structural engineering by:

- The influence of frequency dependency of VE damper on wind-induced response was investigated.
- High accuracy of the power spectral method of wind-induced responses reflecting frequency dependency was verified.
- Based on the zero crossing rate method to build up the global damping (GD) model.
- A design method for the VE damper based on the Japanese standard for wind loading with the simple model was proposed.