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（博士課程）
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論 文 要 旨

THESIS SUMMARY

系・コース： Department of, Graduate major in	Arch. & Bldg. Engg., Urban Design & Built Environment	系 コース	申請学位（専攻分野）： Academic Degree Requested	博士 Doctor of	(Philosophy)
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要旨（英文 800 語程度）
Thesis Summary（approx.800 English Words ）

The title of this doctoral dissertation is "Numerical Modeling Methods for Full-Scale Viscoelastic Dampers subjected to Long-Duration Loading considering Heat Generation and Transfer". It consists of eight (8) chapters, and mainly divided into two parts. Part 1 (Chapters 2 to 4) builds the fundamental knowledge on how a viscoelastic (VE) damper behaves by investigating a simple two-layered VE damper. Part 2 (Chapter 5 to 7) focuses on the investigation of full-scale VE damper.

Viscoelastic dampers are effective in mitigating earthquake and wind-induced structural vibrations. They are highly sensitive to temperature, excitation frequency, and strain level. When subjected to long-duration loading, their temperature may significantly increase, consequently softening their VE materials and lowering their dynamic mechanical properties. Despite the growing number of full-scale VE damper installations in recent years, only a handful of studies had been conducted on such large-scale devices. Most of those studies are for seismic mitigation which only has few loading cycles. This dissertation focuses on long-duration loading, and the vital roles of heat generation and transfer in VE damper behavior.

Chapter 1 presents a brief history of viscoelastic (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 heat generation and transfer.

Chapter 2 provides a better understanding of the heat transfer aspect in, and characterizes the response of, a VE damper. It did so by utilizing the cycle-by-cycle three-dimensional finite element (3D-FE) analysis method which couples 3D static analysis and transient- and steady-state heat transfer analyses and only considers harmonic loading. Based on its new findings from numerically investigating different damper configurations, it provides a clearer insight to the rule of converting 3D into equivalent one-dimensional (1D) heat transfer for 1D modeling approaches.

Chapter 3 presents the 1D modeling approaches for time-history analysis of VE dampers. First, it provides an overview of the so-called *Long-Duration* (LD) *Method* coupling fractional time-derivatives VE constitutive rule with 1D heat transfer analysis. Based on the new findings of Chapter 2, it updates how the previously proposed computationally efficient *Fast Long-Duration* (FLD) *Method* was devised. It then presents the accuracy of FLD method relative to LD method over different damper configurations, loading conditions, and VE materials.

Chapter 4 proposes an evaluation method for wind engineering application of VE dampers considering the effects of heat generation and transfer. It stitches together the different methods presented in Chapters 2-3 and an available technique of expressing random damper deformations into equivalent sinusoidal waveforms. It considers heat transfer coefficient as the important evaluation parameter.

Chapter 5 utilizes the 3D-FE analysis method (Chapter 2) to numerically investigate a full-scale brace-type VE damper subjected to long-duration loading. It looks into the distributions of local temperatures and strain energy density, thus, providing vital information on how full-scale VE dampers behave.

Chapter 6 discusses the experimental study on a full-scale brace-type VE damper at extreme low ambient temperature of about 5 °C to 6 °C. It provides additional important information on VE dampers behavior since most of the previous experimental studies were conducted at relatively warm temperature of 21 °C to 30 °C.

Chapter 7 proposes a performance evaluation method for full-scale brace-type VE damper considering ambient temperatures. It utilizes the experimental results in Chapter 6 and those from previous experimental studies conducted at relatively warm temperature of 21 ℃ to 30 ℃.

Chapter 8 gives the conclusions and the recommendations for future works.

This dissertation contributes to structural engineering by:
- characterizing the response of VE damper in relation to the heat transfer aspect;
- proposing an evaluation method for practical application of VE dampers that considers heat transfer coefficient as an important parameter;
- numerically investigating full-scale VE dampers subjected to long-duration loading considering heat generation and transfer, and;
- proposing a performance evaluation method for full-scale VE damper considering ambient temperature.