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論文審査の要旨（2000 字程度）

The thesis entitled “**Strain-Based Damage Evaluation of Structural and Non-Structural RC Walls for Performance-Based Seismic Design”** is a comprehensive study of the damage assessment of structural and non-structural reinforced concrete (RC) walls using numerical modeling in order to implement practical design tools to assess the damage level under different levels of earthquakes to avoid costly repairs and significant socio-economic consequences. Current methods for assessing earthquake-induced damage in these walls are often resource-intensive and challenging to implement in routine practice. To address this gap, the study develops strain-based damage evaluation methods tailored to structural and non-structural RC walls, contributing to performance-based seismic design frameworks that aim to limit damage and enhance the post-earthquake functionality of RC buildings.

Chapter 1, “Introduction”, presents the current design practice and related research on RC walls of buildings and states the objective, which is predicting the damage level of walls based on material strains under earthquakes.

Chapter 2, “Literature Review”, provides a comprehensive review of existing studies, focusing on the damage mechanisms of RC wall components, the behavior and observed damage of structural and non-structural walls under seismic loads, and the existing approaches for assessing such damage. It also explores the influence of design variables on damage to these components.

Chapter 3, “Numerical Simulation of Reinforced Concrete Walls”, introduces suitable numerical modeling techniques to simulate the behaviors of structural and non-structural RC walls under lateral loads. These modeling approaches are chosen to meet specific requirements, such as capturing global and local responses, ensuring computational efficiency, maintaining applicability across diverse RC wall designs, etc., making them well-suited for integration into performance-based seismic design workflows.

Chapter 4, “Damage Evaluation of Structural Reinforced Concrete Walls”, presents strain-based damage evaluation criteria corresponding to the conceptual damage levels (damage levels I, II, III, and IV) outlined in the Japanese Post-Earthquake Damage Evaluation Guidelines. The strain limits are in the form of concrete and longitudinal reinforcement strains, with the drift ratio at the limit of each damage level determined by the minimum drift ratios corresponding to the proposed strain limits for that damage level. These strain limits are found to effectively capture drift ratios at the limits of different damage levels based on experimental damage observations from the 27 specimens. This method allows for predicting damage that directly impacts the post-earthquake usability of buildings, enabling functionality evaluation during the design phase using numerical tools. The proposed strain-based limit states are compared with the ASCE/SEI 41 acceptance criteria for three performance levels. The comparison provides insights into how these strain-based criteria align with the performance levels in the established standard.

Chapter 5, "Parametric Study to Identify Variables Affecting Damage Levels of Structural Reinforced Concrete Walls", shows a parametric study to analyze the effects of material properties (concrete compressive strength and yield strength of longitudinal reinforcement), reinforcement ratios (longitudinal boundary and web reinforcement), and loading conditions (axial load ratio and shear span-to-wall length ratio) on different damage levels and ultimate deformation of structural RC walls. The results highlight that loading conditions significantly influence damage progression and ultimate deformation and offer practical insights for optimizing wall designs to meet desired damage targets under the considered seismic hazards.

Chapter 6, "Damage Evaluation of Non-Structural Reinforced Concrete Walls", discusses the ability of the Shear-Flexure Interaction Multiple Vertical Line Element Model (SFI-MVLEM) to capture the shear-flexure interaction of the stocky non-structural walls, which are typically bounded within a single floor. Validation against eight full-scale specimens demonstrates the model's accuracy in reproducing global and local responses, including the average shear contribution to displacement. Four damage states, ranging from minor to severe, are defined for non-structural RC walls based on the progression of visible damage and the level of repair effort required to reinstate the component. The concrete and longitudinal reinforcement strain limits are proposed to predict these damage states and are found to effectively capture the drift ratios at the limit of experimental damage states.

Chapter 7, "Empirical Equations and Fragility Functions for Damage Evaluation of Non-structural Reinforced Concrete Walls", introduces the development of practical tools in the form of predictive equations and fragility curves for non-structural walls. These tools simplify damage prediction without requiring numerical simulations and assist in design revisions to achieve desired damage targets. They are derived from sensitivity analyses and numerical simulations performed on representative models of non-structural walls commonly used in Japanese construction.

Chapter 8, "Summary, Conclusions, and Recommendations", summarizes the achievements that bridge critical gaps in damage evaluation for structural and non-structural RC walls. This research provides a comprehensive framework for evaluating and mitigating seismic damage in structural and non-structural RC walls. Integrating strain-based damage criteria with validated numerical models enables predictions of seismic damage during the design phase. The contributions of this research bridge critical gaps in damage evaluation for structural and non-structural RC walls, advancing performance-based seismic design to ensure buildings meet specific damage and functionality targets under seismic hazards. Furthermore, the chapter lays a foundation for future research on designing buildings to achieve the required functionality.

The work on **Strain-Based Damage Evaluation of Structural and Non-Structural RC Walls for Performance-Based Seismic Design** has a significant impact on the engineering community to secure the safety and resiliency of buildings and is considered sufficient for the degree of Doctor of Philosophy.