# 論文 / 著書情報
# Article / Book Information

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# 論 文 要 旨

THESIS SUMMARY

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| 専攻：<br>Department of | Environmental Science and Technology 専攻 | 申請学位（専攻分野）：<br>Academic Degree Requested | 博士 (Engineering)<br>Doctor of |
| 学生氏名：<br>Student's Name | Eko Yuniarsyah | 指導教員（主）：<br>Academic Supervisor(main) | Prof. Susumu Kono |
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要旨（英文 800 語程度）
Thesis Summary（approx.800 English Words ）


The thesis is entitled "Seismic Performance of Lightly Reinforced Concrete Walls" and consists of seven chapters. The use of lightly reinforced concrete (LRC) walls is common for residential and government buildings in Japan. The 2011 Tohoku and 2016 Kumamoto Earthquakes clarified the weakness of LRC walls. Many of them suffered severe damage mainly due to shear failures and the damage impaired the building functions after the earthquakes to deter quick recovery. It is therefore necessary to accurately predict the behavior of LRC walls under seismic loading. The main objective of this research is to develop a backbone model for shear-governed LRC walls to predict their seismic behavior, and to assess a variety of damage levels for both new and existing LRC walls.

Chapter 1 "Introduction" briefly describes the challenges involved in designing LRC walls. It also identifies research needs and clarify objectives. The outline of the thesis is also described in this chapter.

Chapter 2 "Literature Review" addresses the available literatures on previous studies on the seismic performance of LRC walls. Various shear strength models and analysis techniques are also summarized.

Chapter 3 "Development of Backbone Curve for Lightly Reinforced Concrete Walls" introduces a proposed performance based backbone model for LRC walls. The selected trilinear model is associated with three limit states: diagonal cracking, peak shear capacity, and ultimate deformation. The proposed shear capacity model was formulated to include the ductility by modifying revised UCSD shear model for RC walls. It was validated using 39 experimental specimens of rectangular walls combined with 210 FEM rectangular wall cases, which are explained in Chapter 6. The proposed shear formula resulted in significant improvement in computing the shear capacity of LRC walls. The proposed shear capacity was used to develop backbone curves by modifying ASCE/SEI 41-13 and Wallace's backbone curves. The proposed backbone curve provides a good estimate to the force-drift response in LRC wall database.

Chapter 4 "Experiment 1: Seismic Behavior of As-Built Lightly Reinforced Concrete Walls" states the effects of axial force, amount of shear reinforcement,

and shear span to wall length ratio on seismic behaviors of LRC walls through an experiment. The experiment included four real-scale LRC walls focusing on damage processes and failure modes. The experimental results showed that axial load ratio, shear span to wall length ratio, and amount of horizontal reinforcement affected damage process and failure mode. In addition, a quantitative damage evaluation in terms of crack width, crack length, and concrete spalling area was carried out to investigate the correlation between seismic damage and drift. The damage level of walls was assessed using "Guidelines for Performance Evaluation of Earthquake Resistant Reinforced Concrete Buildings (Draft)" (Architectural Institute of Japan, 2004), which takes into account damage level such as residual crack width or stress level of concrete and reinforcement. Considering the total damage (crack length and spalling area) of concrete, the criteria of the guidelines well captured damage level of LRC walls. The limit stress level was proposed to be raided from 67% to 80% of the compressive strength to better estimate the drift of serviceability limit state of concrete. In addition, the ratio of concrete spalling area was proposed as one of damage state index to determine the limit state.

Chapter 5 "Experiment 2: Seismic Behavior of Retrofitted Lightly Reinforced Concrete Walls" presents the experimental study on three upgraded LRC walls to improve the seismic behavior by enhancing both shear and ultimate drift capacities. Two specimens were upgraded by placing an additional wall panel and the other specimen was upgraded by improving the reinforcement details. It was concluded that adding RC and UFC panels improved the seismic behavior of LRC walls and prevented crack formation of the wall panel. Increasing the amount of horizontal reinforcement and providing confinement in the boundary regions decreased the opening of crack width and increased ductility.

Chapter 6 "Parametric Study of Lightly Reinforced Concrete Walls using FEM Analysis" explains the finite element analysis to simulate the hysteretic characteristics and damage process of specimens tested in Chapter 4. LRC walls specimens were modeled using hexahedral and beam elements with bond links. The finite element analysis well simulated the maximum lateral load capacities and hysteresis loops. The damage progress reasonably agreed with experimental observations. Additional finite element analysis with 210 cases were conducted combining seven axial load levels, six shear reinforcement ratios, and five shear span to wall length ratio to validated the proposed shear capacity equation in Chapter 3.

Finally, Chapter 7 "Conclusions" summarizes the main findings of this study and further research needs related to the design of LRC walls.