CHAPTER 1. INTRODUCTION

1.1. BACKGROUND OF THE RESEARCH

The Indonesian archipelago is located at the intersection of three major tectonic plates—the Eurasian, Indo-Australian, and Pacific plates. This geological setting subjects the country to frequent and severe seismic activity. Specifically, the city of Padang, positioned directly adjacent to the active Mentawai subduction zone and transected by the Sumatran fault system, faces a demonstrably high risk from powerful, recurrent earthquakes, as tragically underscored by the devastating 2009 West Sumatra earthquake (Putra et al., 2012).

While the Indonesian National Standard (SNI) for Seismic Resilience has been continuously updated, a significant portion of existing infrastructure, particularly older Reinforced Concrete (RC) structures, were erected under prior, less stringent seismic codes. Consequently, these buildings often lack the essential strength and ductility required to withstand the design seismic loads. Past tragic events that resulted in major structural failures emphasize the importance of evaluating this building's resistance to seismic forces.

Evaluating the performance of these structures necessitates a shift beyond traditional strength-based analysis and towards the Performance-Based Seismic Engineering (PBSE) approach. PBSE's core objective is to define and ensure a specified, acceptable level of damage (Performance Limit State) when a structure is subjected to a given earthquake intensity. The Non-linear Static Analysis (Pushover Methodology) has emerged as the recognized, standard tool for quantifying this expected seismic performance (Gwalani & Singh, 2023).

One of the most effective and widely adopted structural retrofitting methods for enhancing the seismic performance of existing RC buildings is the incorporation of Shear Walls. Shear walls provide substantial lateral stiffness and strength, which are crucial for controlling excessive story drifts. The inclusion of well designed shear wall can enhance the poor seismic performance affected by irregularities such as soft stories, poor detailing in beam-column joints, etc (Ozkul et al., 2019). Nevertheless, the configuration and positioning of these shear walls—specifically, whether they are placed symmetrically or eccentrically relative to the building's center of mass—critically influences the structure's torsional response during an earthquake. Improper placement risks introducing detrimental eccentricities that could exacerbate damage to the RC shear wall.

Therefore, this research undertakes a comprehensive analysis to investigate the impact of adding and configuring shear walls on a representative RC building model located in Padang. By utilizing the Non-linear Pushover Analysis conducted with the SeismoStruct software, this study will quantitatively determine the resulting changes in the capacity curve and the achieved performance level. Ultimately, this work seeks to provide insights and recommendations for safe, optimal structural retrofitting strategies in this highly seismic region.

1.2. OBJECTIVE AND BENEFITS OF THE RESEARCH

1.2.1. Objective of the Research

The primary goals of this study are as follows:

1. To conduct a non-linear static (pushover) analysis to evaluate and compare the seismic capacity curves of the unretrofitted reference Reinforced Concrete (RC) structure against three retrofitted models. These retrofitted models share the same total shear wall area, but their performance is compared across distinct configurations: core-only placement, perimeter placement, and combined core-perimeter placement.
2. To determine and compare the seismic performance level achieved by each structural model when subjected to the design seismic hazard spectrum specific to the Padang area.
3. To establish whether the incorporation of the determined shear wall configurations is sufficient to meet the minimum life safety (LS) performance criteria as mandated by Performance-Based Seismic Engineering (PBSE) guidelines.

1.2.2. Benefit of the Research

The findings and conclusions derived from this thesis are expected to generate several significant benefits across various stakeholders:

1. This research is expected to provide a better understanding of how different shear wall configurations influence the seismic performance of reinforced concrete buildings.
2. The study will enrich the existing body of knowledge regarding the seismic behavior of Reinforced Concrete (RC) frame structures strengthened with shear walls in highly active seismic zones, particularly within the context of Indonesian seismic codes (SNI) and Performance-Based Design (PBSE) principles.

3. The results concerning the achieved performance levels can serve as practical input for local government and regulatory bodies in Padang. This data can inform urban planning, disaster mitigation policies, and the prioritization of structural rehabilitation programs for vulnerable public and commercial buildings.

1.3. SCOPE AND LIMITATION

The scope limitation presented in this study are as follows:

1. Subject Building Model: The analysis is based exclusively on a single, representative 5-story Reinforced Concrete (RC) frame structure model. The reference model characteristics will be fixed throughout the comparative study. For this analysis, the structural models were designed using Indonesian codes as SNI 1727:2020 as the loading code, SNI 1726:2019 as the seismic loading code, and SNI 2847:2019 regarding structural concrete requirements for building structures.

   The study utilizes four distinct structural models for comparison:

   1. Model 1 (Baseline): The unretrofitted RC frame structure, establishing the initial seismic vulnerability.
   2. Model 2 (Exterior Configuration): Retrofitted with shear walls concentrated in the structural core.
   3. Model 3 (Interior Configuration): Retrofitted with shear walls placed in the predominantly along the building perimeter.
   4. Model 4 (Hybrid Configuration): Retrofitted with a combination of shear walls in both the core and along the perimeter.

   For the retrofitted models (Models 1, 2, and 3), the total cross-sectional area of the added shear walls is maintained as a constant value. The study's primary variation lies solely in the configuration (placement and distribution) of this constant area across the building plan.

2. Geographical and Seismic Data: All seismic hazard parameters, including the design response spectrum and peak ground acceleration (PGA), are derived specifically for the Padang, West Sumatra region, based on the latest applicable Indonesian Seismic Codes (SNI 1726:2019) Site-specific soil effects (e.g., liquefaction) are not explicitly considered in the superstructure analysis.

3. Analysis Methodology: The seismic performance evaluation is limited to the Non-linear Static Analysis (Pushover) using Seismostruct as the main software. The code use for the evaluation is ASCE 41-23.

1.4. ORGANIZATION OF THE THESIS

CHAPTER I INTRODUCTION

This chapter serves as the foundation of the research. It presents the background outlining the seismic hazard in Padang, the specific objectives and anticipated benefits, the defined scope and limitations of the structural analysis, and the overall thesis organization.

CHAPTER II REVIEW OF LITERATURE

This chapter provides the theoretical framework for the study. It critically examines concepts related to seismic hazards, Performance-Based Design (PBSE) principles, the behavior of Reinforced Concrete (RC) structures and Shear Wall mechanisms under lateral loads, and the theoretical underpinnings of Nonlinear Static Analysis (Pushover) Methodology.

CHAPTER III METHODOLOGY

This section details the step-by-step procedures used to execute the research. This includes the process of data acquisition, the generation of the structural models (unretrofitted and retrofitted with shear walls), the definition of material constitutive models, and the specific application of the Pushover analysis procedure.

CHAPTER IV RESULTS AND DISCUSSION

This chapter presents and thoroughly discusses the analytical findings. It includes the results of the structural modeling, the derivation of the capacity curves for all models, and the final evaluation of the Structural Performance Level based on FEMA-356 criteria.

CHAPTER V CONCLUSION

This concluding chapter summarizes the answers to the research objectives and highlights the primary findings.

BIBLIOGRAPHY

ATTACHMENT