Abstract

Confined brick masonry (CBM) structures are increasingly popular in earthquake-prone regions due to their combination of structural robustness, cost-effective material use, and efficient wall-to-column connections. These structures provide significant advantages in terms of stability and resilience during seismic events, as their construction techniques offer strong lateral resistance and improved load distribution. However, despite their widespread adoption in both urban and rural settings, critical knowledge gaps persist regarding their response to various influential factors. Parameters such as geometric variations in wall dimensions, material properties, and the presence of openings for windows and doors are known to significantly affect their seismic performance but have not been comprehensively investigated in previous studies.

This thesis addresses these gaps through in-depth numerical investigations using a finite element macro-model approach. This approach enables detailed simulations of CBM walls under seismic loads, incorporating the effects of key variables. By employing the concrete damage plasticity method, the study predicts damage progression and performs pushover analyses to evaluate ultimate strength, stiffness, and energy dissipation. The research systematically examines the effects of geometry, material properties, and openings on the seismic response of CBM walls.

Extensive parametric studies focus on critical aspects such as the size, shape, and position of openings. Findings indicate that openings constituting less than 10% of the masonry area preserve effective load paths, while larger openings require additional reinforcement. Rectangular openings, particularly those taller than they are wide, exhibit better performance un-

der lateral forces, highlighting the importance of precise geometric design. The placement of openings also plays a significant role, with poorly positioned openings reducing both strength and stiffness, while strategically positioned ones optimise load distribution.

The study further explores the bond between masonry and tie-elements, such as vertical tie-columns, demonstrating that strong connections significantly enhance seismic resilience. Among the various connection types studied, machine-made toothed connections outperform hand-made and no-tooth configurations, offering greater strength, stiffness, and energy absorption capacity. The research also evaluates the impact of different toothing projections, with results showing that designs featuring a 100 mm vertical and 50 mm horizontal projection improve load transfer mechanisms and minimise stress concentrations.

Material properties and mortar mix proportions are also critically assessed. Fly ash bricks, particularly those paired with optimised mortar mixes, outperform traditional clay bricks in terms of ultimate strength and seismic performance. While higher compressive strength generally correlates with better performance, the study reveals exceptions where material-specific characteristics influence ductility and overall resilience.

This research provides practical and actionable recommendations for improving the design and construction of CBM structures in seismic zones. By addressing key factors such as wall-to-column connections, optimal opening configurations, and effective confinement schemes, this study lays a solid foundation for improving the resilience and safety of CBM structures. Its findings contribute to the broader understanding of CBM construction and are expected to inform future design standards and guidelines for earthquake-resistant infrastructure.