（様式課程博士３）

学 位 論 文 の 要 旨

専　攻　名	工学	ふりがな 氏　名	ゆうき　あれはんどろ　ほさか　べんとーら Yuuki Alejandro Hosaka Ventura
学位論文題目	Experimental and analytical study on the effect of a middle tie beam element on the in-plane strength of confined masonry walls （枠組組積造壁体の面内強度に及ぼす中間梁の影響に関する実験および解析研究）		

The middle tie beam refers to a reinforced concrete beam located at mid height of the wall. The 1997 special standard for construction and design of housing in El Salvador mentioned this element alongside dimensions and reinforcement requirements. Due to a lack of further specifications, this element became a common practice in confined masonry constructions. However, in a revision made to the special standard, the mention of this element was removed. Furthermore, the study by Hasbun et al. stated that this was done without any background investigation. As such, the main objective of the first part of this study is to analyze the effect a middle tie beam has on the in-plane strength of confined masonry walls. The second part focuses on developing a finite element model of masonry compressive prisms to study the effect of mortar bed thickness and mortar compressive strength. This study was comprised of five chapters.

Chapter 1 presents the historical background and motivation for this study, as well as its objectives.

Chapter 2 presents the test results and the seismic response analysis carried out with the 2021 experiment. This experiment tested the effect of the middle tie beam and brick compressive strength on the seismic performance of confined masonry walls. For this, four walls were tested in cyclic loading. Two were control walls with low compressive strength handmade bricks and typical Japanese concrete bricks, respectively. The other two walls had a middle tie beam, which were made with the handmade bricks and the Japanese concrete bricks, respectively.
The test results showed that in a sliding failure mode, the middle tie beam has no significant effect on the in-plane strength of walls. However, there was evidence of improvement in terms of ductility in the walls with this element. Additionally, the effect of the middle tie beam on the equivalent damping factor was observed after the walls had achieve their maximum in-plane strength.
For the seismic response analysis, the capacity response spectrum method was utilized. This analysis showed that the response point of the walls for a severe seismic demand would occur before the maximum strength in the performance curve.

Chapter 3 presents the methodology for the design of the walls and the results of the 2020 experiment. Additionally, it presents the analysis carried out to understand the effect of the middle tie beam in terms of in-plane strength. For this, a comparison between shear strength obtained from equations and experimental results was carried

続紙　有☑　　無☐

out.
The data utilized comes from our experiments in 2020 and 2021, and a review of past investigations. This review served the additional purpose to help understanding the experimental behavior of confined masonry walls with a middle tie beam. Each of these walls was then classified in one of three failure modes: diagonal tension, sliding or mixed. Then, equations were selected from relevant investigations, and used to evaluate the in-plane capacity of the experimental data. For this selection, the equations were evaluated in how they consider the contribution of each wall element and how they could be adapted to include the middle tie beam.
The comparison had the objective to determine which equations could predict the in-plane shear capacity more accurately, and under which failure mode.
Once the equations for each failure mode were defined, these were tested to see if they could predict the in-plane strength and failure mode of the experimental data. For this, all three equations were evaluated utilizing material test data. The lowest value among them and its failure mode were considered the in-plane strength and failure mode of the wall, respectively.
Overall, the evaluation process was able to determine equations that could accurately predict the sliding, diagonal tension, and mixed failure modes. However, the methodology was found to be inadequate when utilized to predict the in-plane strength and failure mode of the experimental data, and it was found that test conditions might prove to be more effective in determining the possible failure mode of the walls.

Chapter 4 presents the development of a finite element model of masonry compression prisms in an engineering simulation software to study the effect of mortar bed thickness and mortar compressive strength on the masonry compressive strength.
For this, the 10mm mortar bed prisms of a previous experimental study were utilized to calibrate a microplane model for brick and mortar. Once this was done, the same materials were utilized in the 30mm and 60mm mortar bed prisms and compared with the experimental data. The results showed that the material model could accurately predict the compressive strength of prisms with variable mortar bed thickness.

Chapter 5 presents the summary of the conclusions reached in every chapter.

【771 文字（語）】

（注）和文 2,000 字又は英文 800 語以内　　続紙　有☐　無☑

（様式課程博士８）

学位論文審査結果の要旨

専攻	工学専攻環境工学コース	氏名	Yuuki Alejandro Hosaka Ventura
論文題目	Experimental and analytical study on the effect of a middle tie beam element on the in-plane strength of confined masonry walls（枠組組積造壁体の面内強度に及ぼす中間梁の影響に関する実験および解析研究）		
主査	黒木　正幸		
審査委員	田中　圭		
審査委員	島津　勝		
審査委員	菊池　健児		
審査委員			

審査結果の要旨（1000字以内）

コンファインドメーソンリー（枠組組積造）壁体は，れんが組積体の周辺を鉄筋コンクリート造の柱梁で拘束した壁体であり，耐震性を有する構造として途上国の中低層の建物に広く採用されている。しかしながら，近年の大規模地震により壁体の破壊に起因する建物の倒壊が見られており，一層の耐震化を図る必要があると考えられている。本研究では，壁体の中央高さ付近に追加する鉄筋コンクリート造中間梁の効果を明らかにし，枠組組積造壁体の耐震性の向上に活用することを目的としている。

まず，著者は壁体試験体に対する静的水平加力実験を実施し，すべり破壊挙動が卓越する場合には中間梁の採用による強度増大は期待できないことなどを示している。一方で，中間梁を有する壁体は変形が抑制されるため安定したエネルギー吸収能力を発揮し，低強度のれんがを用いた場合であっても極めて稀に発生する大規模地震に対して倒壊に至らない設計が可能であることを等価線形化法による地震応答計算により示している。また，せん断引張破壊，せん断圧縮破壊，すべり破壊のそれぞれの破壊形式に対する強度算定式を提示し，その推定精度を収集した実験データとの比較により明らかにしている。

さらに，中間梁の効果を解析的に検討するための基本的な問題として，壁体の大部分を構成するれんが組積体の強度特性に及ぼす目地モルタルの強度および厚さの影響を非線形有限要素法解析により検討している。その結果，目地モルタルとれんがの強度差が大きい場合についても，目地の厚さが10mmから30mm程度の範囲において，既往の実験による組積体の強度特性と同様の特性が解析により得られることを示している。

著者による以上の研究成果は，枠組組積造壁体の耐震性の向上に対し寄与するところが極めて大きいと評価できる。また，論文審査会や公聴会ならびに最終試験における質問に対しても本人から明解かつ的確な説明がなされた。よって，本論文は博士（工学）の学位に値するものと審査委員が全員一致で判定した。