



AIN SHAMS UNIVERSITY
FACULTY OF ENGINEERING

**PERFORMANCE-BASED ASSESSMENT OF
MEDIUM-RISE MASONRY BUILDINGS**

By

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**A Thesis Submitted in Partial Fulfillment of the
Requirements for the Degree of**

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Statement

This thesis is submitted as a partial fulfillment of Master of Science in Civil Engineering (Structural Engineering), Faculty of Engineering, Ain shams University.

The author carried out the work included in this thesis, and no part of it has been submitted for a degree or a qualification at any other scientific entity.

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I believe that I have given my all effort in developing this research as accurately and truthfully as possible. Moreover, I am surely personally responsible for the conclusions and opinions expressed in this research.

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Abstract

The behavior of masonry walls depends on the behavior of several materials that have different characteristics such as blocks, mortar, reinforcement and grout. Such combination makes nonlinear analysis of such walls challenging. Consequently, there is a need to develop numerical models of such complex combination that are both accurate and simple. These macro models are used to simulate the in-plane response of structural walls under cyclic loading simulating earthquake effects which is difficult to be implemented in the laboratory. The validity of the developed models was investigated against previous experimental results and comparison showed that developed models could be used in simulating reinforced fully-grouted masonry shear walls.

The principal objective of this study was to predict the seismic performance of medium rise reinforced masonry shear walls having rectangular, flanged and end-confined cross sections while varying wall aspect ratio, level of applied axial stress and vertical reinforcement ratio. The second main objective was to predict the probability of a specific damage state by using fragility curves as a sort of performance based assessment criteria. The third objective was to study the ductility response of a structure composed of different wall types and having different ductility capacities and consequently the response modification factor for the whole building can be specified and implemented through this study.

Results showed that displacement ductility capacity was very sensitive to the level of axial compression much more than the effect of vertical reinforcement, where displacement ductility decreases significantly with the increase of axial load compared to increase in vertical reinforcement ratio. Also, it was concluded that higher aspect ratio (height to length ratio) walls poses lower ductility capacity.

Fragility diagrams were used to predict the probability of exceeding a specific state of damage (initial cracking, steel yielding, wall toe crushing and steel buckling or fracture) when walls are subjected to a seismic demand input parameter which is considered as drift ratio. It was found that end-confined wall

section is the least vulnerable wall system for the third and fourth damage states followed by flanged then rectangular wall sections. The third and fourth damage states are directly related to ductility and hence the best indicator for the seismic performance of structural wall systems.

Regarding to structure integrity for a building composed of ten walls having different ductility capacities, it was concluded that the outcome global ductility response of a building was totally different from individual walls and it is highly sensitive to the ratio of participation of ductile wall system such as end-confined and flanged wall sections. And by considering equal displacement approach which is implemented in many codes, it could be considered that response modification factor equal to system displacement ductility.

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LIST OF SYMBOLS

H_W	= wall height
L_W	= wall length
C	= distance between neutral axis and maximum compression fiber
L_S	= distance between maximum and minimum moment of wall height
A_R	= wall aspect ratio
L_P	= equivalent plastic hinge length
D_b	= bar diameter
μ_Δ	= displacement ductility
$\mu_{\Delta 0.8u}$	= displacement ductility measured up to 20% strength degradation
μ_ϕ	= curvature ductility
ϕ	= section curvature
ϕ_y	= yield curvature
ϕ_p	= inelastic curvature
Θ_p	= inelastic rotations
Δ_y	= yield displacement
Δ_p	= inelastic displacement
Δ_u	= displacement at ultimate strength
$\Delta_{0.8u}$	= displacement at 20% strength degradation
ϵ_{mu}	= ultimate masonry compressive strain
ϵ_m	= masonry strain
ϵ_s	= steel strain
ϵ_y	= steel yield strain
P	= axial compressive load
Q_u	= ultimate shear strength
Q_y	= lateral load corresponding to yielding
Q_d	= design lateral load
σ	= axial compressive stress
A_g	= section gross area
E_m	= masonry modulus of elasticity
E_s	= steel modulus of elasticity