TRIBHUVAN UNIVERSITY

INSTITUTE OF ENGINEERING

PULCHOWK CAMPUS

DEPARTMENT OF CIVIL ENGINEERING

M.Sc. Program in Structural Engineering

Thesis no: S00104

OUT OF PLANE SEISMIC RESPONSE OF INFILL BRICK MASONRY WALL

KRISHNA RAJ PANTHA

January- 2007

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A thesis submitted by

KRISHNA RAJ PANTHA

In partial fulfillment of the requirement for the degree of

MASTER OF SCIENCE

IN

STRUCTURAL ENGINEERING

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COPY RIGHT

CERTIFICATE

This is to certify that the work contained in this thesis entitled "Out of Plane Seismic Response of Infill Brick Masonry Wall", in partial fulfillment of the requirements for the degree of Master of Science in Structural Engineering, as a record of research work, has been carried out by Mr. Krishna Raj Pantha (061/MSS/r/106) under my supervision and guidance in the institute of Engineering, Pulchowk Campus, Lalitpur. The work embodied in this thesis has not been submitted elsewhere for a degree.

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Dr. Roshan Tuladhar
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January, 2007

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ABSTRACT

Significance of RC bands in preventing failure of infill wall especially in out of plane direction was investigated. Also the change on magnitude of various stress components on bounding RC frames due to presence of RC bands was examined. Two types of models viz. the infill walls with and without RC bands were prepared and studied numerically to get comparative results. Micro modeling i.e. eight nodded solid element for bricks, non-linear link elements for mortar and solid elements with sufficient subdivisions for bounding RC frame was carried out for one focused infill panel and macro modeling i.e. equivalent diagonal strut modeling for infill walls and single solid element for bounding RC frames was carried out for the infill walls except the focused infill panel. Non linear direct integration time history analysis was carried out for the both types of models. Only the output results of focused infill panel was studied for both types of models.

It was found that the presence of RC bands reduces the tendency of failure of infill wall especially in out of plane direction. It was concluded by studying the stresses on bricks, displacement of bricks and stresses on mortar. The probable crack propagation was plotted after studying the stresses on mortar determined from forces on link elements. Sufficient cracks were seen on wall without RC bands and fewer cracks were seen on walls with RC bands. The magnitude of maximum stresses on bounding frames i.e. beams and columns were found more in model without RC bands than in model with RC bands. But in model with RC bands, the stresses on the column at band column junction were significantly large in comparison with the stresses on the column at same location in model without RC bands. Hence except the stresses on band column junction overall responses for the model with RC bands were less in magnitude in comparison to the model without RC bands and therefore the provision of RC bands on infill wall was found beneficial if due care is given at band column junction.

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LIST OF ABBREVIATION

a	Width of equivalent strut
h_{col}	Column height between centerlines of beams
h_{inf}	Height of infill panel
E_{fe}	Expected modulus of elasticity of frame material
E_{me}	Expected modulus of elasticity of infill material
I_{col}	Moment of inertial of column
L_{inf}	Length of infill panel
r_{inf}	Diagonal length of infill panel
t_{inf}	Thickness of infill panel and equivalent strut
θ	Angle whose tangent is the infill height-to-length
E	Young's modulus of elasticity
ρ	Density
ν	Poisson's ratio
V	Compressive wave velocity
$\mathbf{K}$	Stiffness matrix
$\mathbf{C}$	Damping matrix
$\mathbf{M}$	Diagonal mass matrix
$\mathbf{t}$	Time function
$\mathbf{u}$	Displacement
$\dot{\mathbf{u}}$	Velocity
$\ddot{\mathbf{u}}$	Acceleration
$\mathbf{r}$	Applied load
$\mathbf{\Delta}t$	Time step
σ	Compressive strength of brick
f_m	Compressive strength of masonry prism
λ_1	Relative stiffness parameter
n	Number of degree of freedom
$\mathbf{\Phi}$	Modal matrix whose columns are Eigen vectors
$\boldsymbol{\omega}$	Natural frequency
τ_{max}	Shear strength of RCC