SEISMIC PERFORMANCE OF REINFORCED CONCRETE FRAMES

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STATEMENT OF ORIGINALITY

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PUBLICATIONS

The following publications were written based on the work presented in this thesis.

Journal Papers

Kashyap, J., Ozbakkaloglu T. and Griffith, M. (2008). "Seismic Behaviour of Reinforced Concrete Frames in Low Seismicity Regions." In Preparation.

Kashyap, J., Griffith, M. and Ozbakkaloglu, T. (2008). "Seismic Performance of Brick Infilled Reinforced Concrete Frames." In Preparation.

Conference Papers

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ABSTRACT

Many intra-tectonic plate regions are considered to have low to moderate seismic risk. However, devastating earthquakes can occur in these regions and result in high consequences in terms of casualties and damage. Non-ductile detailing practice employed in these structures make them prone to potential damage and failure during an earthquake. Furthermore, the use of infill walls is a divisive issue as on positive side dual wall-frame systems have beneficial effects related to strength, stiffness, and ductility. However, if not designed properly infill wall can also lead to undesirable structural failures of complete wall frame system. Although, there has been significant amount of international research in this area, it is worth noting that very little research exists for Australian frames.

This thesis presents the experimental and analytical research conducted at The University of Adelaide to gain some insight into the behaviour of typically detailed Australian reinforced concrete frames subjected to ground motions. The main objectives of this research were (1) to investigate the behaviour of non-seismically designed reinforced concrete frames under a 500-YRP earthquake; (2) to determine the different magnitudes of earthquake (YRP) that are likely to cause excessive drifts in or collapse of gravity-load-designed reinforced concrete frames and (3) to investigate the effect of infill walls on the moment-resisting frames subjected to seismic loads. The experimental program consisted of earthquake simulation tests on a 1/5 scale model of a 3-storey reinforced concrete frame and four ½-scale reinforced concrete brick infilled frame specimens subjected to quasi-static cyclic loading. The analytical study included static pushover and non-linear dynamic analyses of the 3-, 5- and 12-storey reinforced concrete frames.

From the overall performance of gravity-load-designed bare reinforced concrete frames considered in this study, it was concluded that the non-seismically designed frames appear to be capable of resisting a "design magnitude earthquake" (i.e., 500-YRP) in low earthquake hazard regions. However, their behaviour under more severe earthquakes (e.g. a 2500-YRP earthquake) is questionable. Perhaps the earthquake design requirements should consider as an alternative the ‘collapse prevention’ limit state for longer return period earthquakes, of the order of 2000–2500-YRP. The experimental research on reinforced concrete infilled frame indicated that the infill wall does not adversely effect the in plane ultimate strength, stiffness, and ductility of the bare reinforced concrete frame.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

NOTATIONS

a	Acceleration coefficient
C	Earthquake design coefficient
C_{eu}	Ultimate base shear coefficient
C_{max}	Maximum base shear coefficient
C_s	Ratio of maximum strength at failure
C_w	Code-prescribed strength
C_y	Actual structural yield strength
Dc	Smaller column dimension for rectangular column
Db	Diameter of the smallest bar in the column
E_b	Young's modulus of brick infill
E_c	Young's modulus of concrete
E_s	Young's modulus of steel
f_c	Concrete compressive strength
f_{sy}	Yield strength of steel
g	Acceleration due to gravity
H_{total}	Total height of the building
h_{storey}	Height of each of the storey of the building
I	Importance factor
k_p	Probability factor
L	Length
P	Annual probability of exceedance
R_f	Structural response modification factor
R_u	Ductility reduction factor
S	Site factor
S_a	Dynamic ground acceleration
T	thickness of infill
V	Base shear
W	Weight of building
Z	Earthquake hazard factor

ΔE	Cumulative energy dissipated
Δ_y	Displacement at yield
Δ_{max}	Maximum displacement
Δ_{roof}	Roof displacement
Δ_{storey}	Storey displacement (interstorey)
μ_s	Structural ductility factor
Ω_s	Overstrength above code
Ω_y	Overstrength at first yield
Ω_{total}	Total overstrength
θ	Angle of infill diagonal to the horizontal

ACI	American concrete institution
ARP	Annual return period
AS	Australian standard
ATC	Applied technology Council
CEB	Comité euro-international du béton
	(Euro-international committee for concrete)
DE	Design earthquake
DME	Design magnitude earthquake
EPA	Effective peak acceleration
FEMA	Federal emergency management agency
GLD	Gravity load designed (frame)
IDI	Interstorey drift index
IMRF	Intermediate moment resisting frame
LVDT	Linear Voltage Displacement Transducer
MCE	Maximum considered earthquake
MRF	Moment resisting frame
NEHRP	National earthquake hazards reduction program (American)
OMRF	Ordinary moment resisting frame
PGA	Peak ground acceleration
RC	Reinforced concrete
SAA	Standards Association of Australia

SEAOC	Structural Engineers Association of California
SMRF	Special moment resisting frame
TFT	Taft earthquake
UBC	Uniform building code
URM	Unreinforced masonry
YRP	Year return period