SEISMIC PERFORMANCE AND FRAGILITY CURVES FOR REINFORCED CONCRETE FRAME AND SHEAR WALL RESIDENTIAL BUILDINGS IN PUERTO RICO

By

Lourdes Amelia Mieses Hernández

A thesis submitted in partial fulfillment
of the requirements for the degree of

DOCTOR OF PHILOSOPHY
in
CIVIL ENGINEERING
UNIVERSITY OF PUERTO RICO
MAYAGÜEZ CAMPUS
2007

Approved by:

______________________________	________________________
Ali Saffar, Ph.D. Member, Graduate Committee	Date
______________________________	________________________
José A. Martínez Cruzado, Ph.D. Member, Graduate Committee	Date
______________________________	________________________
Luis E. Suárez, Ph.D. Member, Graduate Committee	Date
______________________________	________________________
Ricardo López, Ph.D. President, Graduate Committee	Date
______________________________	________________________
Ismael Pagán Trinidad, M Sc. Chairperson of the Department	Date
______________________________	________________________
José R. Arroyo, Ph.D. Representative of Graduate Studies	Date

ABSTRACT

Puerto Rico is situated in an earthquake prone region. Most of residential buildings in Puerto Rico are reinforced concrete structures. Because of the imminent risk of being affected by a strong earthquake, it is important to study their damage vulnerability. The lack of local earthquake vulnerability curves for Puerto Rico and the fact that local construction practice differs from that in USA motivates the author to look at the development of reliable fragility curves based on typical buildings properties and selection of ground motions based on local geology characteristics and past worldwide earthquakes scaled to different peak ground acceleration to obtain a wide range of maximum accelerations. This study is directed to low rise and medium rise concrete residential buildings in Puerto Rico. Typical lateral resisting systems, comprising moment frames and structural walls are considered. The analytical models are two-dimensional and are analyzed using the nonlinear dynamic time history method considering flexural nonlinear behavior for frames and both flexural and shear nonlinear behavior for shear walls. Algan's formulation (1982) and HAZUS drift limits were used to calculate the expected damage of the models. Damage to structures is quantified based on the inter-story drift ratio of the structure. The damage states considered were: Minor, Moderate, Substantial and Major, for Algan and Slight, Moderate, Extensive and Complete for HAZUS. With this information, lognormal functions expressed in the form of two parameters (log-median and log-standard deviation) were fitted and fragility curves developed as a function of PGA. It is common for concrete housing to have resisting elements oriented in only one direction. These structures are evaluated for forces in both directions independently and also taking in account both directions simultaneously. Multistory residential buildings in Puerto Rico commonly have shear walls oriented in both directions. A set of four fragility curves, one for each damage state is developed for each scenario studied. A total of 13 sets of fragility curves for each method are proposed. Multistory models proved to be the least vulnerable of the structures analyzed. These curves are useful tools for the insurance companies in Puerto Rico in order to improve their risk assessments.

RESUMEN

Puerto Rico está situado en una zona propensa a movimientos sísmicos importantes. Debido a esta amenaza latente, es de vital importancia conocer la vulnerabilidad sísmica de estructuras construidas en la Isla. Esta investigación esta dirigida específicamente a estructuras residenciales. La mayor parte de edificaciones para uso residencial son construidas principalmente con concreto armado y bloques de hormigón y el sistema para resistir las cargas laterales está conformado por pórticos y muros de corte. Ante la falta de curvas de vulnerabilidad locales, y debido a que las prácticas constructivas varían con respecto a Estados Unidos, se desarrollaron curvas de fragilidades basadas en construcciones típicas y en la selección de terremotos sintéticos que toman en cuenta las características geológicas de la Isla. Además se utilizaron diversos registros de terremotos pasados en distintos lugares, normalizados a distintas aceleraciones máximas, de manera tal que se cuenta con un amplio espectro de situaciones sísmicas. Luego se realizaron análisis no lineal dinámico en dos dimensiones, se consideró el comportamiento no lineal a flexión de los pórticos y el comportamiento no lineal a flexión y a cortante de las paredes y se cuantificó el estado de daño siguiendo la metodología propuesta por Algan (1982) y por HAZUS basado en la deriva de entrepiso como cuantificador del daño. Los límites de daño considerados son: "Menores", "Moderados", "Sustanciales" y "Mayores". A partir de los datos obtenidos se calcularon las probabilidades de exceder los diferentes estados de daño y se ajustaron curvas lognormales definidas por dos parámetros (media y desviación estándar lognormal) en función de la aceleración máxima del terreno. Los sistemas estructurales considerados comprenden pórticos de uno y dos niveles, paredes de uno y dos niveles y multipisos estudiados tanto en la dirección fuerte como en la débil y considerando ambas direcciones. El resultado final consiste en trece grupos de curvas de fragilidad, uno para cada sistema estructural. Cada grupo consta de cuatro curvas, una para cada estado de daño que representa la probabilidad de alcanzar o exceder dicho estado de daño dado una aceleración del suelo. Estas curvas obtenidas constituyen una herramienta útil al momento de realizar análisis de riesgos por parte de las compañías aseguradoras locales.

For the people who love me, care about me, encourage me and trust me…people who are always in my mind and my heart:
Specially to my family, to my best friends Lushiang and Rosivanna, and to my beloved boyfriend Héctor…

ACKNOWLEDGEMENTS

Thanks to God for all blessing received, for allowing me to be here and live the experience of pursing graduates study, for giving me the necessary strength to keep going.

I am sincerely grateful to my advisor Dr. Ricardo López, for his guidance and support during the investigation. I am greatly indebted also to Dr. Ali Saffar for his ideas and special interest in this investigation. I wish to thanks Dr. Luis Suárez and Dr. José Martínez-Cruzado for their suggestions and contribution in the course of this thesis.

I also want to acknowledge Dr. Luis Godoy, Dr. Carlos Prato, Dr. Daniel Wendichansky, Dr. Ricardo Ramos, Dr. Felipe Acosta who provided me valuable knowledge during my course work that contribute indirectly to the realization of this work. Also my gratitude to all personnel from the Civil Engineering and Surveying Department of the University of Puerto Rico for always being very cordial and helpful, for always be concerned about me and the course of my studies.

I also wish to thank Eng. Eduardo Torres for providing his help in the recompilation and creation of prototypes structures and for being my work mate for two years; his work was very useful for this research.

Special thanks to the Insurance Commissioner of Puerto Rico for sponsoring this research and providing financial support and to the Regulations and Permits Administration in Puerto Rico (ARPE), Mayagüez and San Juan office for allowing the use of their facility and provide valuable information for the investigation.

I also owe my gratitude to these persons who have helped me and make me fell like home when I needed most, especially to family Rodríguez Michel in Aguadilla who opened their house to me, and took care of me when I was sick. To my first house mate and actual godmother, for being like a sister to me and made me easier being far from home. To Jeannette, Jamell, Anthony, Marlene and Carlos, who were very supportive at the beginning of my studies.

My profound thanks to all of my friends, whom I was pleased to meet here, for sharing this experience and being a valuable support during these years. To Hebenly and her son Daniel for sharing with me special moments and being like family to me.

Finally, my love and gratitude to my parents Jose Mieses and Lourdes Hernández, to my brothers, relatives and unconditional friends for encourage me, support me and trust me. To my boyfriend Héctor, for his love, his support, for motivates me to accomplish my goal especially for waiting for me during this year from a distance, and pushing me to finish.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

1 INTRODUCTION

1.1 PROBLEM DESCRIPTION

Earthquakes generate a variety of economic impacts (Bookshire *et al*. 1997). Every year several destructive earthquakes hit different regions of the world causing loss of huge amounts of properties and lives. The high economic loss and death toll prompts research to deal with reducing the seismic risk in the earthquake prone regions (Erduran and Yakut 2004).

There are still a lot of structures throughout the world, which are highly vulnerable to seismic action. Identifying structures that have high vulnerability is of critical importance for both reliable loss estimation as a result of expected earthquakes and setting priority criteria for strengthening of structures (Erduran and Yakut 2004). The definition of comprehensive and realistic drift limits that are associated with known damage states remains one of the unresolved issues in Performance Based Earthquake Engineering (Ghobarah 2004).

Since 1989 insurance and reinsurance companies have suffered losses from disasters in the United States that have wreaked havoc with their balance sheets. Figure 1-1 shows the magnitude of the catastrophic losses experienced by the insurance industry in the United States from 1949 to 1997. Prior to hurricane Hugo in 1989 (where insured losses were over $4 billion), the insurance industry had never suffered any loss over $1 billion from a single disaster. Since that time there have been several disasters which exceeded this amount such as the Northridge Earthquake of 1994 resulting in over $12.5 billions in insured losses (Kunreuther 1999).

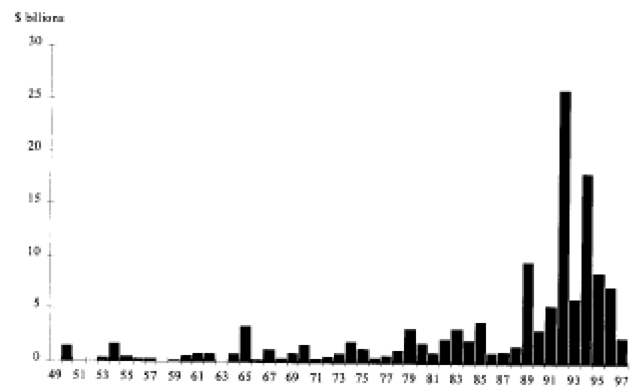


Figure 1-1. Insured catastrophe losses (1949-1997). (Kunreuther 1999)

In the case of Puerto Rico, the island is situated in an earthquake prone region, lying within a seismic active zone that presents a wide variety of seismic fault zones. It is located in the northeastern margin of the Caribbean Plate where it collides with the North American Plate while moving eastward with respect to the North American Plate (Irizarry 1999). It has been 89 years since the last major earthquake hit the island in 1918. The last strong earthquake felt in Puerto Rico occurred in August 4, 1946 to the northeast of the Dominican Republic having a surface magnitude of 7.8 (Irizarry 1999). According to official data, one hundred sixteen people died in the 1918 event, while the economic loss was calculated at four million dollars, two times the annual budget for the whole island at the time.

This research is part of a study financed by the Insurance Commissioner of Puerto Rico on the expected maximum probable loss of buildings subjected to earthquakes, hurricanes and floods.

1.2 MOTIVATION AND SIGNIFICANCE OF THE RESEARCH

Most of the residential buildings in Puerto Rico are reinforced concrete structures with additional masonry walls. Because of the imminent risk of being affected by a strong earthquake, it is important to study the behavior and damage vulnerability of these structures. This is of particular importance to the insurance companies in Puerto Rico in order to improve their risk assessments.

The lack of local earthquake vulnerability curves for Puerto Rico, and the fact that construction practice for residential buildings in Puerto Rico differs from that in the USA, motivated the author to look at the development of reliable fragility curves based on typical buildings properties and selection of ground motions based on local geology characteristics and past worldwide earthquakes.

The most recent attempt to take in account local design practices was carried out by Lopez *et al*. (2001). The study intended to revise the applicability of the HAZUS capacity curves to Puerto Rico. It was limited to comparing capacity curves obtained from the analysis of the models with the capacity curves defined by HAZUS. The authors found a large variability for existing concrete buildings. They also pointed out that the capacity curves obtained are at least equal or more resistant than the Moderate-code design level category in HAZUS. A total of 15 concrete models were analyzed; these models comprised a wide range of story levels and lateral resisting systems. The need of a more vast inventory of building and a deeper investigation of the earthquake performance of concrete building arises.

Previous studies (Lui 1996, Ferrito 1997) show that a nonlinear time history analysis is the best approach to obtain information on the magnitude change of deformations in structures mainly when nonlinear effects are important. Keeping that in mind, although the time and computational effort needed to analyze the amount of models necessary to obtain an specific fragility curve is larger, the nonlinear dynamic time history analyses was selected as the analytical method for the investigation.

1.3 OBJECTIVES

The main objectives of this work are to evaluate the earthquake performance and to develop tools for estimating expected damages for existing concrete residential buildings in Puerto Rico.

The specific objectives established in order to accomplish the principal goal proposed in this work are:

- To identify structural characteristics of typical reinforced concrete residential structures in Puerto Rico.

- To analyze the expected damage of these structures subjected to past earthquake records and local synthetics records scaled to different peak ground accelerations.

- To develop fragility curves for each type of buildings with different number of stories.

1.4 SCOPE

This study is addressed to low rise and medium rise concrete residential buildings in Puerto Rico. Typical lateral resisting systems, comprising moment frames and structural walls are considered. Hilly terrain reinforced concrete houses raised on gravity columns are not considered because they were studied by Vázquez (2002).

The analytical models are two-dimensional and are analyzed using the nonlinear dynamic time history method and the Takeda model to define the nonlinear behavior of the elements.

The earthquake ground motions considered in this study are synthetic earthquakes for San Juan, Mayagüez and Ponce developed by Irizarry (1999) for Puerto Rico and with baseline correction by Montejo (2004) and three worldwide past records: 1994 Northridge Earthquake (Castaic Station), 1940 Imperial Valley Earthquake (El Centro Station), and 1986 San Salvador Earthquake (Camino Real Hotel Station).

The study covers only structural damages. Nonstructural damages were not studied.

1.5 SUMMARY OF THE FOLLOWING CHAPTERS

The research work is organized in ten chapters. Each chapter is summarized as follows:

Chapter 1 presents a general introduction to the thesis. The problem description, the relevance of the research project, the objectives and scope of the thesis are defined in this chapter.

Chapter 2, is on literature review and background information. It describes the basic concepts used through the investigations and summarizes previous works done on seismic vulnerability, damage index and fragility curves.

Chapter 3 contains a brief summary of the methodology used in this thesis to develop analytical fragility curves for reinforced concrete residential buildings.

Chapter 4 describes numerical models used by LARZ and adopted in this investigation for non-linear analysis of the 2-D models defined in Chapters 6 and 7. It introduces the assumptions of the models, dynamic characteristics (equation of motion, mass and damping matrices), also the nonlinear properties (material, moment curvature relations, beam, column and wall elements, frames and walls hysteresis model). Last, the solution of the equations of motion and gravity effects are explained.

The description of the earthquakes ground motions records selected as input for the nonlinear dynamics time history analysis are presented in Chapter 5. The parameters that characterize the ground motion amplitude, frequency content and duration are discussed and summarized in this chapter.

The procedures followed to generate the prototype models of one and two reinforced concrete moment resistant frames residential buildings are explained in detail in Chapter 6. The structural characteristics and description of the models analyzed for generating fragility curves are also presented. The models are subdivided in frames and shear wall models. Likewise, Chapter 7 characterizes the multistory concrete shear wall models.

Subsequent to models generation, Chapter 8 and Chapter 9 deal with the description of the methodology followed to generate the fragilitycurves for the aforementioned models using both Algan (1982) and HAZUS damage limits and therefore accomplish the principal goal of the investigation. In addition, the result of seismic fragility curves obtained for each lateral resisting system are presented in this chapter.

Finally, the conclusions of the results obtained in the investigation and recommendations for future work are presented in Chapter 10.

Additional information is presented in appendices. Appendix A contains a database of drift values of reinforced concrete frame models. Appendix B contains a database of drift values of reinforced concrete shear wall models. Appendix C compiles all the analysis data results obtained from the nonlinear analysis and damage state database.

2 LITERATURE REVIEW AND BACKGROUND INFORMATION

2.1 INTRODUCTION

The damage produced by earthquakes in structures and the economic and social consequences have stimulated many studies on seismic risk of structures (Sandi 1986, Yépez *et al*. 1995).

Predicting vulnerability of a whole structure is not easy to handle due to lack of proper experimental and fiel data (Erduran and Yakut 2004). Several seismic vulnerability studies based on different methods have concluded that the vulnerability functions obtained in different countries are not completely reliable (Yépez *et al*. 1994). Therefore, specific vulnerability functions must be obtained to consider, for example, different construction techniques and different types of workmanship (Barbat *et al*. 1996).

One of the first systematic attempts to quantify building vulnerability to earthquakes came from the Applied Technology Council as a report to the Seismic Safety Commission of the State of California, the ATC-13 (1985). ATC-13 essentially derived damage functions by asking experts to estimate the expected percentage of damage that would result to a typical building of a specific construction type being subjected to a given Mercalli Magnitude Intensity (MMI). Based on their personal knowledge and experience, the experts responded to a formal questionnaire with their best estimates of damage ratios (Kishi *et al*. 2001).

Because it was the first systematic attempt to develop damage functions, ATC-13 quickly became the standard reference for earthquake vulnerability assessment. Catastrophes modelers adopted the ATC-13 damage curves virtually unaltered until the 1994 Northridge earthquake. After that event, an attempt to modify the ACT-13 curves was made using actual claims data from Northridge (Kishi *et al*. 2001).

Park and Ang (1987) developed a procedure for earthquake-resistant design to limit the potential damage of buildings to a tolerable level. The procedure is based on the damage model developed earlier (Park and Ang 1985) in which structural damage is expressed as a function of the maximum deformation and dissipated hysteretic energy. The tolerable degree of damage is defined on the basis of calibration with observed damages from past major earthquakes. The design method is examined in the context of reliability.

McCormack and Rad (1997) presented a survey of the seismic hazards for about 30,000 nonresidential buildings in Portland, Oregon, and developed an earthquake damage and loss estimation model. To conduct the building survey, a Rapid Screening Procedure was used. The purpose of this study was to develop a model to estimate earthquake damage and losses for a large community of buildings. The estimating technique developed and presented in this study is not intended for the determination of the seismic safety nor potential damage and losses for individual buildings.

A second major effort to develop a methodology for vulnerability assessment was undertaken by the National Institute of Building Sciences (NIBS) and funded by FEMA. The result was the program HAZUS, released in 1997 as a risk assessment interactive software (Kishi *et al*. 2001).

Hassan and Sozen (1997) developed a seismic vulnerability function of a building inventory in Turkey, based on the readily accessible data for an existing building: the dimensions and arrangement of its structural elements and the floor area. From the graphs proposed by them it can be infered that for the buildings considered, a floor area of 0.5% or a column area of 0.5% was sufficient to prevent damage, and buldings with a floor area less than 0.25% or column area less than 0.25% are ranked as the most vulnerable of the inventory.

FEMA-154 (2002) presented a rapid visual screening of buildings for potential seismic hazards. The handbook provides a procedure to classify surveyed buildings into two categories: those acceptable as not risk to life safety or those that may be seismically hazardous and should be evaluated in more detail by a professional experienced in seismic design.

Matamoros *et al*. (2004) presented a design method called "Flat Rate" whose basis is the adoption of the maximum story drift ratio defined as the ratio of maximum story displacement to total story height as the main indicator of expected level of damage in a structure. The study shows that by using very simple expressions, the expected performance for a regular low-rise building structure can be improved with an increase in the ratio of lateral stiffness to the mass of a structure.

Erduran and Yakut (2004) conducted a research to develop damage curves for reinforced concrete column members. A broad range of parameters that influence the damageability of reinforced concrete columns were investigated using the finite element program ANSYS v6.1. Damage curves expressed in terms of interstory drift ratio were developed for three levels of ductility from the results of numerical investigations. The levels of ductility were determined based on the axial load level and the transverse reinforcement ratio. These curves are useful for estimating damage level of reinforced concrete frame buildings.

In the Erduran and Yakut study it was found that there are several parameters that affect the deformation capacities of the columns. In the parametric study carried out within the scope of their study, the most significant parameters that affect the deformation capacities of the columns were identified as the axial load level, amount of transverse reinforcement, slenderness of the column, and the yield strength of the longitudinal reinforcement. The first two parameters affect the ultimate ductility of the columns and the other affect the yield drift ratio. Also, it was shown that concrete strength and the amount of longitudinal reinforcement greatly influence the load carrying capacity, but have no significant effect on the deformation characteristics of the reinforced concrete columns.

Hueste and Foltz (2004) worked in estimating seismic damage and repair cost using also the interstory drift to gauge expected damage. They state that relating basic displacement or drift limits to damage is an oversimplification because the level of damage is also influenced by the structural system, the distribution of damage, the failure mode of the elements, the non-structural elements, and the specific characteristics of the earthquake, so it is necessary to set different drift limits for each type of structural system.

Kishi *et al*. (2001) developed a methodology, called Advanced Component Method (ACM). ACM replaces earthquakes intensity in terms of the Modified Mercalli Intensity Scale (MMI) with spectral displacement. The building damage is calculated from the spectral displacement. The estimation of component damage was usually achieved by means of expert opinion because of the complexity of the problem. The ACM methodology first breaks down the building into its components of manageable portions. Those components include columns, beams, partitions, etc. The criteria for selecting each component were that one should be able to obtain an individual function describing damageability of each component. Combining the data obtained from the experimental studies conducted at various universities and research organizations in a probabilistic manner developed these individual damage functions. To combine the damage to all components of a given type, a weighting mechanism was developed based on published engineering studies, such that the importance of each component to total building damage is a function of the story on which that component resides.

2.2 BASIC CONCEPTS

2.2.1 CONCRETE MOMENT FRAME:

These buildings consist of a frame assembly of cast-in-place concrete beams and columns. Floor and roof framing consists of cast-in-place concrete slabs, concrete beams, one-way joists, two-way waffle joists, or flat slabs. Lateral forces are resisted by concrete moment frames that develop their stiffness through monolithic beam-column connections. In older construction, or in regions of low seismicity, the moment frames may consist of the column strips of two-way flat slab systems. Modern frames in regions of high seismicity have joint reinforcing, closely spaced ties, and special detailing to provide ductile performance. This detailing is not present in older construction. Foundations consist of concrete spread footings or deep pile foundations (FEMA-310 1998).

2.2.2 CONCRETE SHEAR WALL BUILDINGS:

These buildings have floor and roof framing that consists of cast-in-place concrete slabs, concrete beams, one-way joists, two-way waffle joists, or flat slabs. Floors are supported on concrete columns or bearing walls. Lateral forces are resisted by cast-in-place concrete shear walls. In older construction, shear walls are lightly reinforced, but often extend throughout the building. In more recent construction, shear walls occur in isolated locations and are more heavily reinforced with boundary elements and closely spaced ties to provide ductile performance. The diaphragms consist of concrete slabs and are stiff relative to the walls. Foundations consist of concrete spread footings or deep pile foundations (FEMA-310 1998).

2.2.3 IMPORTANT DEFINITIONS

damage function: relationship between levels of damage and the corresponding level of shaking (mcguire 2004).

Seismic vulnerability: degree of damage observed in structures as a result of the occurrence of an earthquake of a given level of shaking (barbat *et al*. 1996).

Building capacity curve: a plot of a building's lateral load resistance as a function of a characteristic lateral displacement. it is derived from a plot of static-equivalent base shear versus building displacement at the roof, known commonly as pushover curves and related-capacity curves (kircher *et al*. 1997).

Seismic hazard of the site: the probability of occurrence of an earthquake of a given magnitude within a given period of time (sandi 1985, yépez *et al*. 1995).

Seismic risk: probability that some humans will incur loss or that their built environment will be damaged. theses probabilities usually represent a level of loss or damage that is equaled or exceeded over some time period. seismic risk is calculated with a set of earthquakes, the associated loss or damage, and the associated probability of occurrence or exceedance (mcguire 2004).

2.3 LOCAL DAMAGE INDEX.

Williams and Sexsmith (1995) and Bonette (2003) presented a review of seismic damage indices. Damage indices aim to provide a means of quantifying numerically the damage in concrete structures sustained under earthquake loading. Indices may be defined locally, for an individual element, or globally, for a whole structure. Most local indices are cumulative in nature, reflecting the dependence of damage on both the amplitude and the number of cycles of loading. The main disadvantages of most local damage indices are the need for tuning of coefficients for a particular structural type and the lack of calibration against varying degrees of damage.

In the case of concrete structures, damage indices have been developed to provide a way to quantify numerically the seismic damage sustained by an individual elements, stories or complete structures.

Indices may be based on the results of a non-linear dynamic analysis, on the measured response of a structure during an earthquake, or on a comparison of structure's physical properties before and after an earthquake (Williams and Sexsmith 1995).

2.3.1 NON-CUMULATIVE INDICES

The two earliest and simplest forms of damage index were ductility and interstory drift. The ductility ratio can be defined in terms of curvature (μ_ϕ), rotation (μ_θ) or displacement (μ_δ) using equations (2.1), (2.2) and (2.3), respectively:

$$\mu_\phi = \frac{\phi_m}{\phi_y} \tag{2.1}$$

$$\mu_\theta = \frac{\theta_m}{\theta_y} \tag{2.2}$$

$$\mu_\delta = \frac{\delta_m}{\delta_y} \tag{2.3}$$

where ϕ_m, θ_m, and δ_m are maximum curvature, maximum rotation, and maximum displacement at the end of a member, respectively, and ϕ_y, θ_y and δ_y are yield curvature, yield rotation, and yield displacement, respectively.

Banon *et al*. (1981) presents an improvement on the ductility ratio that takes into account the stiffness and strength degradations that occur under cyclic loading (Figure 2-1). The Flexural Damage Ratio is defined as:

$$FDR = \frac{k_o}{k_m} \tag{2.4}$$

where k_o is initial secant stiffness, k_m is the equivalent secant stiffness of the maximum response experienced, and k_f is the ultimate secant stiffness.

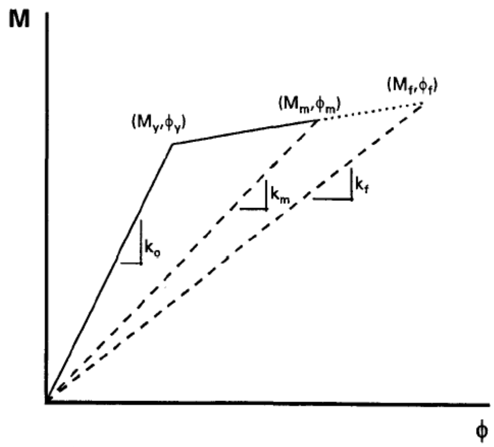


Figure 2-1. Definition of stiffness degradation (Banon et al. 1981).

In comparisons with test data, it was found that neither ductility ratios nor the FDR give a consistent indication of failure.

Another widely used damage indicator is the interstory drift. It has been generally accepted that interstory drift can be used to gauge expected damage. Algan (1982) and HAZUS (2003) uses interstory drift as centerpiece of earthquakes induced damage estimation.

2.3.2 DEFORMATION-BASED CUMULATIVE INDICES

Stephens and Yao (1987), Wang and Shah (1987), Wang and Wang (1992), Chung *et al*. (1987, 1987a) proposed different damage indices to model the accumulation of damage which occurs under cyclic loading, usually performed either by using a low-cycle fatigue formulation, in which damage is taken as the function of the accumulated plastic deformation, or by incorporating a term related to the hysteretic energy absorbed during the loading.

2.3.3 COMBINED INDICES

Williams and Sexsmith (1995), Guzmán (1998) and Valles *et al*. (1996), describe the Park and Ang (1985) damage index which is the best-known and most used of all the cumulative damage index. It consists in a linear combination of normalized deformation and energy absorption:

$$D = \frac{\delta_m}{\delta_u} + \beta_e \frac{\int dE}{F_y \delta_u} \tag{2.5}$$

where D is the damage index, δ_m is the maximum response deformation under an earthquake, dE is the incremental dissipated hysteretic energy, δ_u is the ultimate deformation capacity under monotonic loading, F_y is the yield strength of the longitudinal reinforcement, β_e is a nonnegative constant and is a factor which considers the effect of cyclic loadings on structural damage. It is a function of shear span ratio, normalized axial stress, longitudinal steel ratio and confinement steel ratio.

Park *et al*. (1985) suggested D = 0.4 as a threshold value between repairable and irreparable damage, while the same authors in 1987 suggested the more detailed classification presented in Table 2-1:

Table 2-1Damage threshold (Park *et al*. 1987).

$D < 0.1$	No damage or localized minor cracking
$0.1 \le D < 0.25$	Minor damage – light cracking throughout
$0.25 \le D < 0.4$	Moderate damage – severe cracking, localised spalling
$0.4 \le D < 1.0$	Severe damage – crushing of concrete, reinforcement exposed
$D \ge 1.0$	Collapsed

More recently, Ang *et al*. (1993) suggested using a value of D = 0.8 to represent collapse.

2.4 GLOBAL DAMAGE INDEX.

The global damage state of a structure depends on the distribution and severity of localized damages. The approach most widely used to obtain the global damage state is to take an average of the local indices, weighted by the local energy absorption (Williams and Sexmith 1995). Thus for a single story:

$$D_{story} = \frac{\sum D_i E_i}{\sum E_i} \tag{2.6}$$

where D_i is the local damage index at location i and E_i is the energy absorbed at location i.

Damaged structures usually exhibit reductions in their natural frequencies due to stiffness degradations. Roufaiel and Meyer (1987) came out with a correlation for a simple global damage index:

$$D_{global} = \frac{\delta_m - \delta_y}{\delta_f - \delta_y} = \frac{14.2\delta_y\left(\sqrt{\frac{f_{und}}{f_{dam}}} - 1\right)}{\delta_f - \delta_y} \tag{2.7}$$

where f_{und} and f_{dam} are the fundamental frequencies of the structure, before and after it is damaged, δ_f and δ_y are the ultimate and yielding deformation capacity under monotonic loading. A number of different softening indices: the maximum softening D_{ms}, the plastic softening D_{ps}, the final softening D_{fs}, presented in equation (2.8), can be formulated in terms of the three periods indicated in Figure 2-2.

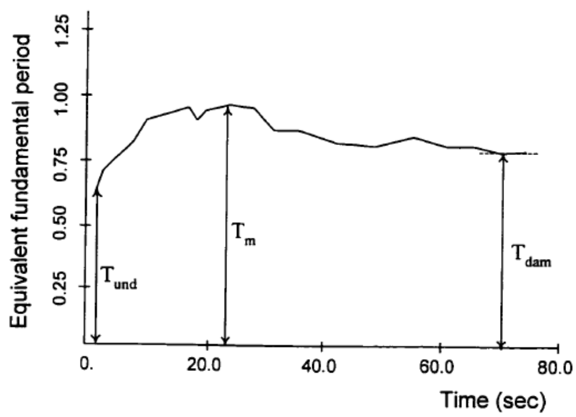


Figure 2-2. Evolution of equivalent fundamental period for Millikan Library (Williams and Sexmith 1995).

$$D_{ms} = 1 - \frac{T_{und}}{T_m};\ D_{ps} = 1 - \frac{T^2_{dam}}{T^2_m};\ D_{fs} = 1 - \frac{T^2_{und}}{T^2_{dam}} \tag{2.8}$$

where T_{und} and T_{dam} are the fundamental period of the structure before and after the earthquake and T_m is the maximum period obtained during the earthquake.

Of these indices, the maximum softening is considered the best indicator of the global damage state (Williams and Sexsmith 1995).

Mork (1992) extended the maximum softening index to include the second mode. He defined two damage parameters:

$$D_1 = 1 - \sqrt{\frac{k_{1,m}}{k_{1,und}}} \tag{2.9}$$

$$D_2 = 1 - \sqrt{\frac{k_{2,m}}{k_{2,und}}} \tag{2.10}$$

where k_1 and k_2 values are the spring constants for a two degree of freedom system having two equal masses and giving the same first and second periods as the actual structure. Thus k_1 and D_1 may be assumed to represent the lower part of the structure and k_2 and D_2 the upper part.

2.5 DRIFT DAMAGE FORMULATION

Conventional force-based design succeeded in accomplishing the life safety performance criterion but failed in damage control, resulting in significant monetary loss and downtime especially during the major earthquakes in the last decade. It is now widely accepted that the most viable parameter in controlling the earthquake induced structural and nonstructural damage is the deformation demand.

Algan (1982) presented a formulation to estimate the damage of a reinforced concrete building using the drift index and percentage of walls in each story. The damage index of each story of a reinforced concrete frame without walls is directly the drift index. In the case of the walls, the damage index is given by the difference of the drift index angle for that story and the joint rotation at the bottom floor level. The structural walls are considered as isolated cantilever beams for the selection of a damage index. The parameters related to damage of structural walls are presented in Figure 2-3.

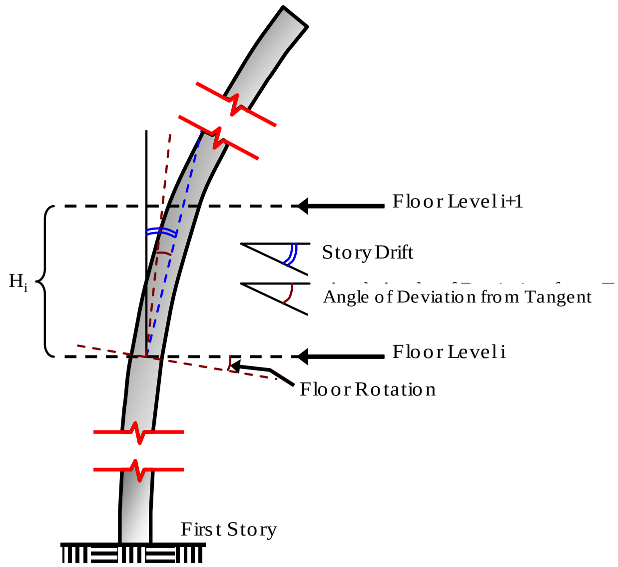


Figure 2-3. Parameters related to damage of structural walls.

In most cases, there is a combination of moment resisting frames and wall elements, so it is necessary to quantify the contribution of each of the systems to the response of the building.

In order to evaluate the flexural and shear contributions to the response, the deformed shape is thought of as linear combination of shear and flexural components. The relation is given by:

$$Z_{0,i} = A(Z_{Si}) + B(Z_{Fi}) \tag{2.11}$$

where:

$Z_{0,i}$ = Normalized deformed shape of the building at level i,

Z_{si}= Mode shape of a shear beam at hi (hi is the position of level i measured from the base),

Z_{Fi} = Mode shape of a flexural beam at $h_{i,}$ and

A, B = constants, where A+B = 1.

The relation that the sum of the constant A and B equals 1 is due to the fact that the shapes are defined with a unit displacement at the top level. The relation implied by Equation (2.11) is referred as “matching” of deformed shape at level i.

The deformed shape of the building can be obtained by loading the building with a triangular load distribution (Saidii and Sozen, 1979). For structures of usual proportions subjected to typical earthquake motions, the distribution of maximum displacement is quite similar to the first-mode shape even in the range of nonlinear response. Therefore, first-mode shape of the building can also be used to identify $Z_{0,i}$ in the abscense of more detailed analysis. (Algan, 1982).

The analytical expressions corresponding to fundamental mode shape for shear and flexure cantilever beams with uniform mass and stiffness in terms of non-dimensional coordinate h/H_t (h refers to position along the beam and H_t is the length of cantilever) are as follows (Clough and Penzien, 1975). For shear:

$$Z_S(h/H_t) = \sin\left(\frac{\pi h}{2H_t}\right) \tag{2.12}$$

and for flexure:

$$Z_F(h/H_t) = 0.3671\left[\sin\left(1.875\frac{\pi h}{H_t}\right) - \sinh\left(1.875\frac{\pi h}{H_t}\right)\right] + \frac{1}{2}\left[\cosh\left(1.875\frac{\pi h}{H_t}\right) - \cos\left(1.875\frac{\pi h}{H_t}\right)\right] \tag{2.13}$$

The normalized mode shapes of a shear and flexure cantilever beam are presented in Figure 2-4 The first behavior is assigned to frame building and the second to buildings with walls.

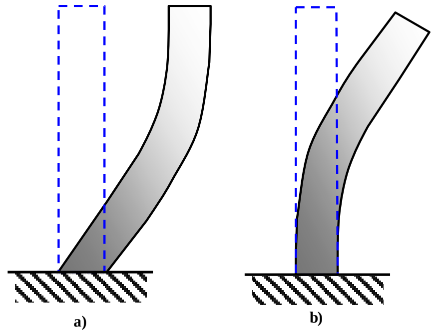


Figure 2-4. Normalized mode shape: a) For frames, b) For walls.

The constants A and B can be determined as follows:

Constant B (flexure contribution to the response) can be expressed in terms of A (shear contribution to the response) as:

$$B = 1 - A \tag{2.14}$$

when deformed shape is matched at the top by the linear combination of shear and flexure components.

For each floor of the building, value of A is defined by:

$$A = \frac{Z_{o,i} - Z_{Fi}}{Z_{Si} - Z_{Fi}} \tag{2.15}$$

The value of A that will be used in the computation of the damage is an average of the constant A defined above. This value is given by:

$$A = \frac{\sum_{N-1}^{1}\left(Z_{o,i} - Z_{Fi}\right)}{\sum_{N-1}^{1}\left(Z_{Si} - Z_{Fi}\right)} \tag{2.16}$$

where N is the number of levels at wich the deformed shape Z_0 is defined.

The damage index for a story DI_i is given by:

$$DI_i = \left[\left[\left(1 - C_i\right) + (A)\left(C_i\right)\right]R_i + \left[\left(1 - A\right)\left(C_i\right)\right]T_i\right](100); \quad (2.17)$$

$$R_i = \frac{Z_{i+1} - Z_i}{h_i}; \quad (2.18)$$

$$T_i = R_i - \frac{Z_{i+1} - Z_{i-1}}{h_i + h_{i-1}} \quad (2.19)$$

where:

R_i is the story drift index,

T_i is the wall damage index,

C_i is the ratio of the tributary floor area of the walls to the total floor area,

A is the coefficient determining shear component of displacement response,

Z_i is the displacement at level i,

Z_{i+1} is the displacement at level i+1,

Z_{i-1} is the displacement at level i-1,

h_i is the height of story i, and

h_{i-1} is the height of story i-1.

After the damage index is calculated, the damage state that goes from 0 to 1 is determined. The scale of damage that estimates the damage condition of the building is given in Table 2-2:

Table 2-2. Damage State (Algan 1982)

0.05	None (no repair)
0.35	Minor (Minor or no repair)
0.55	Moderate (some repair)
0.75	Substantial (a lot of repair)
1	Major (demolition and rebuilding)

The damage state ($U_{B,i}$) for structural reinforced concrete members is a simple linear form given by equation (2.20):

$$U_{B,i} = \frac{2}{3}\left(DI_i\right) - \frac{1}{3} \tag{2.20}$$

2.6 FEMA/NIBS EARTHQUAKE LOSS ESTIMATION

The FEMA/NIBS earthquake loss estimation methodology is intended primarily for use by state, regional and community governments. It evaluates a wide range of losses resulting from scenario earthquakes to provide a basis for decisions concerning preparedness and disaster response planning and to stimulate and assist planning for mitigation to reduce potential future losses (Whitman *et al*. 1997).

Kircher *et al*. (1997) and HAZUS-MH MR1 (2003) describe building damage functions that were developed for the FEMA/NIBS earthquake loss estimation. Building response is determined by the intersection of the demand spectrum and the building capacity curves.

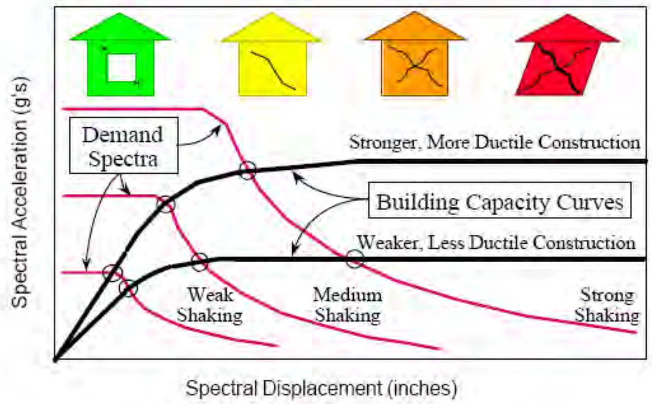


Figure 2-5. Example Intersection of Demand Spectra and Building Capacity Curves (HAZUS-MH MR1 2003).

Values of damage-state drift ratios included in the FEMA/NIBS methodology are based, in part, on available damage data from a number of published sources, including Kustu *et al*. (1982), Ferritto (1982, 1983), Czarnechki (1973), Hasselman *et al*. (1980), Whitman *et al*. (1977) and Wong (1975).

HAZUS assumes that building damage varies from "None" to "Complete" as a continuous function of building deformation. The definition of HAZUS limit states is described below:

For Reinforced Concrete Moment Resisting Frames:

Slight Structural Damage: Flexural or shear type hairline cracks in some beams and columns near joints or within joints.

Moderate Structural Damage: Most beams and columns exhibit hairline cracks. In ductile frames some of the frame elements have reached yield capacity indicated by larger flexural cracks and some concrete spalling. Nonductile frames may exhibit larger shear cracks and spalling.

Extensive Structural Damage: Some of the frame elements have reached their ultimate capacity indicated in ductile frames by large flexural cracks, spalled concrete and buckled main reinforcement; nonductile frame elements may have suffered shear failures or bond failures at reinforcement splices, or broken ties or buckled main reinforcement in columns which may result in partial collapse.

Complete Structural Damage: Structure is collapsed or in imminent danger of collapse due to brittle failure of nonductile frame elements or loss of frames stability.

For Concrete Shear Wall:

Slight Structural Damage: Diagonal hairline cracks on most concrete shear wall surfaces; Minor concrete spalling at few locations.

Moderate Structural Damage: Most shear wall surfaces exhibit diagonal cracks; some shear walls have exceeded yield capacity indicated by larger diagonal cracks and concrete spalling at wall ends.

Extensive Structural Damage: Most concrete shear walls have exceeded their yield capacities; some walls have exceeded their ultimate capacities indicated by large, through-the-wall diagonal cracks, extensive spalling around the cracks and visible buckled wall reinforcement or rotation of narrow walls with inadequate foundations. Partial collapse may occur due to failure of nonductile columns not designed to resist lateral loads.

Complete Structural Damage: Structure has collapsed or is in imminent danger of collapse due to failure of most of the shear walls and failure of some critical beams or columns.

Table 2-3 describes the buildings types used by HAZUS and Table 2-4 presents the interstory drift ratio limits for each damage state proposed by HAZUS-MH MR1 (2003).

2.7 FRAGILITY CURVES

Fragility curves are lognormal functions that describe the probability of reaching, or exceeding, structural and nonstructural damage states, given deterministic (median) estimate of spectral response, for example spectral displacement, or peak ground acceleration. These curves take into account the variability and uncertainty associated with capacity curve properties, damage states and ground shaking (Kircher *et al*. 1997).

Figure 2-6 provides an example of fragility curves for the four damage states used in the FEMA/NIBS methodology and illustrates the differences in damage-state probabilities for three levels of spectral response corresponding to weak, medium, and strong earthquake ground shaking, respectively. The terms "weak", "medium" and "strong" are used here for simplicity; in the actual methodology, only quantitative values of spectral response are used. The curves distribute damage among Slight, Moderate, Extensive and Complete damage states. For any given value of spectral response, discrete damage-state probabilities are calculated as the difference of the cumulative probabilities of reaching, or exceeding, successive damage states. The probabilities of a building reaching or exceeding the various damage levels at a given response level add up to 100%. Discrete damage-state probabilities are used as inputs to the calculation of various types of building-related loss.

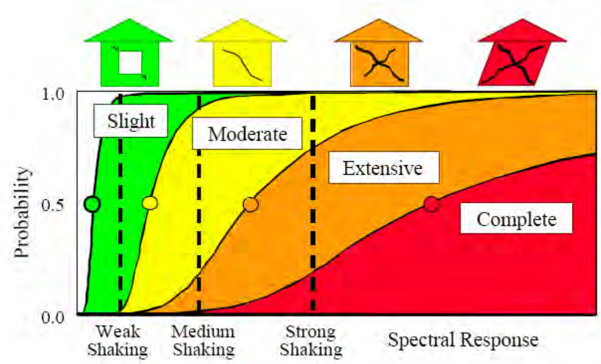


Figure 2-6. Example of Fragility Curves for Slight, Moderate, Extensive and Complete Damage (HAZUS-MH MR1 2003)

The conditional probability of being in, or exceeding, a particular damage state, ds, given the peak ground acceleration, PGA, (or other seismic demand parameter) is defined by equation (2.21).

$$P\left[{}^{ds}\!\diagup_{PGA}\right]=\Phi\left[\frac{\ln\left(PGA\right)-\mu_{\ln}}{\sigma_{\ln}}\right] \tag{2.21}$$

where:

μ_{ln} is the median value of the natural logarithm of the peak ground acceleration at which the building reach the threshold of damage state, ds,

σ_{ln} is the standard deviation of the natural logarithm of the spectral displacement for damage state, ds, and

Φ is the standard normal cumulative function.

Fragility curves have been greatly used to perform seismic risk analysis. Sighal and Kiremidjian (1996) present a systematic approach for developing fragilitycurves for reinforced concrete frames using Montecarlo simulation, later Singhal and Kiremidjian (1998) proposed a Bayesian statical analysis method for combining damage data with analytical earthquake ground motion to enable periodic modification of fragility curves as damage data become available.

Fragility curves can be either empirical or analytical. Shinozuka *et al* (2003) presented both methods. The maximum likelihood method was used for generating the empirical fragility curve from the observation of bridge damage in the 1995 Northridge and 1996 Kobe earthquakes. Analytical fragility curves were constructed for typical bridges in Memphis, Tennessee, utilizing nonlinear dynamic analysis. Shinozuka *et al*. (2000) compared the fragility curves of a bridge by using two analytical approaches: one utilizes the time-history analysis and the other uses the capacity spectrum method. Their result shows a very good agreement for minor damages, but not as good for major damages where nonlinear effects are important.

Later Karim and Yamazaki (2003) developed a simplified method to construct fragility curves for highway bridges of Japan. They proposed a formulation to find fragility curve parameters based on the height of the pier and the over-strength ratio of the structure. The same year Rossetto and Elnashai (2003) proposed new empirical fragility curves for reinforced concrete building based on a data of 99 post-earthquake damage distributions observed in 19 earthquakes for European-type reinforced concrete structures. Ellingwood *et al.* (2004) developed a fragility analysis methodology for assessing the response of light-frame wood construction.

Fragility curves have been also used as a tool for assessment of retrofitting option. Kim and Shinozuka (2004) developed fragilitycurves for two bridges retrofitted by column jacketing. Fragility curves were constructed as a function of PGA utilizing nonlinear dynamic analysis to investigate the effect of column retrofit.

Table 2-3. HAZUS Building Types (HAZUS-MH MR1 2003).

No.	Label	Description	Height			
			Range		Typical	
			Name	Stories	Stories	Feet
1	W1	Wood, Light Frame (≤ 5,000 sq. ft.)		All	1	14
2	W2	Wood, Greater than 5,000 sq. ft.		All	2	24
3	S1L	Steel Moment Frame	Low-Rise	1-3	2	24
4	S1M		Mid-Rise	4-7	5	60
5	S1H		High-Rise	8+	13	156
6	S2L	Steel Braced Frame	Low-Rise	1-3	2	24
7	S2M		Mid-Rise	4-7	5	60
8	S2H		High-Rise	8+	13	156
9	S3	Steel Light Frame		All	1	15
10	S4L	Steel Frame with Cast-in-Place Concrete Shear Walls	Low-Rise	1-3	2	24
11	S4M		Mid-Rise	4-7	5	60
12	S4H		High-Rise	8+	13	156
13	S5L	Steel Frame with Unreinforced Masonry Infill Walls	Low-Rise	1-3	2	24
14	S5M		Mid-Rise	4-7	5	60
15	S5H		High-Rise	8+	13	156
16	C1L	Concrete Moment Frame	Low-Rise	1-3	2	20
17	C1M		Mid-Rise	4-7	5	50
18	C1H		High-Rise	8+	12	120
19	C2L	Concrete Shear Walls	Low-Rise	1-3	2	20
20	C2M		Mid-Rise	4-7	5	50
21	C2H		High-Rise	8+	12	120
22	C3L	Concrete Frame with Unreinforced Masonry Infill Walls	Low-Rise	1-3	2	20
23	C3M		Mid-Rise	4-7	5	50
24	C3H		High-Rise	8+	12	120
25	PC1	Precast Concrete Tilt-Up Walls		All	1	15
26	PC2L	Precast Concrete Frames with Concrete Shear Walls	Low-Rise	1-3	2	20
27	PC2M		Mid-Rise	4-7	5	50
28	PC2H		High-Rise	8+	12	120
29	RM1L	Reinforced Masonry Bearing Walls with Wood or Metal Deck Diaphragms	Low-Rise	1-3	2	20
30	RM1M		Mid-Rise	4+	5	50
31	RM2L	Reinforced Masonry Bearing Walls with Precast Concrete Diaphragms	Low-Rise	1-3	2	20
32	RM2M		Mid-Rise	4-7	5	50
33	RM2H		High-Rise	8+	12	120
34	URML	Unreinforced Masonry Bearing Walls	Low-Rise	1-2	1	15
35	URM M		Mid-Rise	3+	3	39
36	MH	Mobile Homes		All	1	12

Table 2-4. HAZUS Average Inter-Story Drift Ratio of Structural Damage States (HAZUS-MH MR1 2003).

Model Building Type		Structural Damage States			
		Slight	Moderate	Extensive	Complete
Low-Rise Buildings – High-Code Design Level					
W1, W2		0.004	0.012	0.040	0.100
S1		0.006	0.012	0.030	0.080
C1, S2		0.005	0.010	0.030	0.080
C2		0.004	0.010	0.030	0.080
S3, S4, PC1, PC2, RM1, RM2		0.004	0.008	0.024	0.070
Low-Rise Buildings – Moderate-Code Design Level					
W1, W2		0.004	0.010	0.031	0.075
S1		0.006	0.010	0.024	0.060
C1, S2		0.005	0.009	0.023	0.060
C2		0.004	0.008	0.023	0.060
S3, S4, PC1, PC2, RM1, RM2		0.004	0.007	0.019	0.053
Low-Rise (LR) Buildings – Low-Code Design Level					
W1, W2		0.004	0.010	0.031	0.075
S1		0.006	0.010	0.020	0.050
C1, S2		0.005	0.008	0.020	0.050
C2		0.004	0.008	0.020	0.050
S3, S4, PC1, PC2, RM1, RM2		0.004	0.006	0.016	0.044
S5, C3, URM		0.003	0.006	0.015	0.035
Low-Rise (LR) Buildings – Pre-Code Design Level					
W1, W2		0.003	0.008	0.025	0.060
S1		0.005	0.008	0.016	0.040
C1, S2		0.004	0.006	0.016	0.040
C2		0.003	0.006	0.016	0.040
S3, S4, PC1, PC2, RM1, RM2		0.003	0.005	0.013	0.035
S5, C3, URM		0.002	0.005	0.012	0.028
Mid-Rise Buildings[1]					
All	Mid-Rise Building Types	2/3 * LR	2/3 * LR	2/3 * LR	2/3 * LR
High-Rise Buildings[1]					
All	High-Rise Building Types	1/2 * LR	1/2 * LR	1/2 * LR	1/2 * LR

1. Mid-rise and high-rise buildings have damage-state drift values based on low-rise (LR) drift criteria reduced by factors of 2/3 and 1/2, respectively, to account for higher-mode effects and differences between average inter-story drift and individual inter-story drift.

3 METHODOLOGY

3.1 INTRODUCTION

This chapter summarizes the methodology adopted in this investigation to develop analytical fragility curves for reinforced concrete residential building in Puerto Rico. The procedures followed are briefly described, a more detailed explanation is found in each of the following chapters. The main tasks can be listed as:

- Compilation of structural information of a sample of existing residences.
- Definition of prototype structures.
- Selection of the earthquake ground motion records.
- Normalization of the selected records to different peak ground acceleration (PGA).
- Definition of the nonlinear properties of the models, selection of the hysteretic model used and perform nonlinear dynamic analysis.
- Calculation of the expected damage of the models based on the inter-story drift ratio.
- Development of fragility curves.

3.2 DEFINITION OF MODELS

Structural drawings of Puerto Rico residences were collected from the Regulations and Permits Administration in Puerto Rico, Mayagüez and San Juan offices, and also from engineering offices. The structural drawings collected were analyzed and the typical structural parameters such as: concrete strength, yield strength of reinforcing bars, floor area, columns and beams dimensions, percentage of columns or walls to floor area, slab thickness, story height, span length and reinforcement ratio were identified. With this data typical models were defined (a more detailed explanation of the models definition is found in Chapters 6 and 7). Figure 3-1 presents an example of a model created.

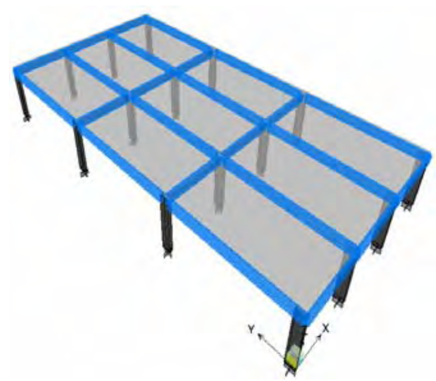
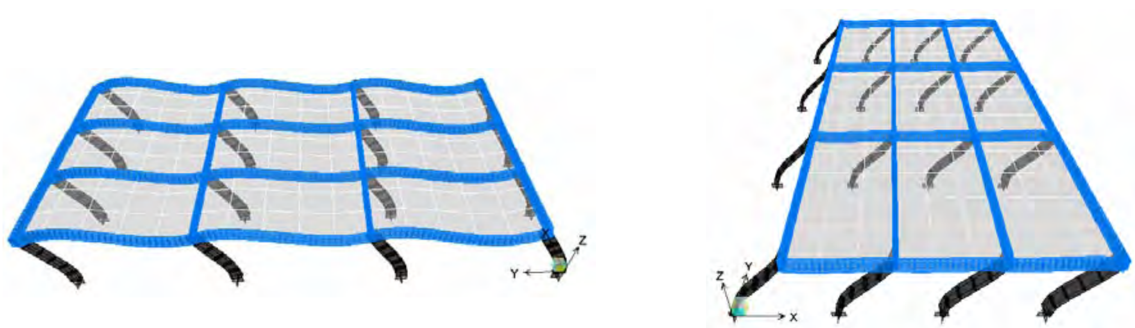


Figure 3-1. Example of a frame model

The models were divided according to their lateral force resisting system in two categories: Moment Resistant Frames, and Shear Wall. Each category was subdivided based on the typical number of stories. Moment Frames comprise one and two-story models and Shear Wall includes one-story, two-story and multistory models. The one and two-story models were also divided by the direction of shaking. Figure 3-2 illustrates the meaning of the direction of shaking. The strong direction refers to the direction in which the moment of inertia of the columns is larger



a) **b)**

Figure 3-2. Direction of Shaking: a) Model excited in the strong direction, and b) Model excited in the weak direction.

3.3 ANALYSIS OF MODELS

Earthquake ground motions considered in this study were synthetic earthquakes developed by Irizarry (1999) with baseline correction by Montejo (2004) for Puerto Rico, for San Juan, Ponce and Mayagüez area, and recorded ground motions measured during Northridge Earthquake (1994 Castaic Station), Imperial Valley Earthquake (1940 El Centro Station), and San Salvador Earthquake (1986 Camino Real Station). Each record was normalized to different peak ground acceleration values (PGA). Chapter 5 describes with more details these records use as input ground motion for the dynamic analysis of the models.

A nonlinear time history analysis was used for this investigation because several studies indicate that this is the best approach to obtain information on the magnitude change of deformations in structures (Lui 1996, Ferritto 1997).

Before performing the nonlinear dynamic analysis of the models, the nonlinear properties such as moment-curvature relationships were defined. The takeda nonlinear model was selected as the hysteretic model because a past study indicates that this model is accurate in predicting the inelastic behavior or RC members under flexure. (Banon et al 1981).

Once the structural parameters of the models were selected and the prototypes models created, they were analyzed using the program LARZ (Saiidi and Sozen 1979). The numerical models used by the program are explained in Chapter 4.

3.4 CALCULATION OF DAMAGE STATES

Algan's formulation (1982) to estimate the damage of a reinforced concrete building was used to calculate the expected damage of the models. With his formulation the damage of the structures is quantified by a damage index (DI) based on the inter-story drift ratio of the structure. The damage states considered were: Minor, Moderate, Substantial and Major damage states. Damage states were also calculated using HAZUS drift limits to defines Slight, Moderate, Extensive and Complete damage states.

3.5 DEVELOPMENT OF FRAGILITY CURVES

After creating a database of damage state versus peak ground acceleration for each model, the next step followed was to calculate cumulative distribution functions by dividing the number of data points that are in or exceed a particular damage state by the number of data points of the whole sample as proposed by (Shinozuka *et al*. 2003). This step is presented in equation (3.1). With this information lognormal functions with two parameters (log-median and log-standard deviation) were fitted and fragility curves developed.

$$f_i = \frac{m_i}{N} \tag{3.1}$$

where:

f_i = cumulative distribution function data points,

m_i = number of data points that are in or exceed a particular damage state, and

N = number of data points of the whole sample.

The methodology was used for each of the structural types to obtain a set of thirteen fragility curves for each damage state: One and Two-Story reinforced concrete frame and shear wall models were studied considering the whole sample, shaking applied in the weak direction and in the strong direction of the columns or walls, and multistory reinforced concrete walls were considered only in the strong direction because these models have plenty of walls in both directions. Figure 3-3 shows an example of one set of fragility curves for each damage state.

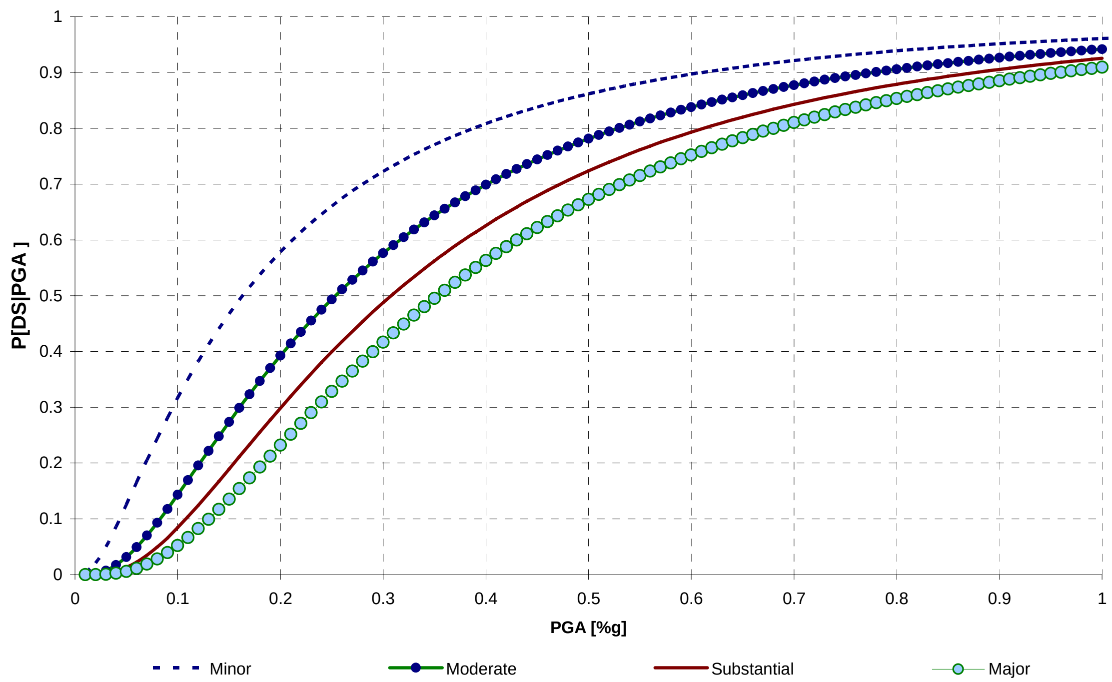


Figure 3-3. Example of Fragility Curves for Minor, Moderate, Substantial and Major Damage State

4 NUMERICAL MODEL

4.1 INTRODUCTION

This chapter explains numerical models used by the computer program LARZ and adopted in this investigation to analyze the buildings. The frames were represented by beam and column element models developed by Saiidi and Sozen (1979), and the walls were modeled by wall elements developed by López (1988). The assumptions made are also explained.

4.2 ASSUMPTIONS

The model has one translational DOF at each floor and one rotational DOF at each joint. The structures represented in LARZ are planar reinforced concrete structures with the supports fixed, subjected to a base motion acceleration or displacement in one direction or to a lateral story-force distribution. The model is characterized by the geometry, the moment-curvature relationships of each element, and the nonlinear shear properties of wall elements.

Nonlinear behavior of beams is only due to flexure and it is defined by Takeda's rules; the nonlinear behavior of shear wall is defined by both flexure and shear. Shear contribution is defined by Hoedajanto (1983)

4.3 EQUATION OF MOTION

The Dynamic Time History Analysis is a step-by-step analysis. The equation of motion for a multi degree of freedom system can be express by Nwton's law as:

$$[M]\{\Delta\ddot{x}\}+[C]\{\Delta\dot{x}\}+[K]\{\Delta x\}=-[M]\{\Delta\ddot{x}_g\} \tag{4.1}$$

where:

$[M]$ = diagonal mass matrix,

$[C]$ = Rayleigh damping matrix,

$[K]$ = stiffness matrix,

$\{\Delta\ddot{x}\}$ = vector of incremental relative acceleration,

$\{\Delta\dot{x}\}$ = vector of incremental relative velocity,

$\{\Delta x\}$ = vector of incremental relative displacement, and

$\{\Delta\ddot{x}_g\}$ = vector of incremental ground acceleration.

4.3.1 MASS MATRIX

The mass matrix is constructed by lumping the floor masses in the corresponding level resulting in a diagonal mass matrix as shown in Figure 4-1.

$$\begin{bmatrix} M_1 & 0 & 0 & 0 & 0 & 0 \\ 0 & M_2 & 0 & 0 & 0 & 0 \\ 0 & 0 & M_3 & 0 & 0 & 0 \\ 0 & 0 & 0 & .... & 0 & 0 \\ 0 & 0 & 0 & 0 & M_{n-1} & 0 \\ 0 & 0 & 0 & 0 & 0 & M_n \end{bmatrix}$$

Figure 4-1. Mass Matrix

M_1, M_2, … to M_n correspond to the story mass lumped at level 1, 2…, n.

4.3.2 DAMPING MATRIX

The Rayleigh damping is used to compute the damping matrix by assuming that it is proportional to a linear combination of the mass and the stiffness matrices:

$$[C] = c_1 [M] + c_2 [K] \tag{4.2}$$

The variables c_1 and c_2 are obtained by selecting the values of the damping ratios and natural frequencies for the first two modes of vibration. The equation that defines these variables are:

$$c_1 = 2\omega_1\omega_2 \frac{\xi_2\omega_1 - \xi_1\omega_2}{\omega_1^{\,2} - \omega_2^{\,2}} \tag{4.3}$$

$$c_2 = 2\frac{\xi_1\omega_1 - \xi_2\omega_2}{\omega_1^{\,2} - \omega_2^{\,2}} \tag{4.4}$$

Values of damping ratio of 2% were used in this thesis as recommended by López (1988).

4.3.3 STIFFNESS MATRIX

The stiffness matrix is updated every time the element stiffness changes. Each time the matrix changes, the following procedures are done:

- Develop element stiffness matrices for rotational and translational degrees of freedom.

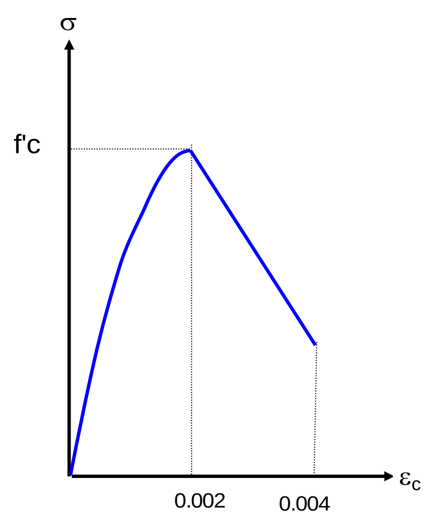
- Assemble stiffness matrix for the entire structure for rotational degrees of freedom at all joints and a single translational degree of freedom at each floor level.

- Uses static condensation to develop a structural stiffness matrix expressed in terms of one translational degree of freedom per floor.

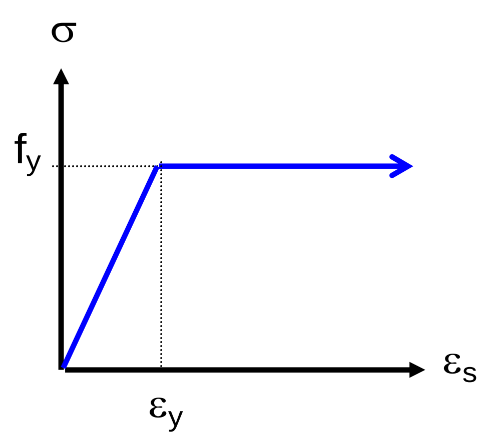
The formulation of the stiffness matrix for beams, columns and walls will be discussed afterwards.

4.4 MOMENT-CURVATURE RELATION

Moment-curvature analysis determines the load-deformation behavior of a concrete section. For computing the moment-curvature of each section it is assumed that concrete stress-strain relationship follows the Kent and Park (1971) curve for an unconfined section and the strain distribution varies linearly with the depth of the section. The steel behavior is assumed to be elasto-plastic. Figure 4-2 present the idealized stress strain curves for concrete and steel.



a)



b)

Figure 4-2. Assumed Stress Strain Curves: a) Kent and Park Model for Unconfined Concrete Sections, b) Steel Elastoplastic Model

The moment-curvature curves were obtained by considering equilibrium of the normal stresses on the cross section for increasing values of the extreme-fiber concrete strain using nonlinear material stress-strain relationships. Figure 4-3 shows the variation of strain and stress through the depth of the section.

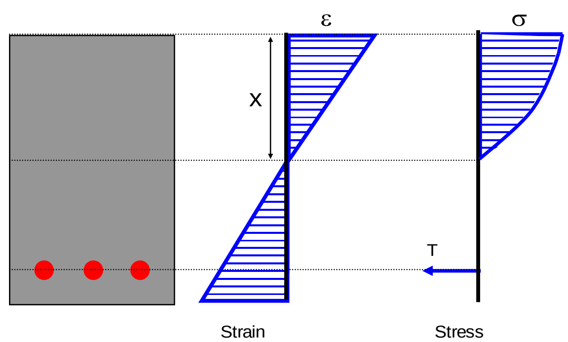


Figure 4-3. Strain and Stress Distribution through the with depth of sections.

Finally the moment-curvature curve was approximate to a tri-lineal curve with break points representing cracking, yielding and ultimate values of moments and curvatures (Figure 4-10).

4.5 BEAM AND COLUMN ELEMENTS

The one-component model (Giberson, 1967) is used to represent the behavior of beams and columns.

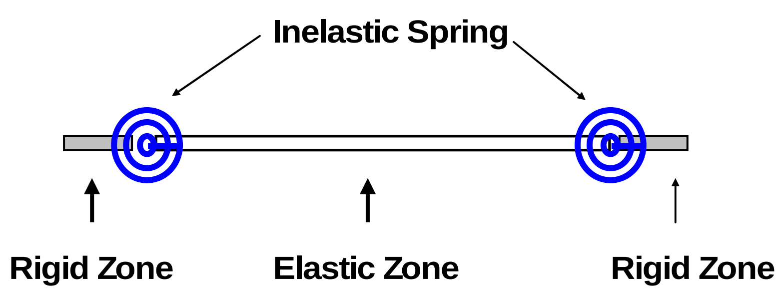


Figure 4-4. One- component model

As shown in Figure 4-4, this element is composed of three parts, two rigid zones at the end of the element, one part that always remains elastic, and two rotational springs where the inelastic behavior takes place.

The properties of the elastic part need to be calculated only once from the initial moment of inertia of the elements. The length of the elastic part is equal to the unsupported length of beam or columns. Rigid portions remain rigid. The only variation in the stiffness of the element has to come from changes in the spring stiffness. In fact the springs control the nonlinear behavior of the element.

4.5.1 BEAM ELEMENT

The one-component element has two degrees of freedom at each end, as shown in Figure 4-5. Because no vertical translations are allowed, the unknown DOF are reduced to two, one rotation at each end.

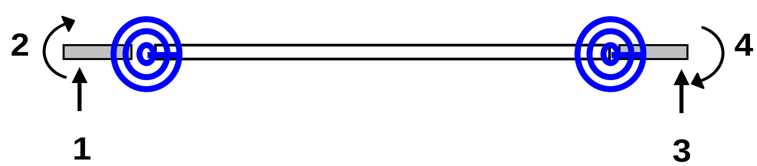


Figure 4-5. Degrees of Freedom

Figure 4-6 shows the deflected shape of the element for end moments M_A and M_B

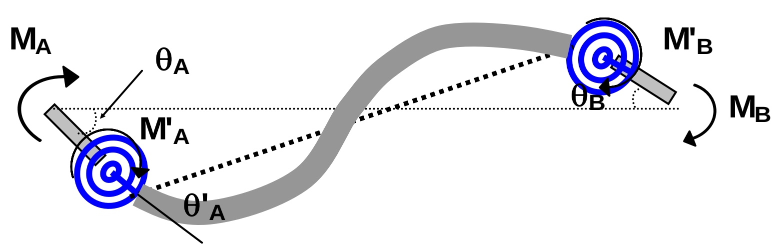


Figure 4-6. Deflected Shape of Beam Element

The realationship between the end moments and the rotations for a beam element without the rigid portions are:

$$\begin{Bmatrix} M'_A \\ M'_B \end{Bmatrix} = \frac{1}{D}\begin{bmatrix} k_{11} & k_{12} \\ k_{21} & k_{22} \end{bmatrix}\begin{Bmatrix} \theta'_A \\ \theta'_B \end{Bmatrix} = [k']\begin{Bmatrix} \theta'_A \\ \theta'_B \end{Bmatrix} \tag{4.5}$$

where:

$$D = \frac{L^2}{12E^2I^2} + \frac{L}{3EI}(f_A + f_B) + f_A f_B + \frac{1}{AGL}\left(\frac{L}{EI} + f_A f_B\right),$$

$$k_{11} = \frac{L}{3EI} + f_B + \frac{1}{AGL},$$

$$k_{12} = k_{21} = \frac{L}{6EI} - \frac{1}{AGL}, \text{ and}$$

$$k_{22} = \frac{L}{3EI} + f_A + \frac{1}{AGL},$$

where:

L- unsupported length of the member,

E- modulus of elasticity of concrete,

I- moment of inertia,

A- area assumed effective in shear, and

G- shear modulus of elasticity.

f_A and f_B- spring flexibilities at left and right end.

The matrix [k'] described considers shear deformation, but does not consider stiffness reduction attributable to shear.

The effect of the rigid portions of the element can be incorporated in the stiffness matrix by considering the equilibrium of each end of the beam. Figure 4-7 shows a free body diagram of the beam element.

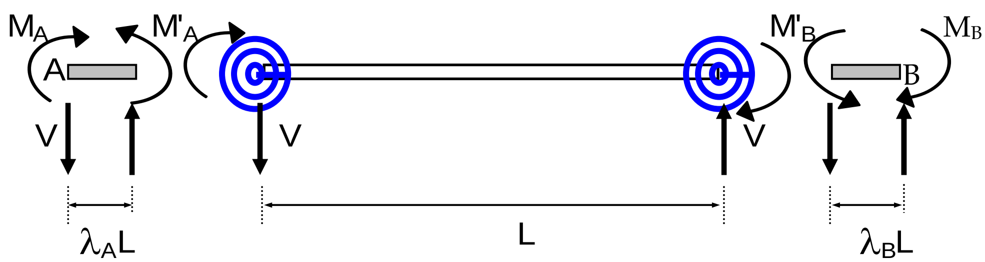


Figure 4-7. Free Body Diagram of Beam Element

Considering the equilibrium of the elastic portions of the element,

$$V = \frac{M'_A + M'_B}{L} \tag{4.6}$$

where V is the shear force in the element.

Considering equilibrium of the elastic and rigid parts, and using Equation (4.6), the following equations are obtained:

$$M_A = M'_A (1 + \lambda_A) + M'_B \lambda_A \tag{4.7}$$

$$M_B = M'_A \lambda_B + M'_B (1 + \lambda_B) \tag{4.8}$$

writing these equations in matrix from:

$$\begin{Bmatrix} M_A \\ M_B \end{Bmatrix} = \begin{bmatrix} 1+\lambda_A & \lambda_A \\ \lambda_B & 1+\lambda_B \end{bmatrix} \begin{Bmatrix} M'_A \\ M'_B \end{Bmatrix} = [T] \begin{Bmatrix} M'_A \\ M'_B \end{Bmatrix} \tag{4.9}$$

where:

λ_A and λ_B = the ratio of length of rigid portions to unsupported length. The rigid portions were not considered in this investigation. Values of $\lambda_A = \lambda_B = 0$ were used.

M_A and M_B= moment at ends of members.

The beam matrix can be formulated now as:

$$[k] = [T][k][T]^T \tag{4.10}$$

where $[k]$ is the stiffness matrix for equation

$$\begin{Bmatrix} M_A \\ M_B \end{Bmatrix} = [k] \begin{Bmatrix} \theta_A \\ \theta_B \end{Bmatrix} \tag{4.11}$$

4.5.2 COLUMN ELEMENT

A way to get the stiffness matrix for columns is to incorporate horizontal translation into the stiffness matrix already derived for the beam element.

First, beam rotations are expressed in terms of column rotations and translations, as shown in Figure 4-8:

$$\begin{Bmatrix} \theta_A \\ \theta_B \end{Bmatrix} = \begin{bmatrix} -\frac{1}{L_T} & 1 & \frac{1}{L_T} & 0 \\ -\frac{1}{L_T} & 0 & \frac{1}{L_T} & 1 \end{bmatrix} \begin{Bmatrix} \delta_A \\ \varphi_A \\ \delta_B \\ \varphi_B \end{Bmatrix} = [B] \begin{Bmatrix} \delta_A \\ \varphi_A \\ \delta_B \\ \varphi_B \end{Bmatrix} \tag{4.12}$$

where:

$L_T = L(1+\lambda_A+\lambda_B)$, - total length of member,

ϕ_A, ϕ_B, - angles between rigid ends A and B and vertical line,

δ_A, δ_B, - lateral displacement at ends A and B, and

θ_A, θ_B, - angles between rigid end A and B and member axis.

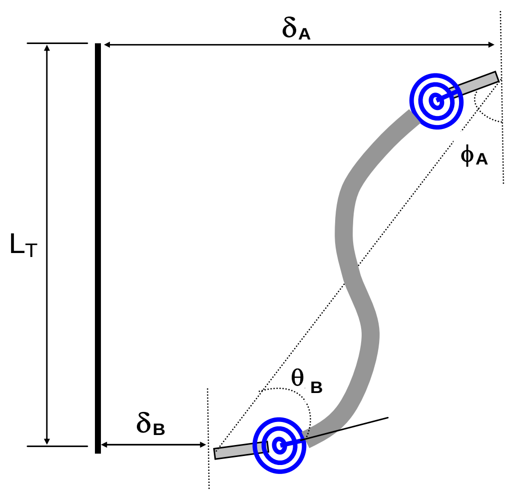


Figure 4-8. Deflected Shape of Column Element

The column stiffness matrix can be obtained using the transformation matrix [B] from:

$$[k_c] = [B]^T [k][B] \tag{4.13}$$

where $[k_c]$ satisfies the equation:

$$\begin{Bmatrix} V_A \\ M_A \\ V_B \\ M_B \end{Bmatrix} = \left[k_c\right] \begin{Bmatrix} \delta_A \\ \varphi_A \\ \delta_B \\ \varphi_B \end{Bmatrix} \tag{4.14}$$

4.6 MOMENT-ROTATION AT A ROTATIONAL SPRING

The key to nonlinear behavior of the one component model is the moment-rotation relation of the spring. First, a primary curve of moment-rotation is calculated. Then, moment-rotation under moment reversal is assumed to follow Takeda's hysteresis rules. The rotation at spring is composed of three values: rotation related to curvature distribution along the element, rotation related to slip of reinforcement, and rotation related to a curvature distribution based on the initial modulus, along the element.

$$R_0 = R_c + R_s - R_e \tag{4.15}$$

where:

R_0 – rotation at spring,

R_c – rotation related to curvature distribution along the element,

R_s – rotation related to slip of reinforcement, and

R_e – rotation related to a curvature distribution, based on the initial modulus, along the element.

Figure 4-9 presents the deflected shape, moments and curvatures distribution for a beam element subjected to a end moment greater than the cracking moment:

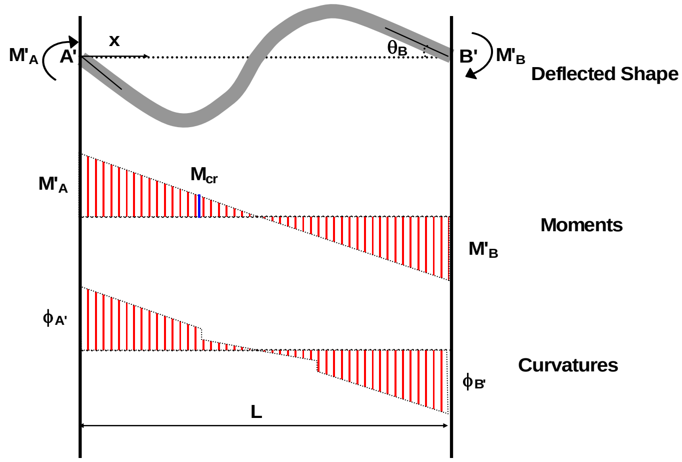


Figure 4-9. End Rotation for Cracked Beam

4.6.1 ROTATION RELATED TO CURVATURE DISTRIBUTION ALONG ELEMENT

The rotation at A′ depends on $M_{A'}$ and $M_{B'}$. However, because it is desired to express rotation at A′ in terms of $M_{A'}$ only, it was assumed that $M_{A'}$=$M_{B'}$. The point of inflection occurs at the center of the element and the rotation at A can be found from the following equations:

$$\theta_x = \theta_{A'} + \int_0^x \phi_x dx \tag{4.16}$$

$$\delta_x = \delta_{A'} + \int_0^x \theta_x dx \tag{4.17}$$

ϕ_x= function of $M_{A'}$.

The boundary conditions at the left end and at mid-span are:

$$x = 0, \delta = 0 \tag{4.18}$$

$$x = \frac{L}{2}, \delta = 0 \tag{4.19}$$

Because the moment-curvature relation used is an approximation composed of straight lines, the moment-rotation relation turns out to be made of straight lines too. In order to define the moment-rotation due to curvatures for springs, it is only necessary to calculate rotations at break points in moment-curvature.

The end rotations at cracking, yielding and ultimate moment are calculated from:

- Cracking point:

$$\theta_c = \frac{L}{6EI_g} M_c \tag{4.20}$$

- Yield point:

$$\theta_y = \frac{L}{6EI_g}\left[\left(1-\alpha^3\right)\phi_y + \alpha^2\phi_c\right] \tag{4.21}$$

where:

ϕ_c – cracking curvature,

ϕ_y – yield curvature,

$\alpha = M_c/M_y$, and

M_y – yielding moment.

- Point to define slope of M-θ relationship after yield:

$$\theta_u = \frac{L}{12}\left\{\left[\frac{(2+\alpha_2)(1-\alpha_2)(\mu\alpha_2+1-\alpha_2)}{\mu}+\alpha_2(1+\alpha_2)-2\alpha_1^{\,3}\right]\frac{\phi_y}{\alpha_2}+2\alpha_1^{\,2}\phi_c\right\} \tag{4.22}$$

where:

$$\mu = \frac{(M_u - M_y)\phi_y}{(\phi_u - \phi_y)M_y},$$

$$\alpha_1 = \frac{M_c}{M_u},$$

$$\alpha_2 = \frac{M_y}{M_u},$$

ϕ_u – ultimate curvature, and

M_u- ultimate moment.

The resulting moment-rotation curve is shown in Figure 4-10.

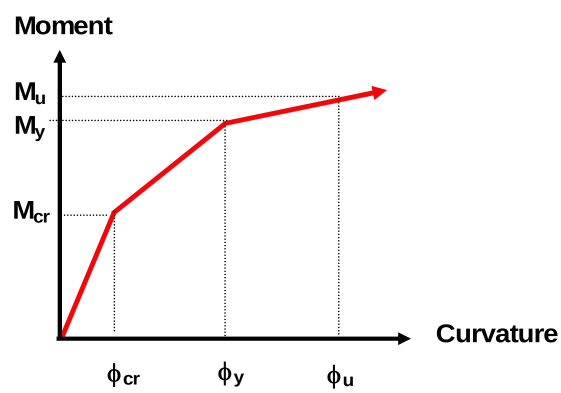


Figure 4-10. Moment Rotation Diagram for Rotational Spring

4.7 WALL ELEMENT

4.7.1 FLEXURE

The wall element consists of a number of linearly elastic segments connected in series. All segments of an element have the same length as presented in Figure 4-11.

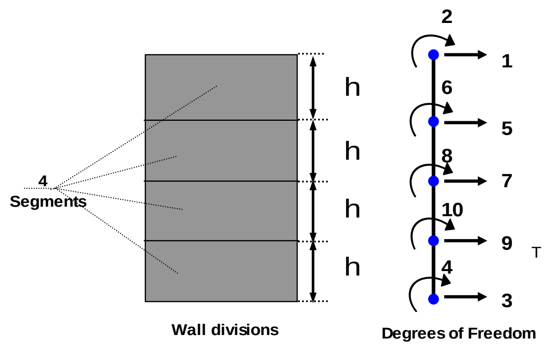


Figure 4-11. Wall Element

Each segment has two DOF at each end: a horizontal translation and a rotation. The stiffness matrix for each segment contains flexure and shear contribution to deformations:

$$\begin{Bmatrix} V_1 \\ M_1 \\ V_2 \\ M_2 \end{Bmatrix} = \begin{bmatrix} k_{11} & k_{12} & k_{13} & k_{14} \\ k_{21} & k_{22} & k_{23} & k_{24} \\ k_{31} & k_{32} & k_{33} & k_{34} \\ k_{41} & k_{42} & k_{43} & k_{44} \end{bmatrix} \begin{Bmatrix} \delta_1 \\ \varphi_1 \\ \delta_2 \\ \varphi_2 \end{Bmatrix} \tag{4.23}$$

where:

$$k_{11} = \frac{1}{\dfrac{L^3}{12EI} + \dfrac{L}{AG}},$$

$$k_{12} = k_{21} = \frac{1}{\dfrac{L^2}{6EI} + \dfrac{2}{AG}},$$

$k_{13} = k_{31} = -k_{11}$,

$k_{14} = k_{41} = k_{12}$,

$$k_{22} = \frac{\frac{4}{3} + \frac{4EI}{AGL^2}}{\frac{L}{3EI} + \frac{4}{AGL}},$$

$k_{23} = k_{32} = -k_{12}$,

$$k_{24} = k_{42} = \frac{\frac{2}{3} - \frac{4EI}{AGL^2}}{\frac{L}{3EI} + \frac{4}{AGL}},$$

$k_{33} = k_{11}$,

$k_{34} = -k_{12}$,

$k_{33} = k_{11}$, and

$k_{44} = k_{22}$.

It is assumed that the wall is subjected to a linear moment distribution within a story. The flexural rigidity, *EI*, can be different for different segments. It is obtained by: (1) letting the moment at the center of the segment be representative of the moment at the whole segment (see Figure 4-12) getting the value of *EI* from the moment-curvature relation for the wall. It is assumed that the curvature of walls follows Takeda hysteresis rules (Section 4.8.1).

The stiffness matrix of the element for the whole story is first assembled in terms of all degrees-of-freedom in the segments. Then, the matrix is condensed to express it in terms of 4 DOF, a translation and a rotation at each end.

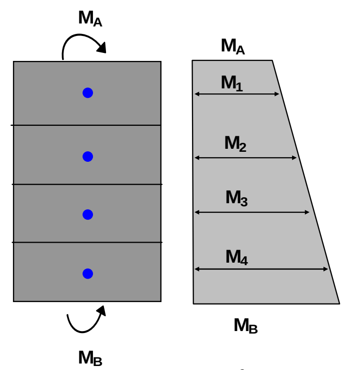


Figure 4-12. Moment at Center of Segment of Wall Element

For purpose of assembling the structure stiffness matrix, the stiffness matrix of wall element is treated in the same way as stiffness matrix of column element.

4.7.2 SHEAR

The value of the shear modulus, G, in Equation (4.23) is the same for all segments of the wall element. Initially, G is based directly on E. If shear stresses are high (above the value of shear stress of $4\sqrt{f'_c}$, psi), the value of G is reduced in all segments. The model used for the calculation of the reduced G was proposed by Hoedajanto (1983), and is presented in Figure 4-13.

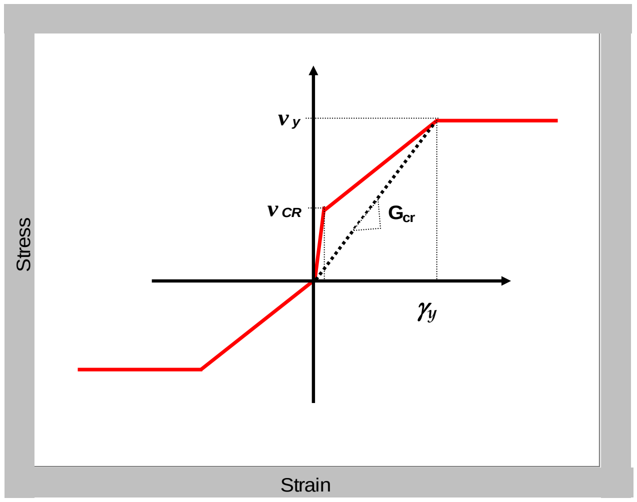


Figure 4-13. Shear Stress- Strain Primary Curve for Wall

The primary curve of shear stress-strain relation can be constructed by assuming that:

$$v_{cr} = 4\sqrt{f'_c} \tag{4.24}$$

$$v_y = \rho f_y \geq v_{cr} \tag{4.25}$$

$$G_{cr} = \rho n G \tag{4.26}$$

$$\gamma_{cr} = \frac{v_{cr}}{G} \tag{4.27}$$

$$\gamma_y = \frac{v_y}{G_{cr}} \tag{4.28}$$

where:

f'_c – compressive strength of concrete,

ρ – wall transverse reinforcement ratio,

f_y- yield stress for steel,

G_{cr}-shear modulus at shear yielding,

n - ratio of modulus of elasticity of steel to modulus of elasticity of concrete,

γ_{cr} -shear strain ant shear stress v_{cr}, and

γ_{cr} -shear strain at shear stress v_{cr}.

The shear force at shear deformation in the wall can be obtained from:

$$V = vA_{sh} \tag{4.29}$$

$$\delta_{sh} = \gamma h \tag{4.30}$$

where:

V - shear force in wall,

v - shear stress in wall,

A_{sh} - area assumed effective in shear in wall,

γ - shear strain in wall, and

h - story height.

The shear modulus G beyond crack is defined as:

$$G = \frac{V_y - V_{cr}}{\gamma_y - \gamma_{cr}} \tag{4.31}$$

4.8 HYSTERETIC MODEL

4.8.1 TAKEDA HYSTERESIS MODEL

The takeda hysteresis model is used to model the flexural behavior of all elements. Its rules define the moment-rotation behavior of nonlinear rotational springs in column and beams elements, and the moment- curvature behavior of individual segments in wall elements.

The model is composed of straight lines as shown in Figure 4-14. It operates on a primary backbone curve with break points at cracking and yielding. The primary curve continues indefinitely after yielding.

Sixteen Rules have been described in detail by Otani and Sozen (1972). The more important rules are mentioned here:

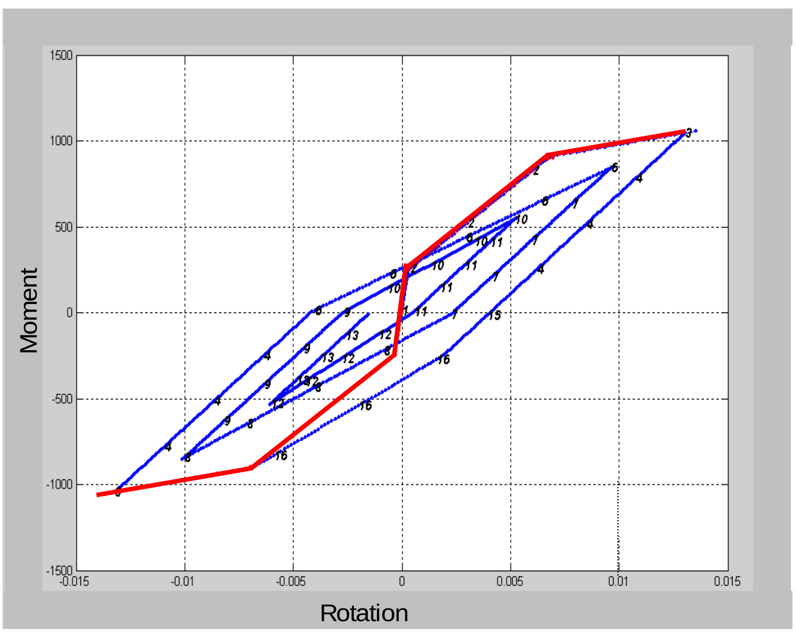


Figure 4-14. Takeda Hysteresis Model.

Before cracking, loading and unloading follow the initial slope. This is equivalent to the element remaining elastic, with no hysteretic energy dissipation.

After cracking, unloading does not follow the primary curve, unloading path depends on whether the yielding force has been exceeded. If yielding has not occurred, unloading path follows a straight line from the maximum attained force to cracking point in the other direction.

If the yield point has been exceeded, the unloading slope is defined by the following equation:

$$K' = S_{YC'}\left(\frac{D_y}{D_{max}}\right)^{\alpha} \tag{4.32}$$

where:

$S_{YC'}$ is the slope of a line joining the yield point in one direction to the cracking point in the other direction,

D_y is the value of the yield deformation,

D_{max} is the value of the maximum deformation attained in the direction of loading, and

α is a coefficient between 0 and 1. A value of α of 0.5 will be used as recommended by López (1988).

4.8.2 HYSTERESIS MODEL FOR WALL

This model was used to simulate the shear deformations of wall element subjected to shear load reversals.

The shear hysteresis model is also composed of straight lines. It operates on a bilinear primary curve symmetric about the origin. Figure 4-15 presents this hysteresis curve.

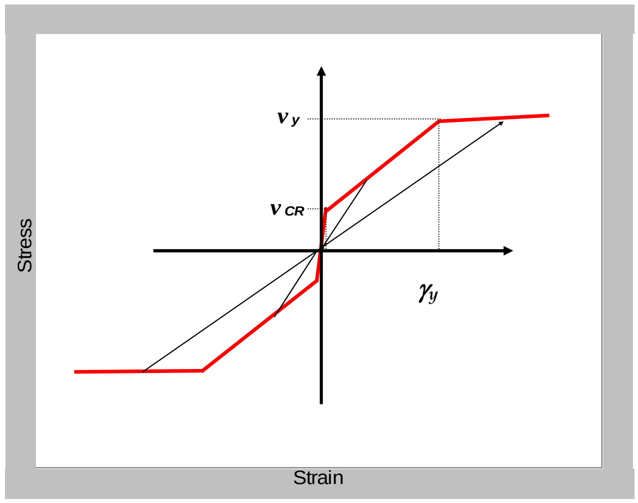


Figure 4-15. Wall Hysteresis Model for Shear.

When loading for the first time, loading path follows the primary curve. When unloading, the paths always points towards the origin.

In subsequent reloading, the unloading path is continued until the primary curve is encountered, or until unloading occurs. If the primary curve is encountered, the path follows primary curve. If unloading occurs before crossing the primary curve, the unloading path points towards the origin, which should be same path that was being followed during loading. In summary, if loading does not go far enough to encounter the primary curve, it goes back through the same path it came.

4.9 SOLUTION OF THE EQUATIONS

Newmark's β method (Newmark, 1959) was used to solve numerically the set defined by Equation(4.1). It is a single step, implicit method widely used for its simplicity and efficiency.

With a value of β taken as 0.25, the method is also known as the constant average acceleration method. It is unconditionally stable for linear problems. For nonlinear problems, instability can occur if the time between integration points is too large in comparison with the significant periods of the structure.

Assume the values of displacement (x_n), velocity ($\dot{x}_n$), and acceleration ($\ddot{x}_n$) are known at present time *n*. The incremental velocity and displacement are defined as:

$$\Delta\dot{x} = \ddot{x}_n \Delta t + \Delta\ddot{x}\frac{\Delta t}{2} \tag{4.33}$$

$$\Delta x = \dot{x}_n \Delta t + \frac{1}{2}\ddot{x}_n\left(\Delta t\right)^2 + \frac{1}{4}\Delta\ddot{x}\left(\Delta t\right)^2 \tag{4.34}$$

where:

$\Delta x, \Delta\dot{x}, \Delta\ddot{x}$ are the values of increment in displacement, velocity and acceleration, and Δt is the integration time step.

Equation (4.34) can be rearranged as follows:

$$\Delta\ddot{x} = \frac{4\Delta x}{\left(\Delta t\right)^2} - \frac{4\dot{x}_n}{\Delta t}\ddot{x}_n - 2\ddot{x}_n \tag{4.35}$$

substituting Equation (4.35) into Equation (4.33) one obtains:

$$\Delta\dot{x} = \frac{2\Delta x}{\Delta t} - 2\dot{x}_n \tag{4.36}$$

Now substituting Equation (4.35) and (4.36) into the differential equation of motion (4.1) gives an equation where the only unknowns are the incremental displacements. These can be found from:

$$\{\Delta x\} = [A]^{-1}\{B\} \tag{4.37}$$

where:

$[A] = \dfrac{4}{(\Delta t)^2}[M] + \dfrac{2}{\Delta t}[C] + [K]$, and

$\{B\} = [M]\left\{\dfrac{4}{\Delta t}\{\dot{x}_n\} + 2\{\ddot{x}_n\} - \{\Delta\ddot{x}_g\} + 2[C]\{\dot{x}_n\}\right\}$.

After the values of incremental displacement are obtained from Equation (4.37), the incremental velocity and acceleration are found from Equation (4.35) and (4.36). From these incremental values, the total values at time ($n+\Delta t$) are obtained.

4.10 GRAVITY EFFECTS

Gravity effect, frequently called P-Δ effect tends to increase the lateral displacements of a structure loaded statically. In this study it is taken into account approximately by softening the stiffness matrix.

Figure 4-16 shows a column of height h, displaced at the top a distance Δ. A gravity load P is applied on top of the column. The moment that the load P induces at bottom of the column is M=PΔ. If, instead of a gravity load P, a lateral force V is applied such that:

$$V = \frac{P\Delta}{h} \tag{4.38}$$

Then the moment at bottom of the column would still be M=PΔ. The force V is the equivalent shear for P-Δ effect of the column.

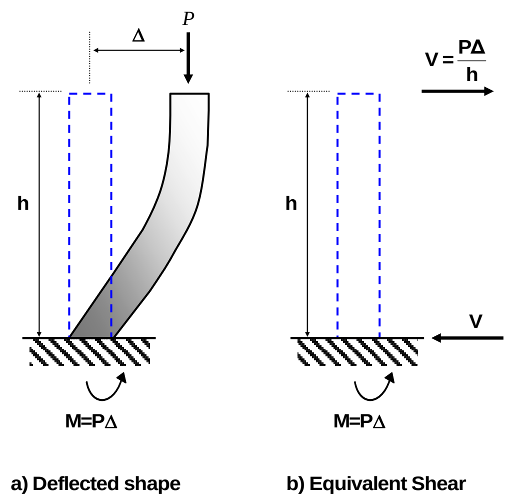


Figure 4-16. P-Δ Effect for a Column.

This concept is applied to a multistory frame in Figure 4-17. The displacement shape including an intermediate story "i" and stories above and below it, with the equivalent shear forces are shown in Figure 4-17 a)

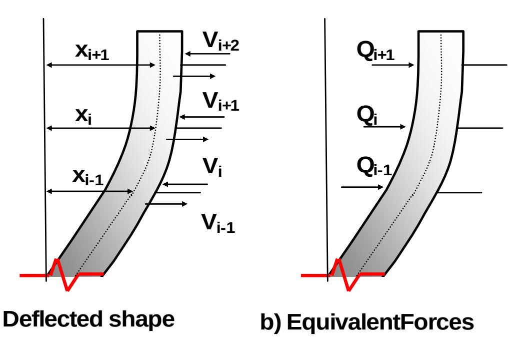


Figure 4-17. Equivalent P-Δ Shear in Frame

The value of V_i is:

$$V_i = \frac{P_i\left(x_i - x_{i-1}\right)}{h_i} \tag{4.39}$$

where:

x_i – lateral displacement level i,

h_i – height of level i, and

P_i – gravity load at level i.

The forces $\boldsymbol{Q_i}$ shown in Figure 4-17 b) are the resultants of the forces V at every level. For example:

$$\begin{aligned} Q_i &= V_i - V_{i+1} = \frac{P_i\left(x_i - x_{i-1}\right)}{h_i} - \frac{P_{i+1}\left(x_{i+1} - x_i\right)}{h_{i+1}} \\ Q_i &= -\frac{P_i x_{i-1}}{h_i} + \left(\frac{P_i}{h_i} + \frac{P_{i+1}}{h_{i+1}}\right) x_i - \frac{P_{i+1} x_{i+1}}{h_{i+1}} \end{aligned} \tag{4.40}$$

The forces for all the frames can be written in vectorial form as:

$$\{Q\} = \left[K_p\right]\{X\} \tag{4.41}$$

For a frame in static equilibrium:

$$\{H\} = [K]\{X\} \tag{4.42}$$

Where:

$\{H\}$ are the applied lateral loads, and

$[K]$ is the stiffness matrix.

Inclusion of gravity effect can be done by adding forces $\{Q\}$ to forces $\{H\}$, which gives:

$$\{H+Q\}=[K]\{X\} \tag{4.43}$$

Substitution of Equation (4.41) into Equation (4.43) gives:

$$\{H\}=\left[K-K_p\right]\{X\} \tag{4.44}$$

where:

$\left[K-K_p\right]$ is the softened stiffness matrix which reflects the P-Δ effect.

5 EARTHQUAKE GROUND RECORDS

5.1 INTRODUCTION

This chapter describes the earthquake ground motions records selected as input for the nonlinear dynamics time history analysis. The ground motion amplitude, frequency content and duration, are summarized. The order of the frequency content also influence the seismic behavior of the structures. This parameter was not taken into account in the selection of the ground motions.

5.2 DESCRIPTION OF EARTHQUAKES

The selection of ground motions plays one of the most important roles in acquiring reliable fragility curves. In the absence of past strong earthquake records in the region, five earthquakes accelerograms were used in this study, two synthetic earthquakes created by Irizarri (1999) for Mayagüez and Ponce City and surroundings, and San Juan City based on the geotectonic characteristics of Puerto Rico, and three past earthquake records widely used by researchers, namely: Imperial Valley, Northridge, and San Salvador earthquakes.

The criterion for the selection of these records is that Irizarry's synthetic earthquakes are based on local geology characteristics and past worldwide earthquake records were selected in such way that they represents different probable hazard scenarios by having a wide range of characteristic that influence damage as it is explained through this chapter.

Figure 5-1 to Figure 5-5 present the original records used in this investigation. These acceleration graphs were scaled to different excitation levels represented by the Peak Ground Acceleration (PGA). The selected values of PGA generally went from 0.1g to 1.5g in increments of 0.1g, until almost all structures reach the Major damage state. The time scale was not changed.

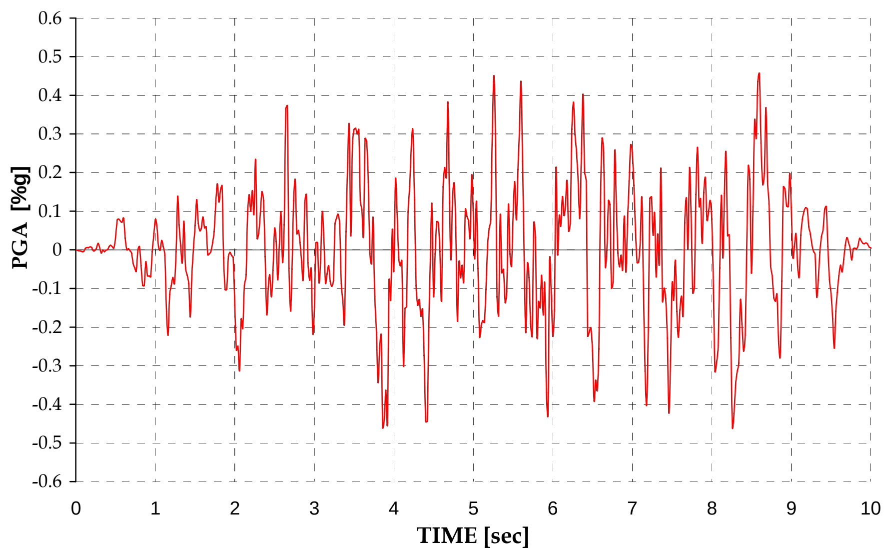


Figure 5-1 Synthetic Ground Record for Mayagüez, Ponce and sourrunding area (Irizarry 1999) with base-line correction by Montejo (2004)

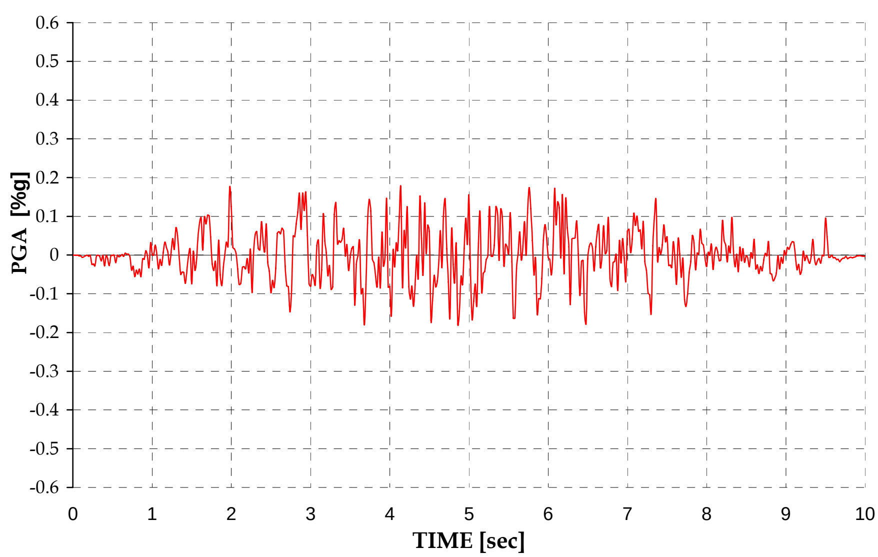


Figure 5-2 Synthetic Ground Record for San Juan and surrounding area(Irizarry 1999) with base-line correction by Montejo (2004)

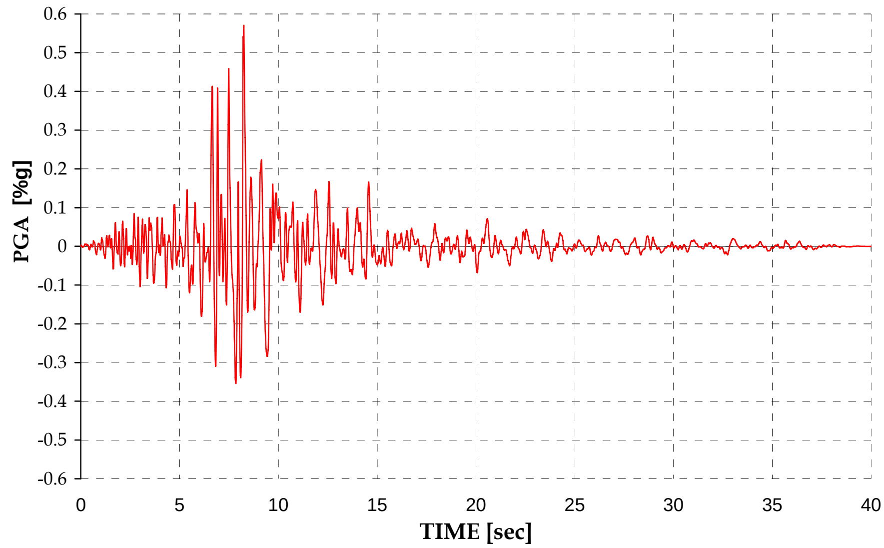


Figure 5-3 Ground Record for The 1994 Northridge Earthquake. Station Northridge24278 Castaic - Old Ridge Route

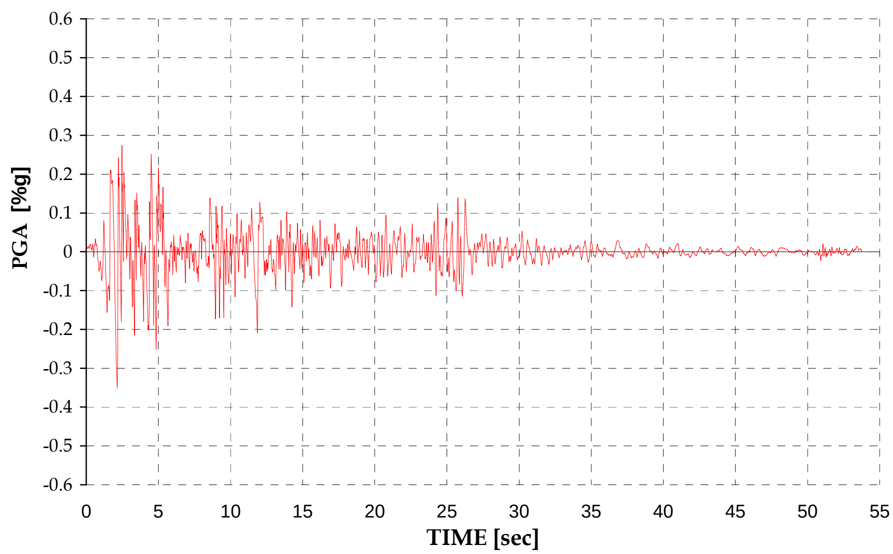


Figure 5-4 Ground Record for The 1940 El Centro Earthquake at Imperial Valley. Station 117 El Centro Array #9117 El Centro Array #9

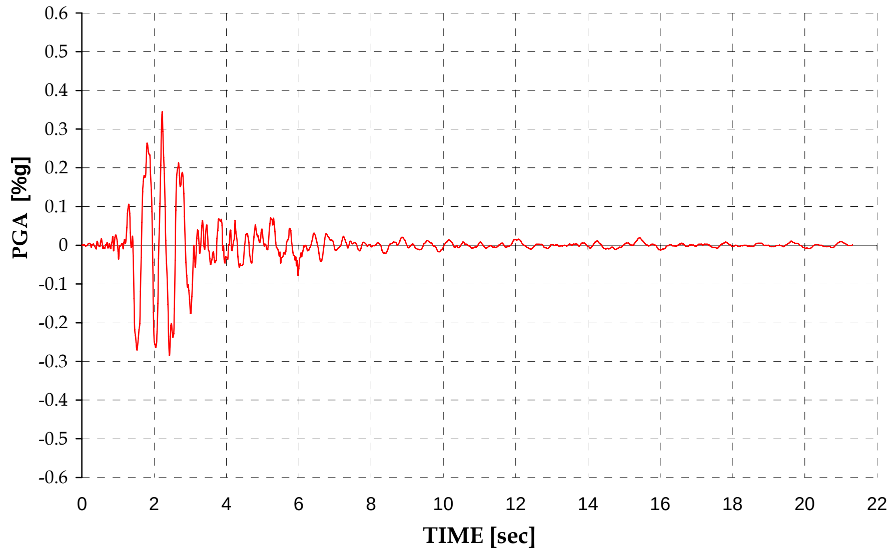


Figure 5-5 Ground Record for The 1986 San Salvador Earthquake. Station Hotel Camino Real

The parameters of the of the five earthquake records: amplitude, frequency content, and duration are discussed below.

5.2.1.1 AMPLITUDE AND DURATION GROUND MOTION PARAMETERS

Table 5-1 and Table 5-2 summarize the basic characteristics of the records. The Peak Ground acceleration is shown only for descriptive purposes, the reader must keep in mind that these original peak ground acceleration values will be scaled before used. Table 5-3 presents the time at which peak values are reached.

The duration of the strong motions affect the nonlinear behavior of the structures and thus the damage state of the structure, because it influences processes such as stiffness degradation due to load reversal repetition. The duration is defined as the time interval between the first and the last acceleration peaks greater than 0.05g. It can be shown in Table 5-1 and Table 5-2 that the records have a wide range of duration, from 9s to 30s.

Table 5-1 Amplitude and Duration Ground Motion Parameters for synthetic earthquakes selected.

Station	Duration sec	PGA [% g]	PGV in/s	PGD in
Mayagüez and Ponce	9	0.46	21.78	4.97
San Juan	9	0.18	7.72	9.54

Table 5-2 Amplitude and Duration Ground Motion Parameter for past earthquakes selected.

Earthquake	Direction	Year	Duration sec	PGA [% g]	PGV in/s	PGD in
Northridge	E-W	1994	18	0.57	20.45	3.5
Imperial Valley	N-S	1940	30	0.35	15	5.24
San Salvador	E-W	1986	5	0.35	12.64	1.58

Table 5-3 Amplitude and Duration Ground Motion Parameter for past earthquakes selected.

Earthquake	t1(sec)	t2(sec)	t3(sec)
Mayagüez and Ponce	3.8	3.68	7.42
San Juan	3.62	5.18	6.08
Northridge	8.26	8.18	6.96
Imperial Valley	2.14	4.4	4.17
San Salvador	2.22	1.64	1.84

t1= time at which Peak Ground Acceleration is reached
t2= time at which Peak Ground Velocity is reached
t3= time at which Peak Ground Displacement is reached

5.2.2 FREQUENCY CONTENT PARAMETERS

The frequency content of the ground motion strongly influences the effect on the structures. To characterize the frequency content of the records, Fourier Amplitude Spectra were built. Figure 5-6 to Figure 5-10 shows the Fourier spectra for the records.

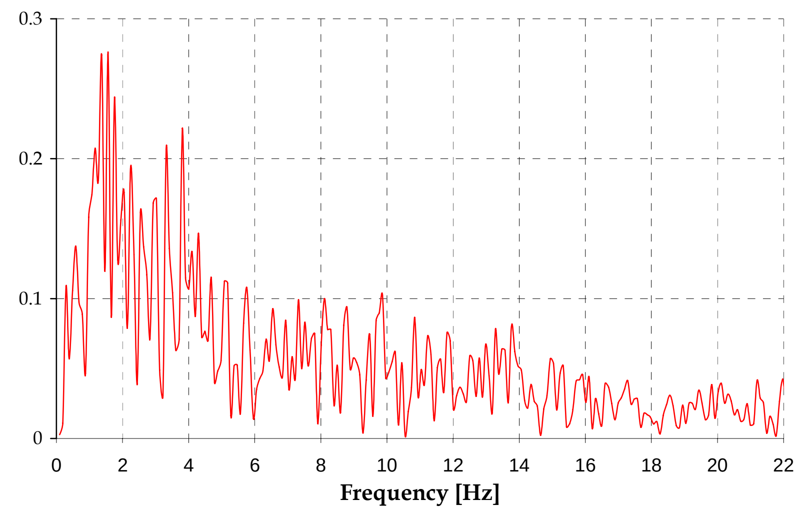


Figure 5-6 Fourier Spectra for The Mayagüez and Ponce Synthetic Earthquake.

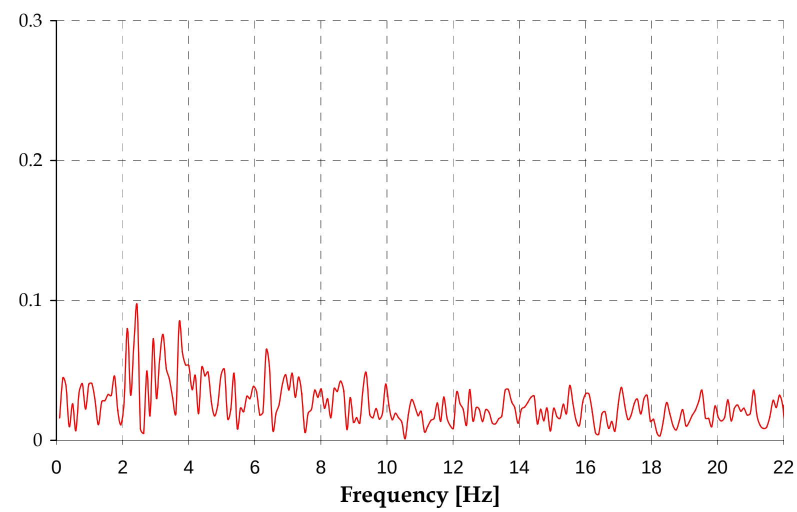


Figure 5-7 Fourier Spectra for The San Juan Synthetic Earthquake.

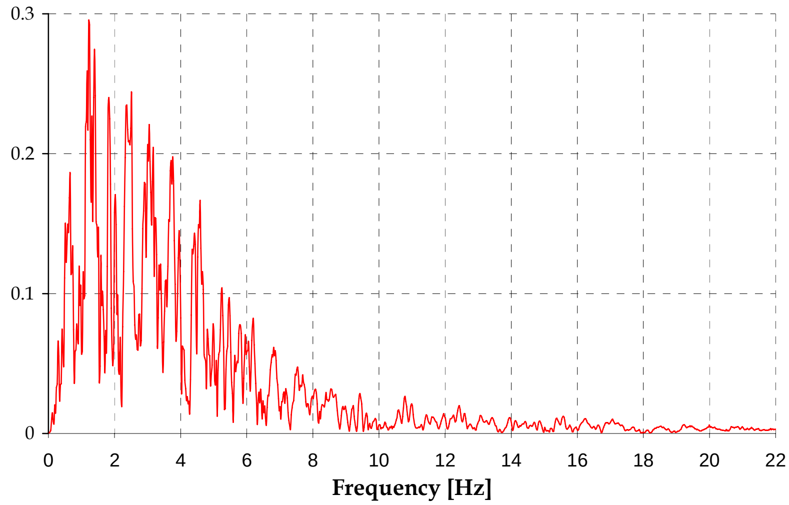


Figure 5-8 Fourier Spectra for The Northridge Earthquake.

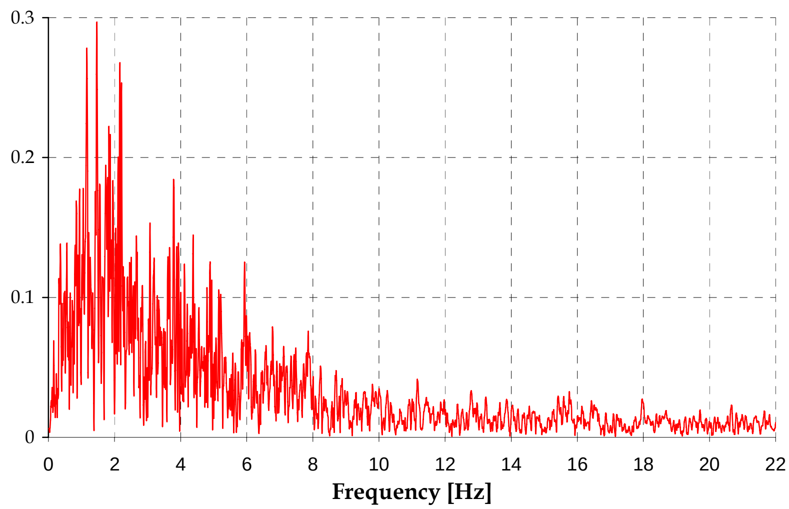


Figure 5-9 Fourier Spectra for The El Centro Earthquake.

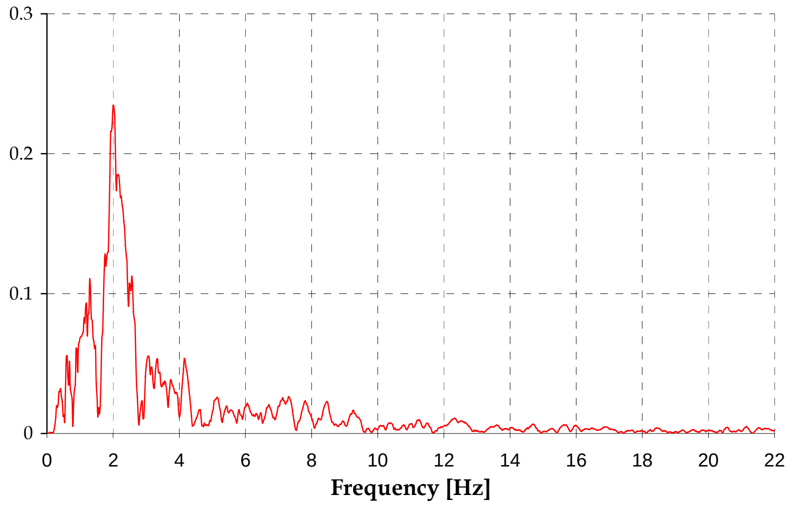


Figure 5-10 Fourier Spectra for The San Salvador Earthquake.

Predominant frequencies where the peak Fourier amplitude occurs are summarized in Table 5-4.

Table 5-4 Dominant Frequencies and Periods.

Earthquake	F (Hz)	T (sec)
Mayagüez	1.20	0.83
San Juan	2.20	0.45
Northrige	1.25	0.80
El Centro	1.46	0.68
San Salvador	2.02	0.50

Figure 5-10 clearly shows that San Salvador earthquake have a narrow spectrum, that implies that have strong dominant frequencies, while the others records have a broad spectrum, showing that the motion contains a variety of frequencies, while the others records have a broad spectrum, showing that the motion contains a variety of frequencies. Northridge (Figure 5-8) and El Centro (Figure 5-9) earthquake are relatively wide (0.1–8 Hz). Mayagüez and San Juan records (Figure 5-6 and Figure 5-7) excite a very wide range of frequencies.

After studying the principal characteristics of the earthquake records, it can be said that the records selected are rich in a variety of peak ground values, frequency content and duration, thus the goal of selecting records that have a wide range of characteristic that influence damage is accomplished.

6 ONE AND TWO-STORY MODELS

6.1 INTRODUCTION

The procedures followed to generate the prototype models of one and two-story reinforced concrete residential buildings are explained in detail in this chapter. The structural characteristic and description of the models analyzed for fragility curves generation are also described. All units used in this chapter are kip-in.

6.2 DEFINITION OF PROTOTYPE STRUCTURES

Residential structural drawings from Mayagüez and Cabo Rojo were collected from the Regulations and Permits Administration in Puerto Rico, Mayagüez office. In addition some engineering and architect's offices colaborated with the investigation and provided structural drawings from other cities: San Sebastián, Lares, Hatillo, Guayama, Salinas, Moca, Guaynabo, and San Juan. With such information, the characteristics of the constructions in the different cities were compared, and it was confirmed that the residences are very similar in all cities. Figure 6-1 and Figure 6-2 present the front elevation and plan view of one of the building collected.

With 61 residential structural drawings of one and two-story, the structures were classified according to their lateral resisting element. The configurations found are: 1) Walls in one direction, 2) Walls in both directions, and 3) Frames in one direction, and 4) Frames in both directions.

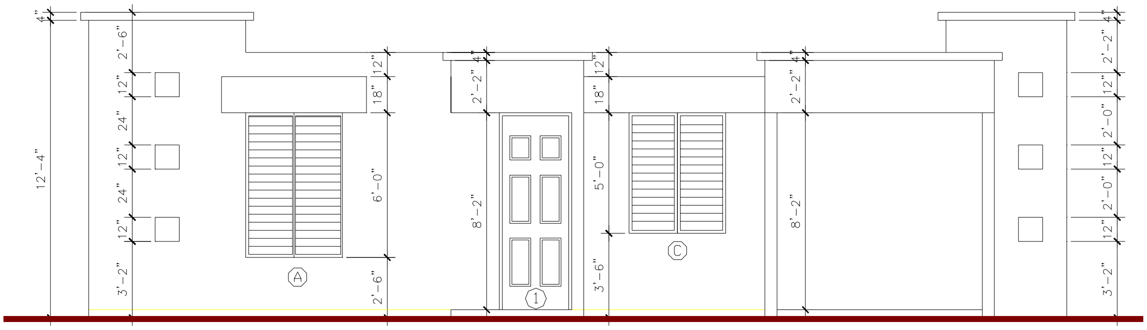


Figure 6-1. Example of a Front Elevation of a Residential House

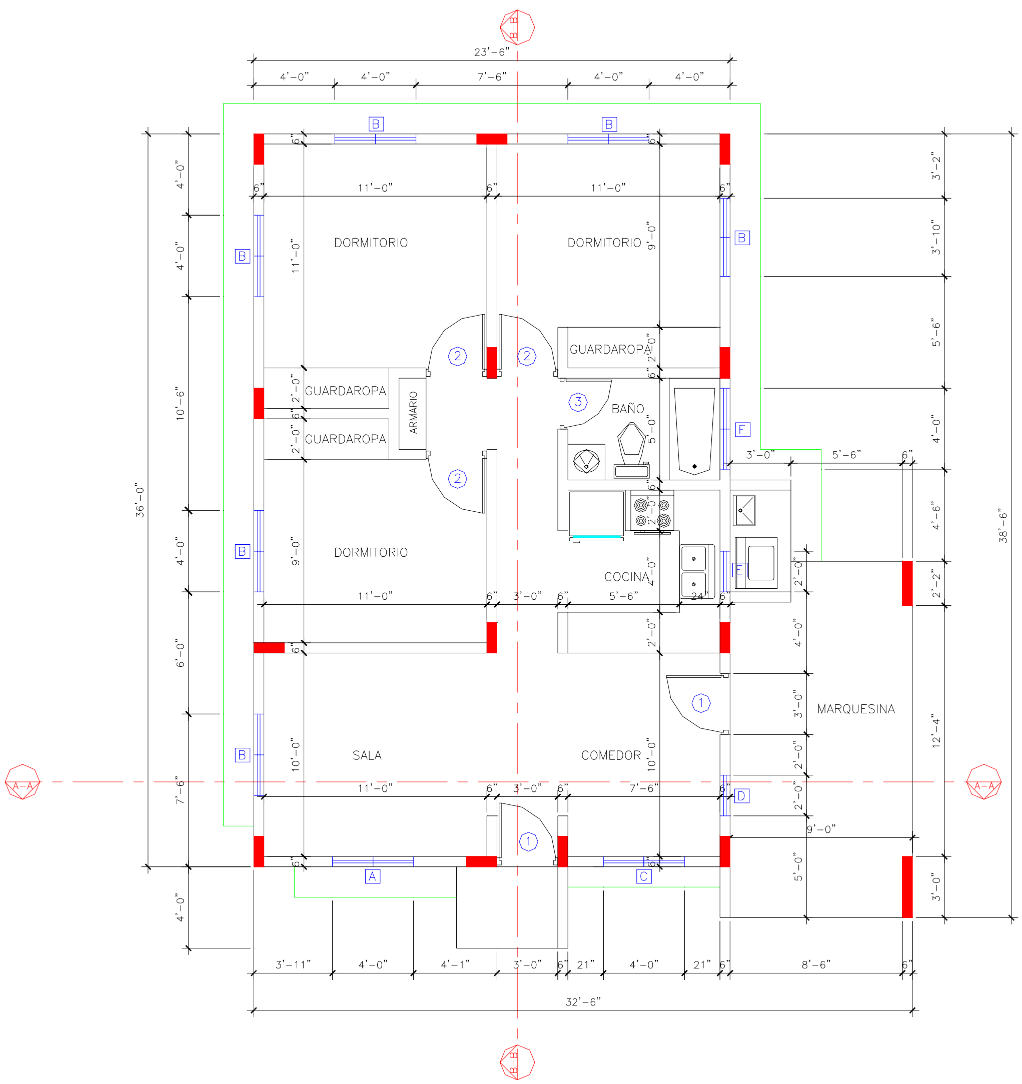


Figure 6-2. Example of a Plan View of a Residential House

Once the information of one and two-story reinforced concrete residential buildings was obtained it was found that there are some particular parameters that remain similar in most residences and others that change. The parameters considered as typical are: floor area, weight of the structures, column or wall dimensions, beam dimensions, slab thickness, span length, and typical reinforcement. Models varied in the following parameters: columns to floor area ratio, columns direction and story height. Figure 6-3 illustrates the meaning of columns direction.

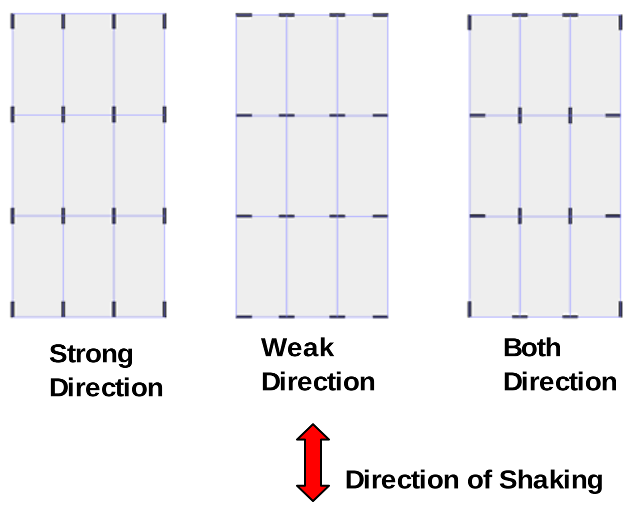


Figure 6-3. Column or Wall Direction

The parameters that were considered fixed are: slab thickness of 5″, beam width of 6″, column or wall smaller dimension of 6″, and an average floor area of 1,800 ft^2. The models had three spans in each direction. The material properties are also considered fixed: concrete strength f'_c=3ksi, modulus of elasticity E=3,200 ksi, shear modulus G=1,200 ksi, and reinforcing bars yield strength f_y=60 ksi.

6.3 MODEL DESCRIPTION

For nonlinear analysis two-dimensional models were generated. This section describes the prototypes created. Section 6.3.1 deals with moment resistant frame models and Section 6.3.2 with shear wall models.

6.3.1 MOMENT RESISTANT FRAME MODELS

Moment Resistant Frames are subdivided in one and two-story models. The structural characteristics of each subdivision are discussed below.

6.3.1.1 ONE-STORY MODELS

Eighteen models were created following the procedure mentioned above. Figure 6-4 shows an example of the first model created:

Floor area = 1800 ft^2, Columns dimensions = 6" x 16", Beam dimensions = 6" x 15", Slab thickness = 5', Story height = 96", Beam Span = 170".

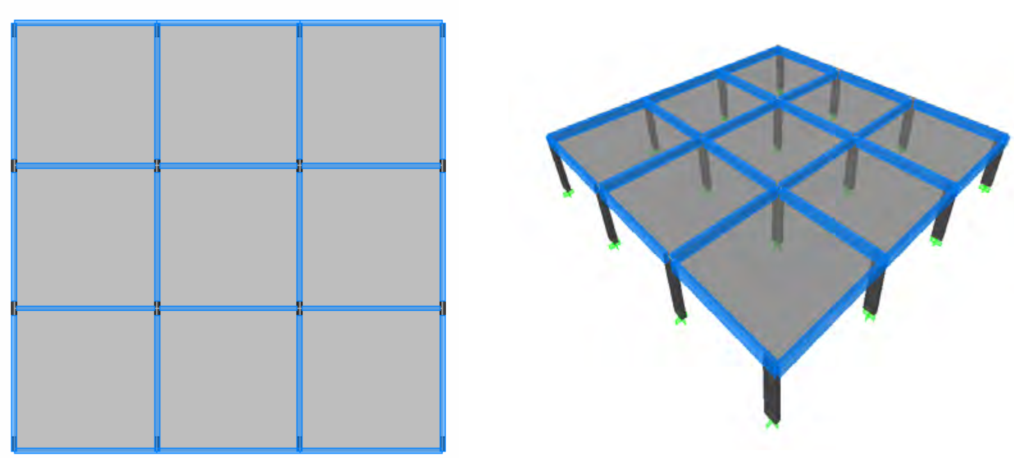


Figure 6-4. One-Story Frame Model, Plan and 3D view.

A typical frame is shown in Figure 6-5. The tributary story weight assigned to the frames is 80 kips. A description of the one-story reinforced concrete frame models generated and analyzed in this investigation is summarized in Table 6-1. The first column identifies the models, the second one describes the column to floor area ratio of the models: two percentages, 0.7% and 1.5%, have been considered in the prototypes, the third column refers to the orientation of the columns: three orientations are taken into account, as shown previously: strong direction, weak direction, and both directions; the fourth column corresponds to the story height: the three heights considered were 96, 120 and 144 in. The last columns specifies the span length, considered constant for the frames.

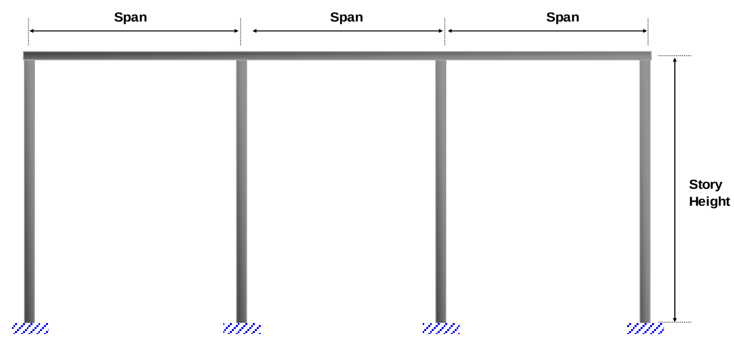


Figure 6-5. Typical One-Story Reinforce Concrete Frame Model

In addition to the geometry description, the models are also characterized by the moment-curvature relationships of each element. A description of the section properties, reinforcing and nonlinear properties of the frames elements is presented next.

Figure 6-6 to Figure 6-8 display the cross section of the frame elements defined to analyze the nonlinear properties of the models. These sections were analyzed and their properties are summarized in Table 6-2. The first column of the table identifies the section. The name was defined to facilitate identification of the column properties, and is described as follows. The first part of the name identifies the element type, beam or column, the numbers define the percentage of column related to floor area and the last part defines the direction of the columns. The second column of the table contains the moment of inertia of each section, columns three to five refer to cracking moment, followed by yield moment and ultimate moment defined in Chapter 4, columns six and seven present the yield and ultimate curvature, and the last column contains the shear area of the sections.

Table 6-1. Description of One-Story Frame models

MODEL	Column (%)	Direction	Story Height (in)	Span (in)
1	0.7	1	96	170
2	0.7	2	96	170
3	0.7	3	96	170
4	0.7	1	120	170
5	0.7	2	120	170
6	0.7	3	120	170
7	0.7	1	144	170
8	0.7	2	144	170
9	0.7	3	144	170
10	1.5	1	96	170
11	1.5	2	96	170
12	1.5	3	96	170
13	1.5	1	120	170
14	1.5	2	120	170
15	1.5	3	120	170
16	1.5	1	144	170
17	1.5	2	144	170
18	1.5	3	144	170

Direction 1 = All columns oriented in both directions (Both Directions)
Direction 2 = All columns oriented in the direction of shaking. (Strong Direction)
Direction 3= All columns oriented in the direction opposite to shaking (Weak Direction)

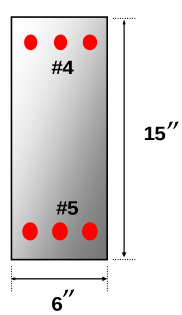
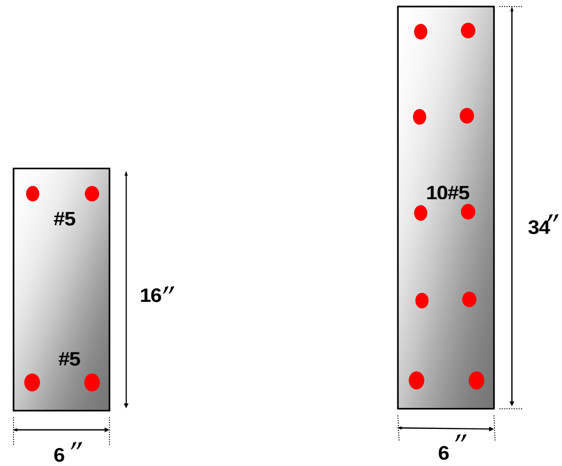


Figure 6-6. Cross Section of Beams. One-Story Reinforced Concrete Frame Model



a) b)

Figure 6-7. Cross Section of Columns Oriented in the Strong Direction (SD). One-Story Reinforced Concrete Frame Model. a) Models with a percentage of columns of 0.7% (Col_0.7-SD) , and b) Models with a percentage of columns of 1.5%(Col_1.5-SD)

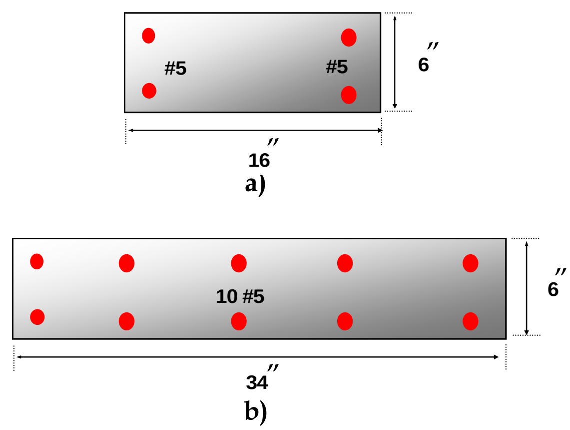


Figure 6-8. Cross Section of Columns Oriented in the Weak Direction (WD) One-Story Reinforced Concrete Frame Model. a) Models with a percentage of columns of 0.7% (Col_0.7-WD), and b) Models with a percentage of columns of 1.5 % (Col_1.5-WD)

Table 6-2. Sections Properties of One-Story Frame models Prototypes

Section	Inertia (in^4)	M_{CR} (kip-in)	M_y (kip-in)	M_u (kip-in)	ϕ_y (1/in)	ϕ_u (1/in)	A_{sh} (in^2)
Beam	1687.50	92	460	493	0.00015	0.00152	75
Col_0.7_SD	2048.00	105	343	389	0.00023	0.00181	80
Col_0.7_WD	288.00	39	104	114	0.00047	0.0027	80
Col_1.5_SD	19652.00	474	1593	1857	0.00008	0.00057	170
Col_1.5_WD	612	83	270	278	0.00092	0.00251	170

The sections assigned to each frame model based on the direction of the columns are present graphically through Figure 6-9 to Figure 6-11. SD means strong direction and WD weak direction.

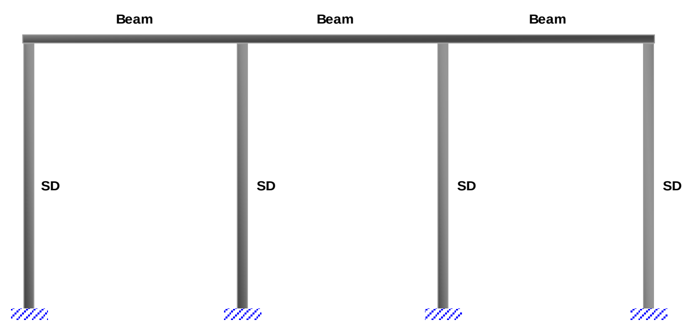


Figure 6-9. Section Assigned to Strong Direction of The One-Story Frame models

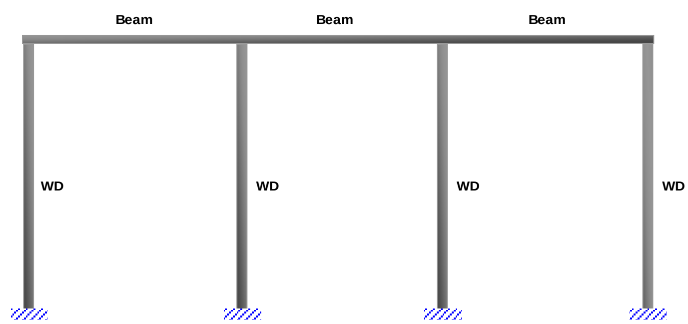


Figure 6-10. Section Assigned to Weak Direction of The One-Story Frame models

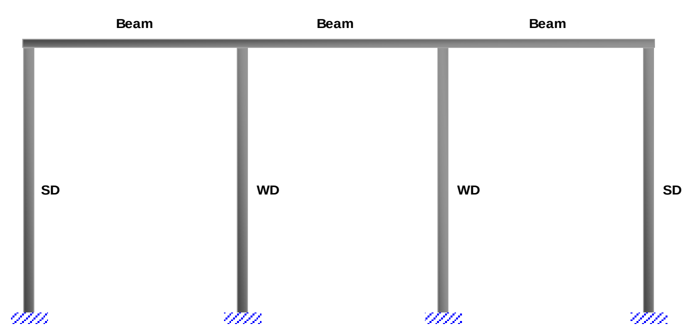


Figure 6-11. Section assigned to Both Directions of The One-Story Frame models

6.3.1.2 TWO-STORY MODELS

Eighteen models were also created for two-story reinforced concrete frames. A typical frame is shown in Figure 6-12. The tributary story weight assigned to the frames is 80 kip. Descriptions of the two-story reinforced concrete frame models generated and analyzed in this investigation are presented in Table 6-3. The first column identifies the models, the second one describes the column to floor area ratio of the models: two percentages, 1.0% and 1.5%, have been considered in prototypes; the third column refers to the orientation of the columns: three orientation are taken in account: strong direction, weak direction, and both directions; the fourth column corresponds to the story height of the first story of the frame model, the height of the second floor is fixed to 96 in, the three first story heights considered are 96, 120 and 144 in. The last column specifies the span length.

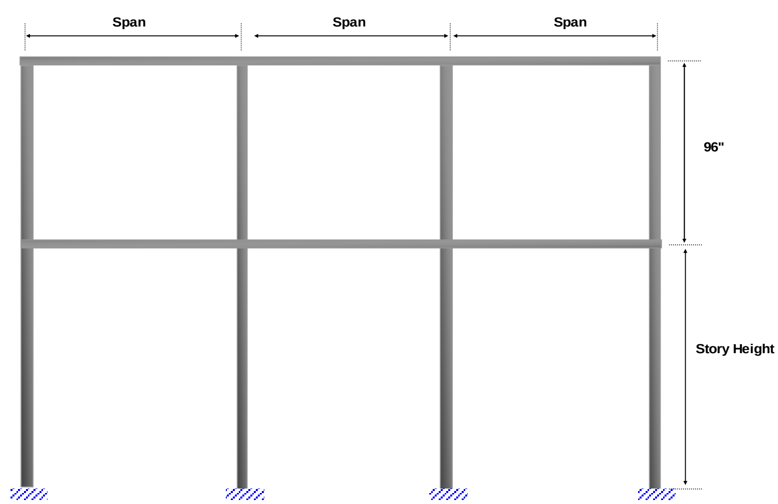


Figure 6-12. Typical Two-Story Reinforced Concrete Frame Model

Figure 6-13 to Figure 6-17 display the cross sections of the frame elements defined to analyze the nonlinear properties of the models. Figure 6-13 presents the section assigned to all beams, Figure 6-14 and Figure 6-15 correspond to the first story column sections, Figure 6-16 and Figure 6-17 to the second floor columns. These sections were analyzed and their properties summarized in Table 6-4. The first column of the table identifies the section. The name was designed to facilitate the identification of the column properties, and is described as follows. The first part of the name identifies the element type, beam or column, the numbers define the percentage of column area related to floor area and the last part defines the direction of the columns. The second column of the table contains moment of inertia of each section, columns three to five refer to cracking moment, the yield moment and ultimate moment defined in Chapter 4, columns six and seven present the yield and ultimate curvature, and the last column contains the shear area of the sections.

Table 6-3. Description of Two-Story Frame models

MODEL	Column (%)	Direction	Firsst Story Height (in)	Span (in)
1	1.0	1	96	120
2	1.0	2	96	120
3	1.0	3	96	120
4	1.0	1	120	120
5	1.0	2	120	120
6	1.0	3	120	120
7	1.0	1	144	120
8	1.0	2	144	120
9	1.0	3	144	120
10	1.5	1	96	120
11	1.5	2	96	120
12	1.5	3	96	120
13	1.5	1	120	120
14	1.5	2	120	120
15	1.5	3	120	120
16	1.5	1	144	120
17	1.5	2	144	120
18	1.5	3	144	120

Direction 1 = All columns oriented in both directions (Both Directions)
Direction 2 = All columns oriented in the direction of shaking. (Strong Direction)
Direction 3= All columns oriented in the direction opposite to shaking (Weak Direction)

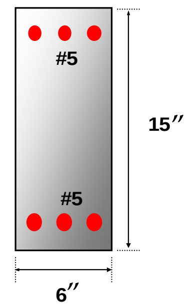
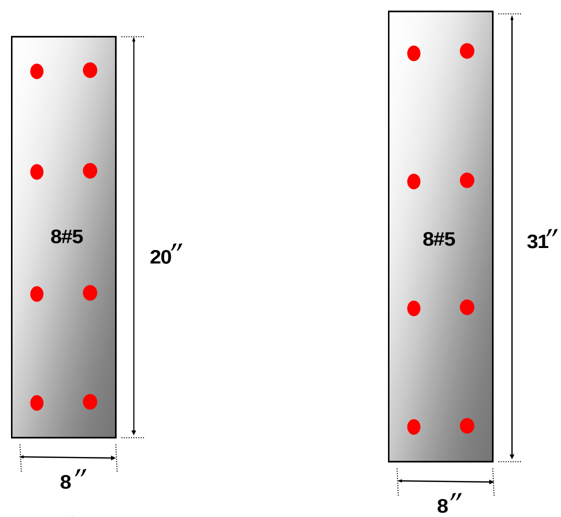
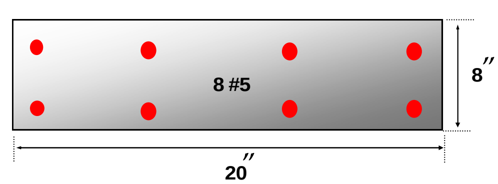


Figure 6-13. Cross Section of Beams. Two-Story Reinforced Concrete Frame Model

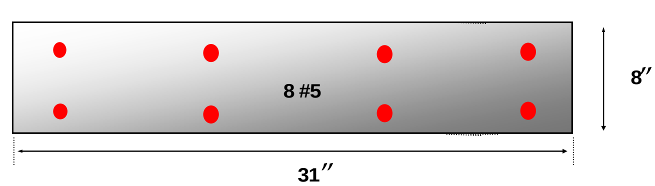


a) b)

Figure 6-14. Cross Section of First Story Columns Oriented in the Strong Direction (SD). Two-Story Reinforced Concrete Frame Model. a) Models with a percentage of columns of 1.0% (Col_1.0_SD_1N) , and b) Models with a percentage of columns of 1.5%(Col_1.5-SD_1N)

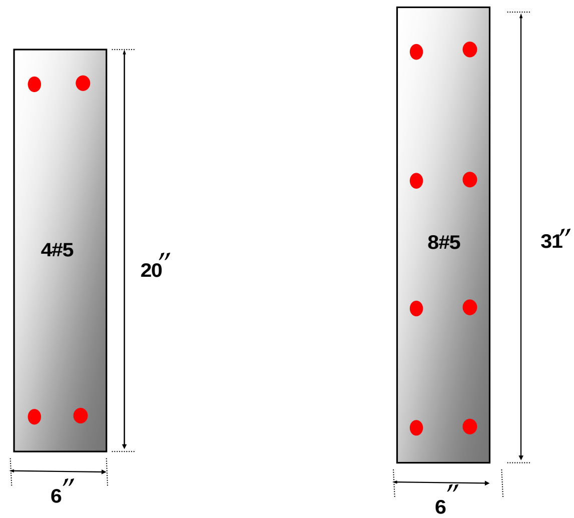


a)



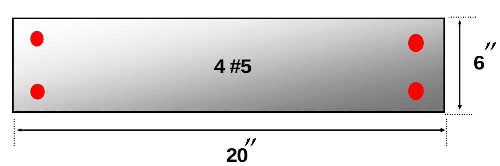
b)

Figure 6-15. Cross Section of First Story Columns Oriented in the Weak Direction (WD). Two-Story Reinforced Concrete Frame Model. a) Models with a percentage of columns of 1.0% (Col_1.0_SD_1N) , and b) Models with a percentage of columns of 1.5%(Col_1.5-WD_1N)

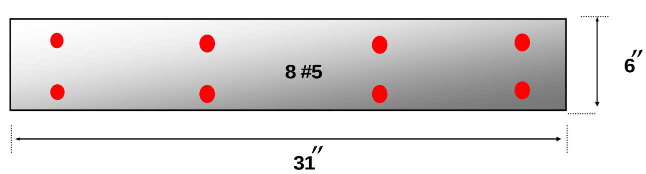


a) b)

Figure 6-16. Cross Section of Second Story Columns Oriented in the Strong Direction (SD). Two-Story Reinforced Concrete Frame Model. a) Models with a percentage of columns of 1.0% (Col_1.0_SD_2N) , and b) Models with a percentage of columns of 1.5%(Col_1.5-SD_2N)



a)



b)

Figure 6-17. Cross Section of Second Story Columns Oriented in the Weak Direction (WD). Two-Story Reinforced Concrete Frame Model. a) Models with a percentage of columns of 1.0% (Col_1.0_SD_1N) , and b) Models with a percentage of columns of 1.5%(Col_1.5-WD_2N)

Table 6-4. Sections Properties of The Two-Story Frame Model Prototypes

Section	Inertia (in^4)	M_{CR} (kip-in)	M_y (kip-in)	M_u (kip-in)	ϕ_y (1/in)	ϕ_u (1/in)	A_{sh} (in^2)
Beam	1687.50	92	685	693	0.000310	0.001400	76
Col_1.0_SD_1N	5333.30	219	1075	1216	0.000240	0.000730	136
Col_1.0_WD_1N	853.33	87	433	434	0.000600	0.001970	130
Col_1.0_SD_2N	4000.00	164	654	660	0.000150	0.001610	101
Col_1.0_WD_2N	360.00	49	159	165	0.000940	0.002620	98
Col_1.5_SD_1N	19900.00	526	1596	2069	0.000100	0.000710	212
Col_1.5_WD_1N	1322.70	135	457	464	0.000800	0.002330	204
Col_1.5_SD_2N	14900.00	394	1805	2012	0.000170	0.000560	159
Col_1.5_WD_2N	558.00	76	305	311	0.000800	0.002340	152

The sections assigned to each frame model based on the direction of the columns are presented graphically in Figure 6-18 to Figure 6-20.

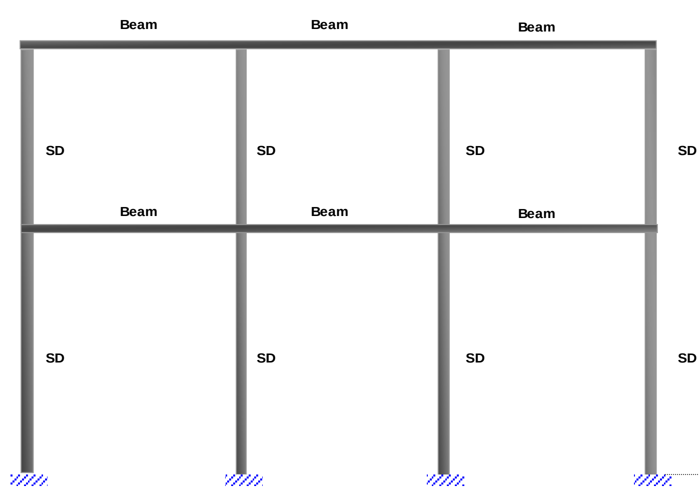


Figure 6-18. Section Assigned to Strong Direction of The Two-Story Frame models

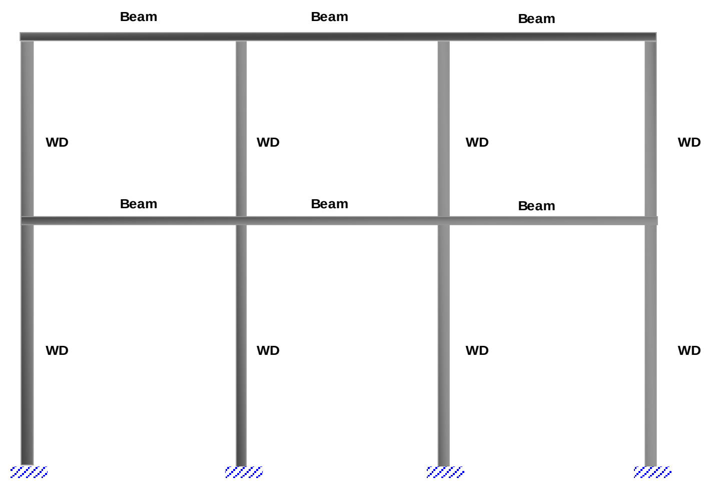


Figure 6-19. Section Assigned to Weak Direction of The Two-Story Frame models

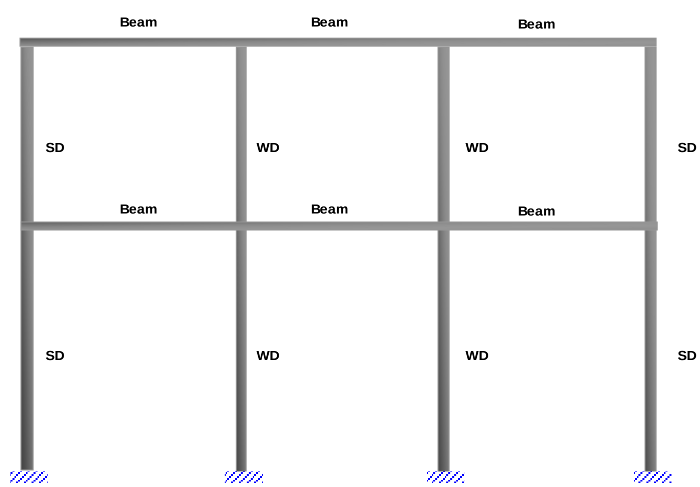


Figure 6-20. Section Assigned to Both Directions of The Two-Story Frame models

6.3.2 CONCRETE SHEAR WALL MODELS

The characterization of one and two-story concrete shear wall models is discussed in this section. Eighteen prototypes for each story height are created. One and Two-Story models are described together because they have the same characteristics except for the number of stories. Figure 6-21 presents an example of a plan view and elevation of the prototypes.

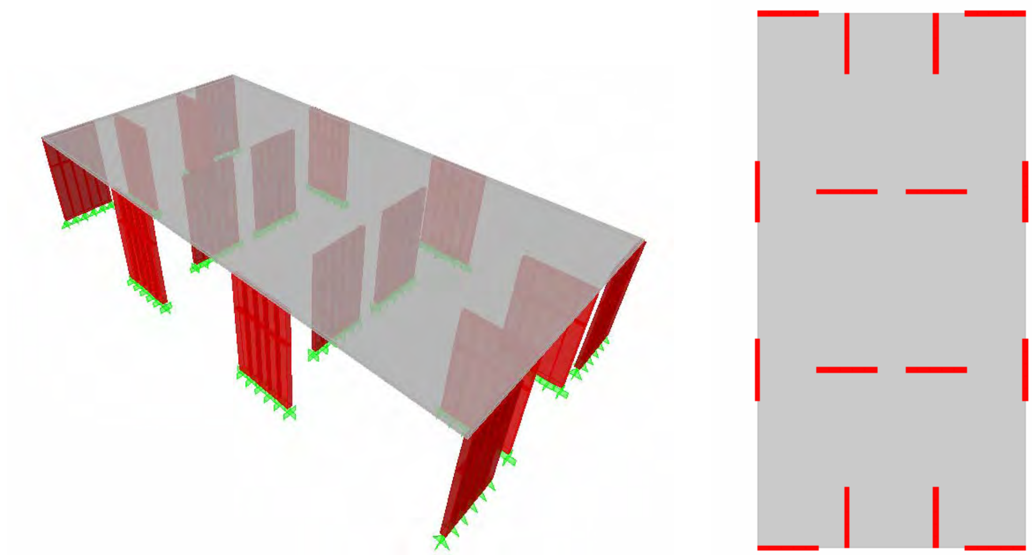


Figure 6-21. One-Story Shear Wall Model, Plan and 3D view.

6.3.2.1 ONE AND TWO-STORY MODELS

Figure 6-22 and Figure 6-23 show the typical models considered for one and two-story shear wall models, respectively. The tributary story weight assigned to each model is 65 kips. A description of concrete shear wall models generated and analyzed in this investigation is presented in Table 6-5. The first column indicates the model number, the second column describes the wall to floor area ratio of the models: two percentages, 1.67% and 3.0%, have been considered in prototypes; the third column refers to the orientation of the walls. The last column contains the story height of the one and two reinforced concrete shear wall model: the three heights considered are 96, 120 and 144 in. Two-story concrete shear wall models have the same height for both stories.

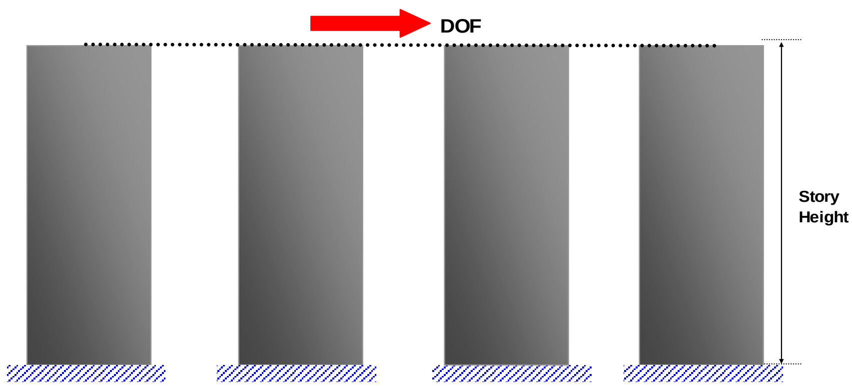


Figure 6-22. Typical One-Story Reinforced Concrete Shear Wall Model

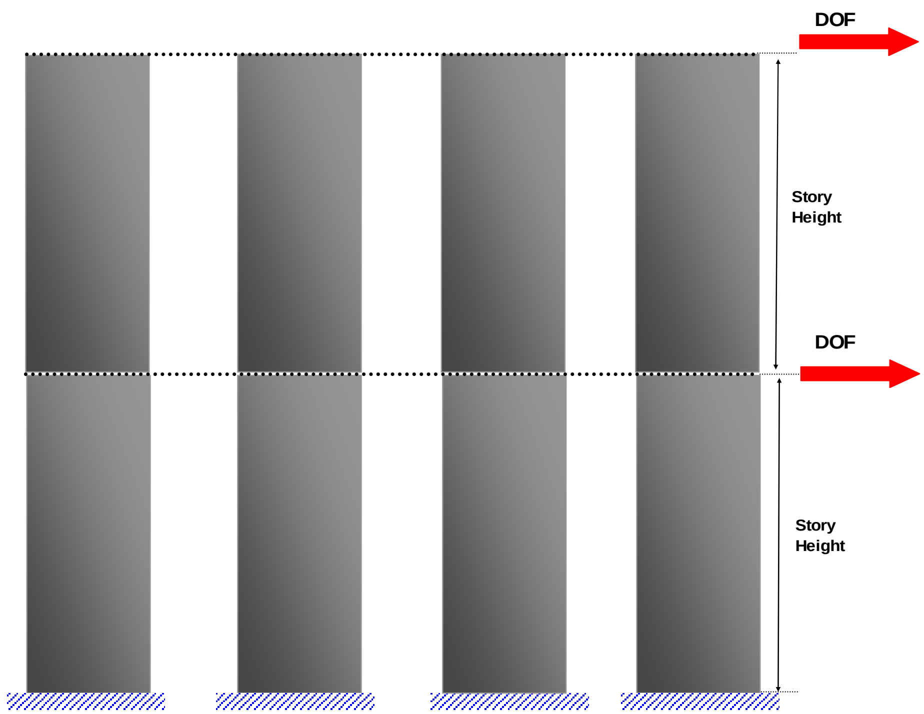


Figure 6-23. Typical Two-Story Reinforced Concrete Shear Wall Model

Table 6-5. Description of One and Two-Story Shear Wall Models

MODEL	Wall (%)	Direction	Story Height (in)
1	1.67	1	96
2	1.67	2	96
3	1.67	3	96
4	1.67	1	120
5	1.67	2	120
6	1.67	3	120
7	1.67	1	144
8	1.67	2	144
9	1.67	3	144
10	3	1	96
11	3	2	96
12	3	3	96
13	3	1	120
14	3	2	120
15	3	3	120
16	3	1	144
17	3	2	144
18	3	3	144

Direction 1 = All walls oriented in both directions (Both Directions)
Direction 2 = All walls oriented in the direction of shaking. (Strong Direction)
Direction 3= All walls oriented in the direction opposite to shaking (Weak Direction)

For shear wall characterization, in addition to the geometry description, it is necessary to analyze nonlinear flexural properties, as moment-curvature relationships, and also nonlinear shear behavior of each element. Next, the section properties, reinforcing and nonlinear properties of the elements are discussed.

Drawings of cross sections of the wall elements defined to analyze the nonlinear properties of the models are shown in Figure 6-24 and Figure 6-25. From these plots, it can be seen that the sections are lightly reinforced with typical reinforcing bars of #3@10” and #3@11”.

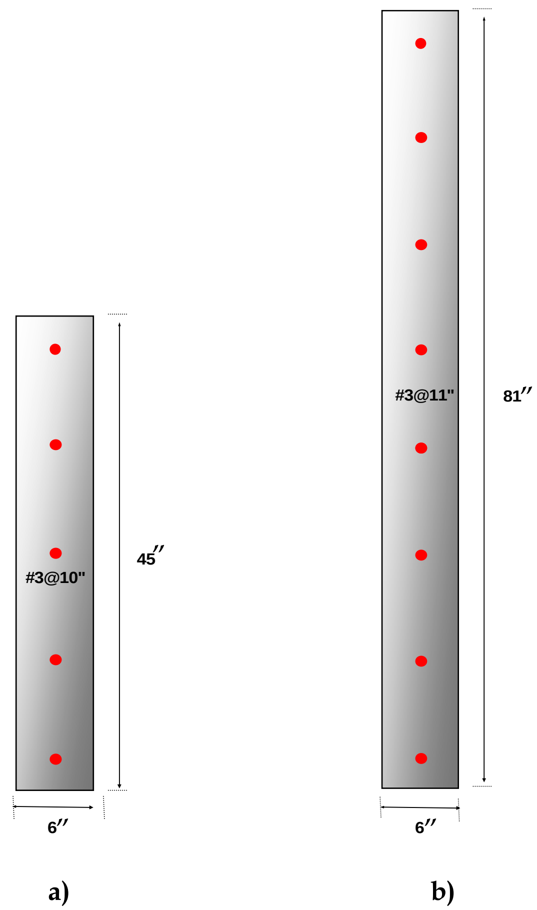


Figure 6-24. Cross Section of First and Second Story Walls Oriented in the Strong Direction (SD). One and Two-Story Reinforced Concrete Shear Wall Model. a) Models with a percentage of walls of 1.67% (Wall_1.67_SD) , and b) Models with a percentage of walls of 3.0%(Wall_3.0-SD)

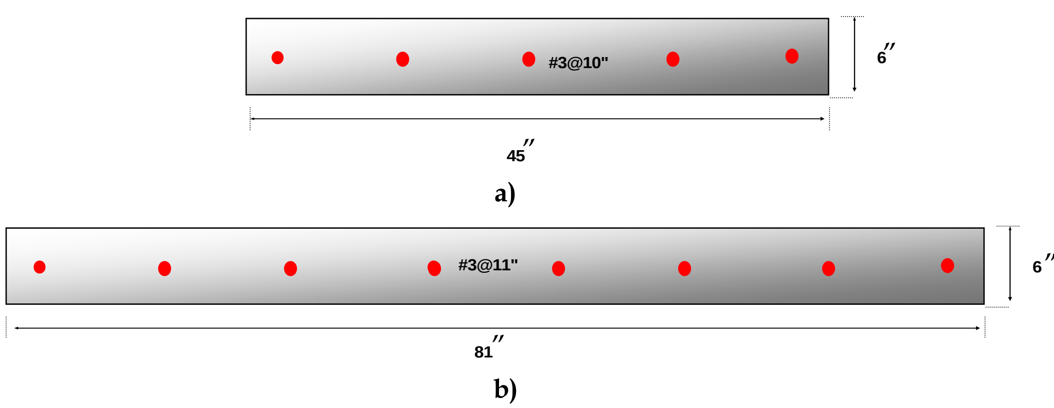


Figure 6-25. Cross Section of First and Second Story Walls Oriented in the Weak Direction (WD). One and Two-Story Reinforced Concrete Shear Wall Model. a) Models with a percentage of walls of 1.67% (Wall_1.67_WD) , and b) Models with a percentage of walls of 3.0%(Wall_3.0-WD)

After the shear wall sections were determined, their flexural properties and shear area were found and they aresummarized in Table 6-6. The same pattern used to codify the frame section names was followed to codify the wall sections. The moment of inertia, cracking moment, yield moment, yield curvature, ultimate curvature and shear area of the sections are presented in Table 6-6.

Due to the light reinforcement of the walls, and high uncracked strength, typical moment- curvature relationship show a curious behavior. The cracking moment of the sections is greater than the yield moment, resulting in a negative stiffness when cracking moment is reached. Figure 6-26 plots a typical moment curvature relationship calculated.

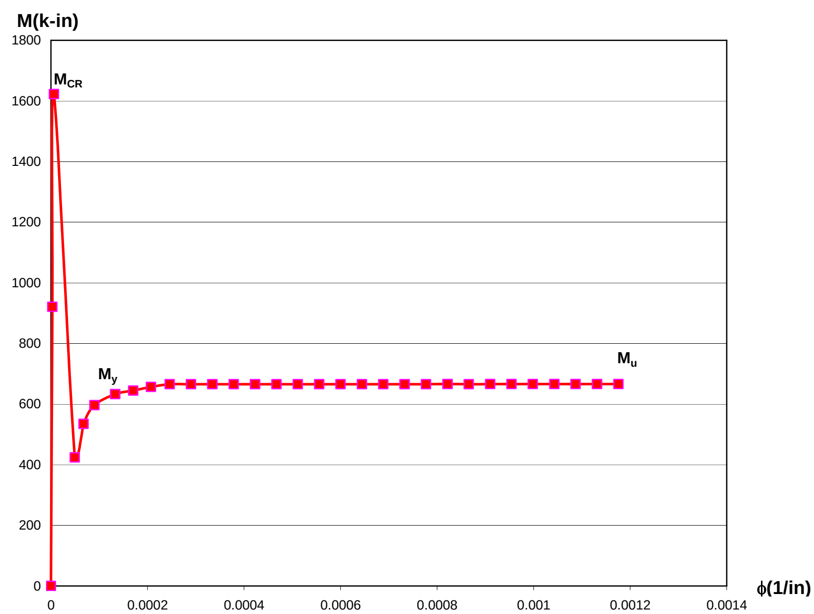


Figure 6-26. Example of Calculated Moment Curvature Relationship of Typical One and Two-Story Reinforced Concrete Shear Wall Model

Because many numerical models do not allow negative stiffness and to take into account the initial stiffness up to cracking moment, two moment-curvature relationships were used as an approximation (Figure 6-27). The first one, elastoplastic with breaking point at cracking moment, is used when models have not reached the cracking moment.

The second one, a bilinear curve with breaking point at yield and ultimate moment is used when models entered in the fictitious plasticity of curve 1. Cracking moment occurs at low deformation values, as structures usually incur in large deformations in a very short time when submitted to real earthquakes excitation, engineers usually use moment curvatures curves that only takes in account yield moment and ultimate moment. For this study, as we are considering a wide range of peak ground acceleration, using both curves lead to a more realistic estimation of seismic behavior for the range of low peak ground acceleration.

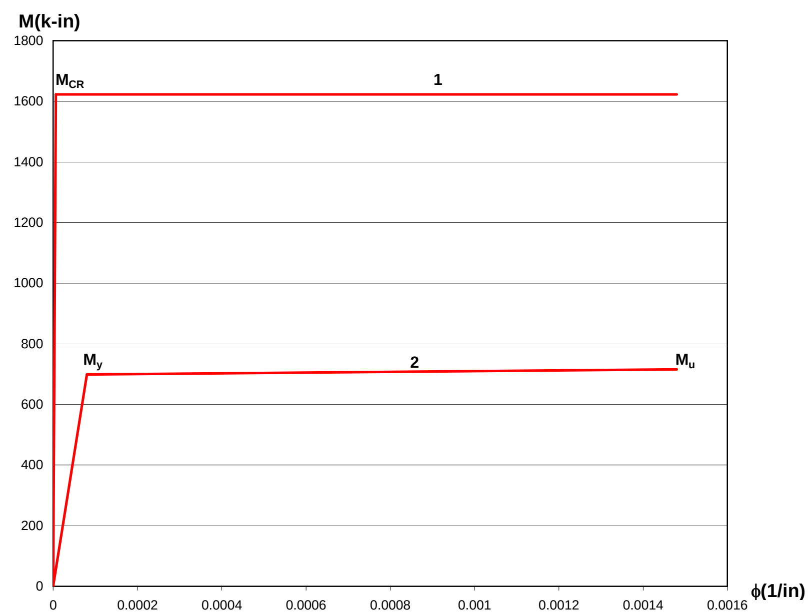


Figure 6-27. Example of Moment Curvature Relationship used for nonlinear analysis of Typical One and Two-Story Reinforced Concrete Shear Wall Model

Table 6-6. Sections Properties of Two-Story Frame models Prototypes

Section	Inercia (in^4)	M_{CR} (kip-in)	M_y (kip-in)	M_u (kip-in)	ϕ_y (1/in)	ϕ_u (1/in)	A_{sh} (in^2)
Wall_1.67-SD	45600.00	831	698	715	0.00018	0.00148	255
Wall_1.67_WD	810.00	110	96	96	0.00103	0.00928	255
Wall_3.0-SD	266000.00	2695	2034	2095	0.00011	0.00094	405
Wall_3.0_WD	1458.00	199	153	153	0.00116	0.01044	405

To define the nonlinear behavior of walls it is necessary to consider not only flexural properties, but also nonlinear shear properties. The shear properties of the walls section are presented in Table 6-7 and Table 6-8. Typical Shear Stress Strain behavior of these sections is presented in Figure 6-28. Table 6-7 contains the cracking shear stress, the shear reinforcement ratio, the product of reinforcement ratio and yield stress of the reinforcing bars that defines the yield shear stress, as seen in Chapter 4. Column five identifies the yielding shear stress assigned to the section. Because of the lightly reinforced section, the contribution of the steel is less than the cracking shear stress, thus a yielding shear equal to cracking shear is assigned, and contribution of the steel reinforcement is neglected.

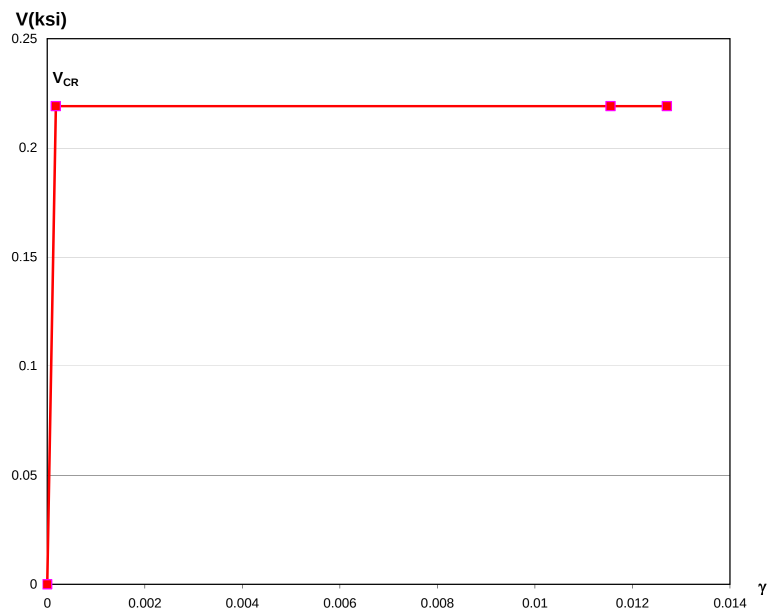


Figure 6-28. Example of Shear Stress Strain Relationship of Typical One and Two-Story Reinforced Concrete Shear Wall Model

Table 6-7. Sections Shear Stress and Strain Properties of Two-Story Frame models Prototypes

Section	v_{cr}(ksi)	ρ_y	$\rho\ f_y$(ksi)	v_y(ksi)	γ_y
Wall_1.67-SD	0.22	0.0017	0.102	0.22	0.012
Wall_1.67_WD	0.22	0.0017	0.102	0.22	0.012
Wall_3.0-SD	0.22	0.0017	0.102	0.22	0.012
Wall_3.0_WD	0.22	0.0017	0.102	0.22	0.012

Table 6-8 contains the shear force – shear deformation break points that defines the contribution of shear forces to the displacement. V_{cr} and V_y are the cracking shear force and the yielding shear force, respectively. Column four shows the yielding shear deformation of the section for models with a story height of 96 in, column five presents the yielding shear deformation of the section for models with a story height of 120 in, and the last column is for a story height of 144 in.

Table 6-8. Sections shear force and shear deformation of Two-Story Frame models Prototypes

Section	V_{CR} (kip)	V_Y (kip)	δ_{shy} (in) for h=96″	δ_{shy}(in) for h=120″	δ_{shy}(in) for h=144″
Wall_1.67-SD	55.87	55.87	1.11	1.39	1.66
Wall_1.67_WD	55.87	55.87	1.11	1.39	1.66
Wall_3.0-SD	88.73	88.73	1.11	1.39	1.66
Wall_3.0_WD	88.73	88.73	1.11	1.39	1.66

7 MULTISTORY REINFORCED CONCRETE SHEAR WALL MODELS

7.1 INTRODUCTION

The metropolitan area of Puerto Rico contains many multistory residential building as shown in Figure 7-1. Inventory of multistory buildings (Godoy and Sosa, 2005) shows that in the metropolitan area there are more than 800 multistory building equal or higher than 6 stories. This chapter explains the procedures followed to define the analytical models to study the seismic vulnerability of these structures. The most relevant characteristics of the models are described also in this chapter. All units used here are kip-in.

Figure 7-1. Panoramic view of multistory buildings in San Juan Area.

7.2 DEFINITION OF ANALYTICAL MODELS

Multistory residential structural drawings were collected from the Regulations and Permits Administration in Puerto Rico, San Juan office. A total of 13 structural drawings were used in this investigation. Figure 7-2 and Figure 7-3 present an example of the front elevation and plan view of the buildings collected. The structural drawings shows a common lateral resisting system. All models present reinforced concrete shear walls oriented in both directions as the main system to resist earthquake loads, thus this system was chosen as representative of the multistory residential buildings in this investigation. Due to the variability of structural parameters, real structures were modeled in both directions instead creating prototypes models. A total of 26 models were obtained from the structural drawings.

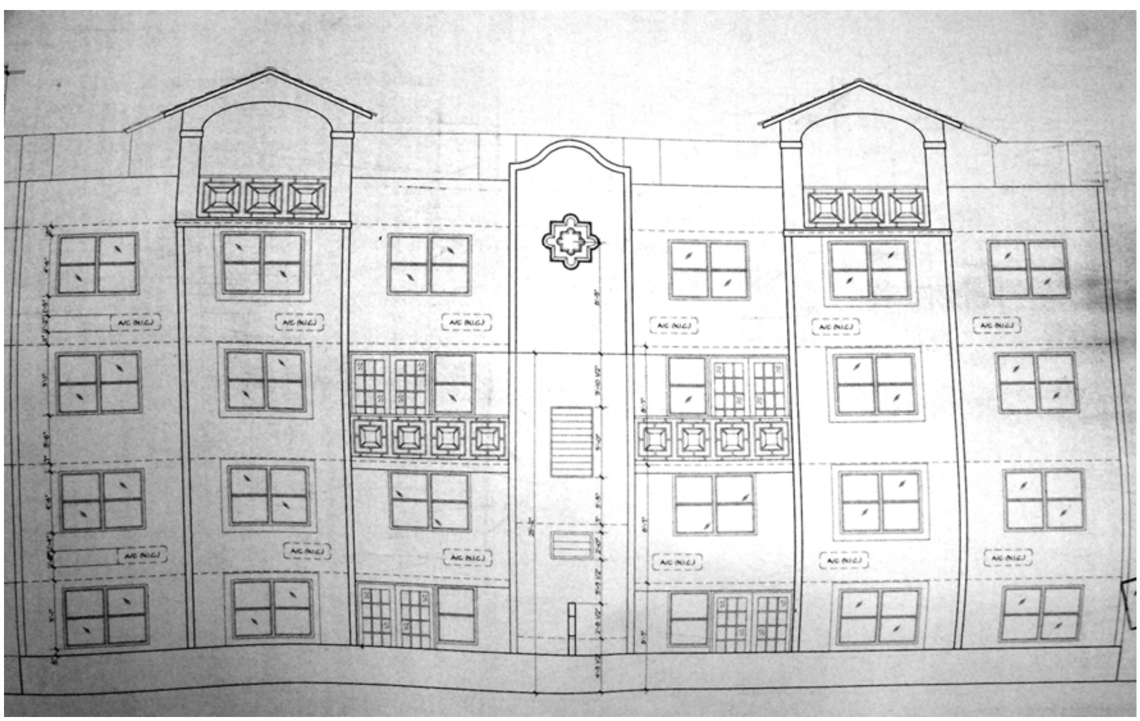


Figure 7-2. Example of a Front Elevation of a Multistory Building

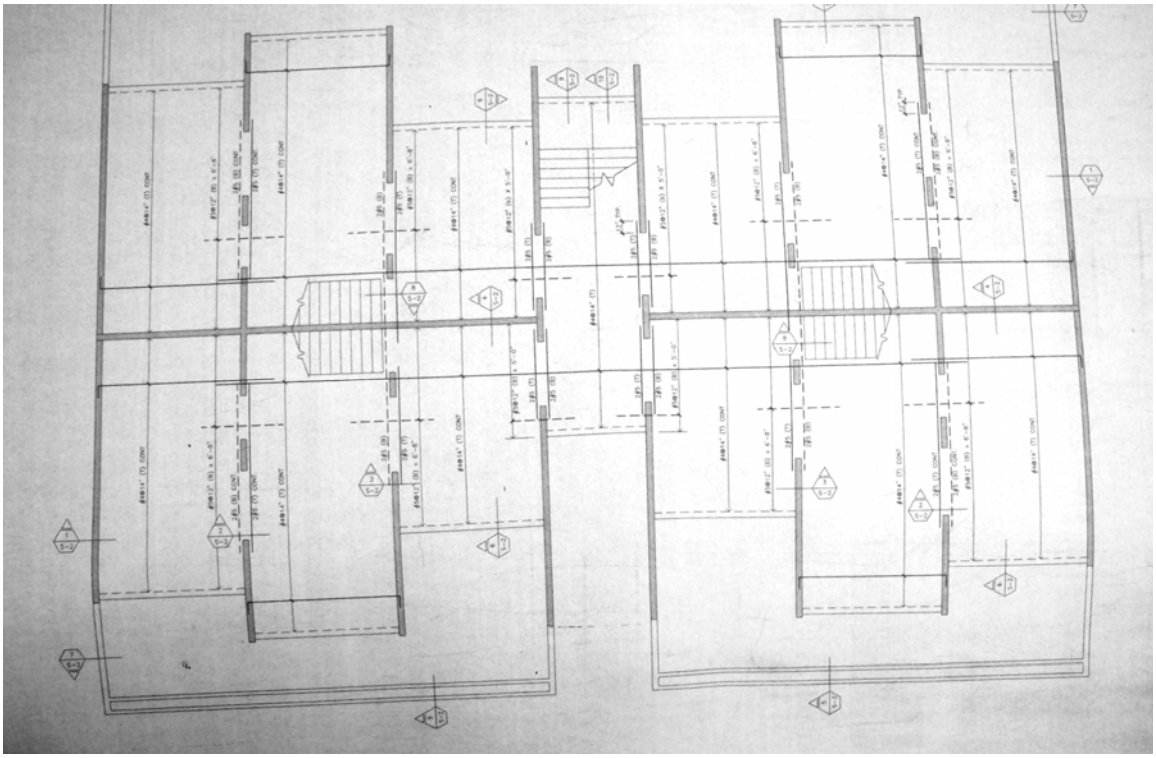


Figure 7-3. Example of a Plan View of a Multistory Building

7.3 MODEL DESCRIPTION

After compiling all the information, 26 models were obtained. The characterization of the multistory models is discussed in this section. All models have the same material properties: concrete strength f'_c=3 ksi, modulus of elasticity E=3,200 ksi, Shear modulus G=1200 ksi, and reinforcing bars yield strength f_y=60 ksi.

Figure 7-4 shows an example of a three story wall model studied. Walls are considered as cantilever walls with a common lateral degree of freedom at each level.

A description of the multistory reinforced concrete shear wall models analyzed in this investigation is shown in Table 7-1. The first column indicates the models, the second column shows the number of stories of each model: models from 3 stories to 10 stories were analyzed; the next columns shows the wall to floor area ratio of the models: a range of percentages from 0.3% to 6.7% were found. The fourth column describes the orientation of the models studied, direction 1 refers to North-South direction of the building and direction 2 refers to East-West direction of the building. The fifth column corresponds to the story height; common height ranges from 8 to 9.5 ft. The last column contains the tributary weight that corresponds to each model.

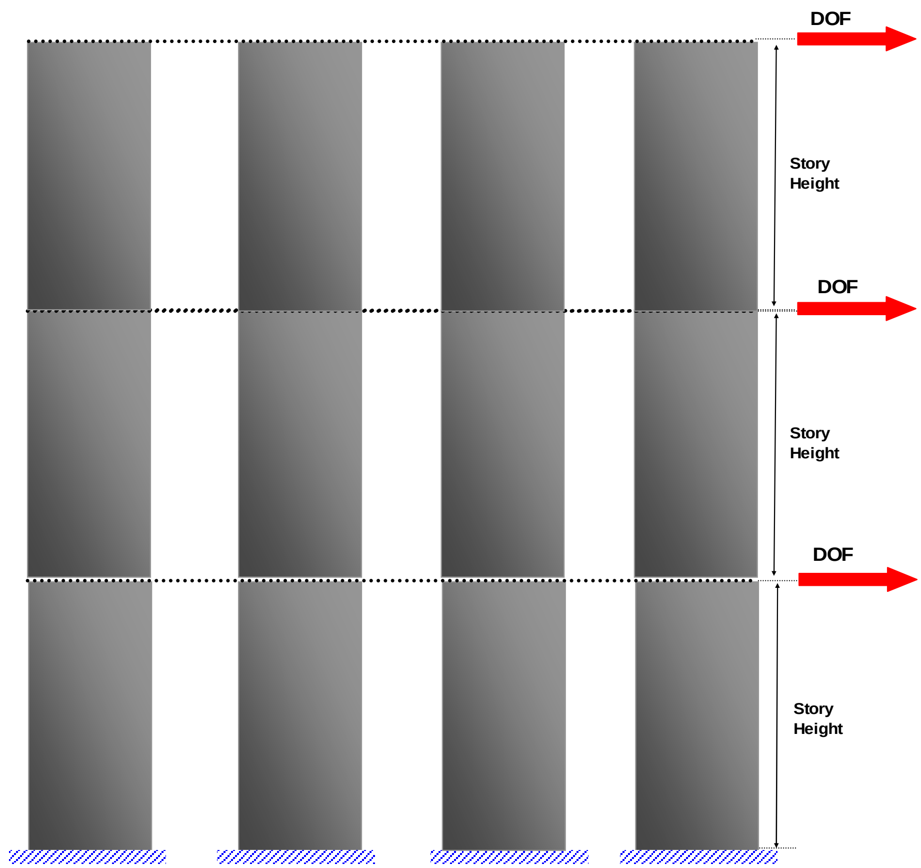


Figure 7-4. Example of a Multistory Reinforced Concrete Shear Wall Model

A sketch explaining the walls section reinforcement and geometry is presented in Figure 7-5. Four types of reinforcement are shown: horizontal and vertical wall reinforcement that applies to all walls, and in some cases boundaries elements and also a central element were found. The cross sections reinforcement of all of the models is presented in Table 7-2.

Table 7-1. Description of Multistory Shear Wall Models

MODEL	Number of Stories	Wall (%)	Direction	Story Height (in)	W(kip)
1	8	2.3	1	113	160
2	8	1.0	2	113	580
3	8	5.4	1	105	140
4	8	1.7	2	105	435
5	4	2.8	1	102	200
6	4	0.3	2	102	340
7	7	5.6	1	96	85
8	7	1.1	2	96	135
9	6	2.2	1	96	320
10	6	0.7	2	96	150
11	10	4.3	1	101	36
12	10	1.2	2	101	494
13	5	3.1	1	106	280
14	5	0.5	2	106	412
15	3	5.3	1	96	163
16	3	1.3	2	96	133
17	3	5.6	1	96	184
18	3	1.2	2	96	147
19	4	2.2	1	104	26
20	4	6.7	2	104	32
21	4	4.5	1	104	110
22	4	2.5	2	104	40
23	3	3.9	1	101	195
24	3	1.4	2	101	88
25	4	2.7	1	101	315
26	4	0.7	2	101	272

Direction 1 = Walls oriented in North-South direction
Direction 2= Walls oriented in East-West direction

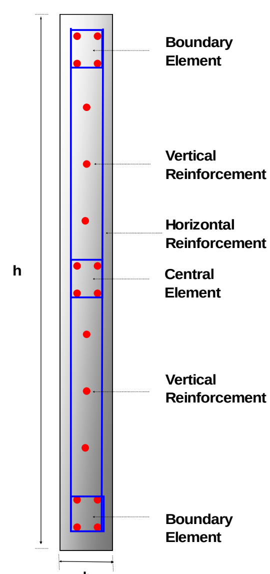


Figure 7-5. Cross Section Sketch of Multistory Shear Wall Models

Table 7-2. Cross Sections Reinforcement of Multistory Shear Wall Models

Model No.	Section No.	Vertical Reinforcement	No. Layer Vertical Reinforcement	Boundary Element	No. Layer Boundary Element	Center Element	No. Layer Center Element	Horizontal Reinforcement	No. Layer Horizontal Reinforcement
1	1	#5@12	2	N/A	N/A	N/A	N/A	#5@12	2
	2	#5@12	2	N/A	N/A	N/A	N/A	#5@12	2
	3	#5@12	2	N/A	N/A	N/A	N/A	#5@12	2
	4	#5@12	2	N/A	N/A	N/A	N/A	#5@12	2
2	1	#5@12	2	N/A	N/A	N/A	N/A	#5@12	2
	2	#5@12	2	N/A	N/A	N/A	N/A	#5@12	2
	3	#5@12	2	N/A	N/A	N/A	N/A	#5@12	2
	4	#5@12	2	N/A	N/A	N/A	N/A	#5@12	2
	5	#5@12	2	N/A	N/A	N/A	N/A	#5@12	2
	6	#5@12	2	N/A	N/A	N/A	N/A	#5@12	2
	7	#5@12	2	N/A	N/A	N/A	N/A	#5@12	2
	8	#5@12	2	N/A	N/A	N/A	N/A	#5@12	2
	9	#5@12	2	N/A	N/A	N/A	N/A	#5@12	2
	10	#5@12	2	N/A	N/A	N/A	N/A	#5@12	2
	11	#5@12	2	N/A	N/A	N/A	N/A	#5@12	2
3	1	#3@12	2	N/A	N/A	N/A	N/A	#3@12	2
	2	#3@12	2	N/A	N/A	N/A	N/A	#3@12	2
	3	#3@12	2	N/A	N/A	N/A	N/A	#3@12	2
	4	#3@12	2	N/A	N/A	N/A	N/A	#3@12	2
	5	#3@12	2	N/A	N/A	N/A	N/A	#3@12	2
	6	#3@12	2	N/A	N/A	N/A	N/A	#3@12	2
	7	#3@12	2	N/A	N/A	N/A	N/A	#3@12	2
	8	#3@12	2	N/A	N/A	N/A	N/A	#3@12	2
4	1	#3@12	2	N/A	N/A	N/A	N/A	#3@12	2
	2	#3@12	2	N/A	N/A	N/A	N/A	#3@12	2
	3	#3@12	2	N/A	N/A	N/A	N/A	#3@12	2
	4	#3@12	2	N/A	N/A	N/A	N/A	#3@12	2
	5	#3@12	2	N/A	N/A	N/A	N/A	#3@12	2
5	1	#4@12	1	N/A	N/A	N/A	N/A	#4@12	1
	2	#4@12	1	N/A	N/A	N/A	N/A	#4@12	1
	3	#4@12	1	N/A	N/A	N/A	N/A	#4@12	1
	4	#4@12	1	N/A	N/A	N/A	N/A	#4@12	1
	5	#4@12	1	N/A	N/A	N/A	N/A	#4@12	1
6	1	#4@12	2	N/A	N/A	N/A	N/A	#4@12	2
7	1	#4@12	1	N/A	N/A	N/A	N/A	#4@12	1
	2	#4@12	1	N/A	N/A	N/A	N/A	#4@12	1
	3	#4@12	1	N/A	N/A	N/A	N/A	#4@12	1
	4	#4@12	1	N/A	N/A	N/A	N/A	#4@12	1
	5	#4@12	1	N/A	N/A	N/A	N/A	#4@12	1
8	1	#4@12	2	18#9 @ 6"	9	10#6 @6	5.00	#4@12	2
9	1	#4@12	1	N/A	N/A	N/A	N/A	#4@12	1
	2	#4@12	1	N/A	N/A	N/A	N/A	#4@12	1
	3	#4@12	1	N/A	N/A	N/A	N/A	#4@12	1
	4	#4@12	1	N/A	N/A	N/A	N/A	#4@12	1
	5	#4@12	1	N/A	N/A	N/A	N/A	#4@12	1
10	1	#4@12	2	10#5 @ 6	5	10#5 @ 6	5.00	#4@12	2

Table 7-2. Continuation

Model No.	Section No.	Vertical Reinforcement	No. Layer Vertical Reinforcement	Boundary Element	No. Layer Boundary Element	Center Element	No. Layer Center Element	Horizontal Reinforcement	No. Layer Horizontal Reinforcement
11	1	#4@12	2	N/A	N/A	N/A	N/A	#4@12	2
	2	#4@12	2	N/A	N/A	N/A	N/A	#4@12	2
	3	#4@12	2	N/A	N/A	N/A	N/A	#4@12	2
	4	#4@12	2	N/A	N/A	N/A	N/A	#4@12	2
	5	#4@12	2	N/A	N/A	N/A	N/A	#4@12	2
	6	#4@12	2	N/A	N/A	N/A	N/A	#4@12	2
	7	#4@12	2	N/A	N/A	N/A	N/A	#4@12	2
	8	#4@12	2	N/A	N/A	N/A	N/A	#4@12	2
	9	#4@12	2	N/A	N/A	N/A	N/A	#4@12	2
	10	#4@12	2	N/A	N/A	N/A	N/A	#4@12	2
	11	#4@12	2	N/A	N/A	N/A	N/A	#4@12	2
	12	#4@12	2	N/A	N/A	N/A	N/A	#4@12	2
	13	#4@12	2	N/A	N/A	N/A	N/A	#4@12	2
	14	#4@12	2	N/A	N/A	N/A	N/A	#4@12	2
	15	#4@12	2	N/A	N/A	N/A	N/A	#4@12	2
	16	#4@12	2	N/A	N/A	N/A	N/A	#4@12	2
12	1	#4@12	2	N/A	N/A	N/A	N/A	#4@12	2
	2	#4@12	2	N/A	N/A	N/A	N/A	#4@12	2
	3	#4@12	2	N/A	N/A	N/A	N/A	#4@12	2
	4	#4@12	2	N/A	N/A	N/A	N/A	#4@12	2
	5	#4@12	2	N/A	N/A	N/A	N/A	#4@12	2
13	1	#3@11	2	6#6 @ 6	3	N/A	N/A	#3@11	2
	2	#3@11	2	6#6 @ 6	3	N/A	N/A	#3@11	2
	3	#4@12	1	N/A	N/A	N/A	N/A	#4@12	1
	4	#4@12	1	N/A	N/A	N/A	N/A	#4@12	1
	5	#4@12	1	N/A	N/A	N/A	N/A	#4@12	1
	6	#4@12	1	N/A	N/A	N/A	N/A	#4@12	1
14	1	#3@11	2	6#6 @ 6	3	N/A	N/A	#3@11	2
	2	#3@11	2	4#6 @ 6	2	N/A	N/A	#3@11	2
	3	#3@11	2	4#6 @ 6	2	N/A	N/A	#3@11	2
	4	#3@11	2	6#6 @ 6	3	N/A	N/A	#3@11	2
	5	#3@11	2	6#6 @ 6	3	N/A	N/A	#3@11	2
15	1	#4@12	1	N/A	N/A	N/A	N/A	#4@12	1
	2	#4@12	1	N/A	N/A	N/A	N/A	#4@12	1
	3	#4@12	1	10#5 @ 6"	5	N/A	N/A	#4@12	1
	4	#4@12	1	10#5 @ 6"	6	N/A	N/A	#4@12	1
	5	#4@12	1	N/A	N/A	N/A	N/A	#4@12	1
	6	#4@12	1	N/A	N/A	N/A	N/A	#4@12	1
	7	#4@12	1	N/A	N/A	N/A	N/A	#4@12	1
	8	#4@12	1	N/A	N/A	N/A	N/A	#4@12	1
	9	#4@12	1	N/A	N/A	N/A	N/A	#4@12	1
16	1	#4@12	2	N/A	N/A	N/A	N/A	#4@12	2
	2	#4@12	2	N/A	N/A	N/A	N/A	#4@12	2
	3	#4@12	2	N/A	N/A	N/A	N/A	#4@12	2
17	1	#4@12	1	N/A	N/A	N/A	N/A	#4@12	1
	2	#4@12	1	N/A	N/A	N/A	N/A	#4@12	1
	3	#4@12	1	10#5 @ 6	5	N/A	N/A	#4@12	1
	4	#4@12	1	10#5 @ 6	6	N/A	N/A	#4@12	1
	5	#4@12	1	N/A	N/A	N/A	N/A	#4@12	1
	6	#4@12	1	N/A	N/A	N/A	N/A	#4@12	1
	7	#4@12	1	N/A	N/A	N/A	N/A	#4@12	1
	8	#4@12	1	N/A	N/A	N/A	N/A	#4@12	1
	9	#4@12	1	N/A	N/A	N/A	N/A	#4@12	1
	10	#4@12	1	N/A	N/A	N/A	N/A	#4@12	1
18	1	#4@12	2	N/A	N/A	N/A	N/A	#4@12	2
	2	#4@12	2	N/A	N/A	N/A	N/A	#4@12	2
	3	#4@12	2	N/A	N/A	N/A	N/A	#4@12	2
19	1	#4@15	1	N/A	N/A	N/A	N/A	#4@15	1
	2	#4@15	1	N/A	N/A	N/A	N/A	#4@15	1
	3	#4@15	1	N/A	N/A	N/A	N/A	#4@15	1
	4	#4@15	1	N/A	N/A	N/A	N/A	#4@15	1
20	1	#4@15	1	N/A	N/A	N/A	N/A	#4@15	1

Table 7-2. Continuation

Model No.	Section No.	Vertical Reinforcement	No. Layer Vertical Reinforcement	Boundary Element	No. Layer Boundary Element	Center Element	No. Layer Center Element	Horizontal Reinforcement	No. Layer Horizontal Reinforcement
21	1	#4@12	1	N/A	N/A	N/A	N/A	#4@12	1
	2	#4@12	1	N/A	N/A	N/A	N/A	#4@12	1
	3	#4@12	1	N/A	N/A	N/A	N/A	#4@12	1
	4	#4@12	1	N/A	N/A	N/A	N/A	#4@12	1
	5	#4@12	1	N/A	N/A	N/A	N/A	#4@12	1
	6	#4@12	1	N/A	N/A	N/A	N/A	#4@12	1
	7	#4@12	1	N/A	N/A	N/A	N/A	#4@12	1
	8	#4@12	1	N/A	N/A	N/A	N/A	#4@12	1
	9	#4@12	1	N/A	N/A	N/A	N/A	#4@12	1
22	1	#4@12	1	N/A	N/A	N/A	N/A	#4@12	1
	2	#4@12	1	N/A	N/A	N/A	N/A	#4@12	1
	3	#4@12	1	N/A	N/A	N/A	N/A	#4@12	1
23	1	#4@12	1	N/A	N/A	N/A	N/A	#4@12	1
	2	#4@12	1	N/A	N/A	N/A	N/A	#4@12	1
	3	#4@12	1	N/A	N/A	N/A	N/A	#4@12	1
	4	#4@12	1	N/A	N/A	N/A	N/A	#4@12	1
	5	#4@12	1	N/A	N/A	N/A	N/A	#4@12	1
	6	#4@12	1	N/A	N/A	N/A	N/A	#4@12	1
	7	#4@12	1	N/A	N/A	N/A	N/A	#4@12	1
	8	#4@12	1	N/A	N/A	N/A	N/A	#4@12	1
	9	#4@12	1	N/A	N/A	N/A	N/A	#4@12	1
	10	#4@12	1	N/A	N/A	N/A	N/A	#4@12	1
	11	#4@12	1	N/A	N/A	N/A	N/A	#4@12	1
	12	#4@12	1	N/A	N/A	N/A	N/A	#4@12	1
	13	#4@12	1	N/A	N/A	N/A	N/A	#4@12	1
	14	#4@12	1	N/A	N/A	N/A	N/A	#4@12	1
24	1	#4@12	1	N/A	N/A	N/A	N/A	#4@12	1
	2	#4@12	1	N/A	N/A	N/A	N/A	#4@12	1
25	1	#3@8	1	N/A	N/A	N/A	N/A	#3@8	1
	2	#3@8	1	N/A	N/A	N/A	N/A	#3@8	1
	3	#3@8	1	N/A	N/A	N/A	N/A	#3@8	1
	4	#3@8	1	N/A	N/A	N/A	N/A	#3@8	1
	5	#3@8	1	N/A	N/A	N/A	N/A	#3@8	1
	6	#3@8	1	N/A	N/A	N/A	N/A	#3@8	1
	7	#3@8	1	N/A	N/A	N/A	N/A	#3@8	1
	8	#3@8	1	N/A	N/A	N/A	N/A	#3@8	1
	9	#3@8	1	N/A	N/A	N/A	N/A	#3@8	1
	10	#3@8	1	N/A	N/A	N/A	N/A	#3@8	1
	11	#3@8	1	N/A	N/A	N/A	N/A	#3@8	1
26	1	#3@12	2	8#5 @ 6	4	N/A	N/A	#3@12	2
	2	#3@12	2	8#5 @ 6	4	N/A	N/A	#3@12	2
	3	#3@12	2	8#5 @ 6	4	N/A	N/A	#3@12	2

After all shear wall sections were analyzed, their flexural properties and shear area were calculated and they are summarized in Table 7-3. The first column indicates the model number, then the sections corresponding to each model are identified by a number. The moment of inertia, cracking moment, yield moment, yield curvature, ultimate curvature, and shear area of the sections are presented in the following columns.

In sections that present higher cracking moment than the yield moment, which have similar moment curvature behavior as the one and two-story shear wall models, the same approximation explained in Section 6.3.2.1 was used to apply the moment-curvature relationship.

Table 7-3. Sections Properties Multistory Models

Model	Section	b(in)	h(in)	Inertia (in^4)	M_{CR} (kip-in)	M_y (kip-in)	M_u (kip-in)	ϕ_y (1/in)	ϕ_u (1/in)	A_{sh} (in^2)
1	1	8	300	18000000.00	49295	94486	128716	0.00001	0.00009	2087
	2	8	330	23958000.00	59647	102710	153256	0.00001	0.00009	2298
	3	8	60	144000.00	1972	4435	5953	0.00005	0.00045	411
	4	8	36	31104.00	710	1826	2500	0.00009	0.00096	246
2	1	8	43	53004.67	1013	2120	3040	0.00007	0.00123	294
	2	8	105	771750.00	6039	13166	17530	0.00003	0.00029	722
	3	8	126	1333584.00	8696	15908	23309	0.00002	0.00025	867
	4	8	126	1333584.00	8696	15908	23309	0.00002	0.00025	867
	5	8	116	1040597.33	7370	13457	19613	0.00003	0.00028	797
	6	8	140	1829333.33	10735	19373	28358	0.00002	0.00023	964
	7	8	140	1829333.33	10735	19373	28358	0.00002	0.00023	964
	8	8	63	166698.00	2174	19373	28358	0.00002	0.00023	432
	9	8	115	1013916.67	7244	13285	19423	0.00003	0.00028	790
	10	8	144	1990656.00	11358	20970	31430	0.00002	0.00021	994
	11	8	185	4221083.33	18746	33580	49742	0.00002	0.00017	1279
3	1	8	305	18915083.33	50952	40711	50564	0.00001	0.00019	2071
	2	8	305	18915083.33	50952	40711	50564	0.00001	0.00019	2071
	3	8	305	18915083.33	50952	40711	50564	0.00001	0.00019	2071
	4	8	305	18915083.33	50952	40711	50564	0.00001	0.00019	2071
	5	8	305	18915083.33	50952	40711	50564	0.00001	0.00019	2071
	6	8	305	18915083.33	50952	40711	50564	0.00001	0.00019	2071
	7	8	305	18915083.33	50952	40711	50564	0.00001	0.00019	2071
	8	8	305	18915083.33	50952	40711	50564	0.00001	0.00019	2071
4	1	8	546	108514224.00	163285	128400	159600	0.00001	0.00011	3712
	2	8	280	14634666.67	42941	34444	43256	0.00001	0.00021	1902
	3	8	426	51539184.00	99398	78679	98342	0.00001	0.00014	2840
	4	8	156	2530944.00	13329	11135	13909	0.00002	0.00037	1059
	5	8	110	887333.33	6627	5637	7050	0.00003	0.00052	745
5	1	6	464	49948672.00	88442	72268	103264	0.00001	0.00014	2374
	2	6	131	1124045.50	7050	6177	8996	0.00002	0.00047	668
	3	6	30	13500.00	370	419	523	0.00010	0.00232	152
	4	6	208	4499456.00	17773	14929	21389	0.00001	0.00030	1062
	5	6	336	18966528.00	46377	42090	55484	0.00001	0.00015	1718
6	1	8	204	5659776.00	22794	33772	40598	0.00002	0.00017	1400
7	1	6	332	18297184.00	45279	37211	53066	0.00001	0.00014	1697
	2	6	138	1314036.00	7823	6667	9507	0.00002	0.00046	703
	3	6	58	97556.00	1382	2483	3712	0.00005	0.00038	299
	4	6	30	13500.00	370	419	522	0.00010	0.00166	152
	5	6	308	14609056.00	38969	32076	45726	0.00001	0.00021	1574
8	1	8	252	10668672.00	34783	232800	272400	0.00001	0.00007	1809
9	1	6	305	14186312.50	38214	64388	135308	0.00001	0.00017	1861
	2	6	305	14186312.50	38214	64388	135308	0.00001	0.00017	1861
	3	6	305	14186312.50	38214	64388	135308	0.00001	0.00017	1861
	4	6	305	14186312.50	38214	64388	135308	0.00001	0.00017	1861
	5	6	305	14186312.50	38214	64388	135308	0.00001	0.00017	1861
10	1	6	240	6912000.00	23662	94667	135308	0.00001	0.00008	2098

Table 7-3 Continuation

Model	Section	b(in)	h(in)	Inertia (in^4)	M_{CR} (kip-in)	M_y (kip-in)	M_u (kip-in)	ϕ_y (1/in)	ϕ_u (1/in)	A_{sh} (in^2)
11	1	6	305	14186312.50	38214	65388	95851	0.00001	0.00011	1591
	2	6	305	14186312.50	38214	65388	95851	0.00001	0.00011	1591
	3	6	305	14186312.50	38214	65388	95851	0.00001	0.00011	1591
	4	6	305	14186312.50	38214	65388	95851	0.00001	0.00011	1591
	5	6	305	14186312.50	38214	65388	95851	0.00001	0.00011	1591
	6	6	305	14186312.50	38214	65388	95851	0.00001	0.00011	1591
	7	6	305	14186312.50	38214	65388	95851	0.00001	0.00011	1591
	8	6	305	14186312.50	38214	65388	95851	0.00001	0.00011	1591
	9	6	305	14186312.50	38214	65388	95851	0.00001	0.00011	1591
	10	6	305	14186312.50	38214	65388	95851	0.00001	0.00011	1591
	11	6	305	14186312.50	38214	65388	95851	0.00001	0.00011	1591
	12	6	305	14186312.50	38214	65388	95851	0.00001	0.00011	1591
	13	6	305	14186312.50	38214	65388	95851	0.00001	0.00011	1591
	14	6	305	14186312.50	38214	65388	95851	0.00001	0.00011	1591
	15	6	305	14186312.50	38214	65388	95851	0.00001	0.00011	1591
	16	6	305	14186312.50	38214	65388	95851	0.00001	0.00011	1591
12	1	6	240	6912000.00	23662	38369	54730	0.00001	0.00014	1245
	2	6	240	6912000.00	23662	38369	54730	0.00001	0.00014	1245
	3	6	240	6912000.00	23662	38369	54730	0.00001	0.00014	1245
	4	6	120	864000.00	5915	9974	14212	0.00002	0.00027	618
	5	6	480	55296000.00	94646	150000	213600	0.00001	0.00007	2504
13	1	8	295	17114916.67	47666	72439	90632	0.00001	0.0002	2029
	2	8	295	17114916.67	47666	72439	90632	0.00001	0.0002	2029
	3	6	180	2916000.00	13310	11377	16438	0.00001	0.00035	919
	4	6	180	2916000.00	13310	11377	16438	0.00001	0.00035	919
	5	6	180	2916000.00	13310	11377	16438	0.00001	0.00035	919
	6	6	204	4244832.00	17096	14513	20957	0.00001	0.00022	1042
14	1	8	150	2250000.00	12324	26567	31722	0.00002	0.00031	1032
	2	8	36	31104.00	710	2841	3425	0.0001	0.00066	244
	3	8	36	31104.00	710	2841	3425	0.0001	0.00066	244
	4	8	72	248832.00	2839	8980	11257	0.00004	0.00041	492
	5	8	72	248832.00	2839	8980	11257	0.00004	0.00041	492
15	1	6	122	907924.00	6114	5305	7704	0.00002	0.00036	622
	2	6	70	171500.00	2013	2067	2810	0.00004	0.0006	356
	3	6	159	2009839.50	10385	28900	33817	0.00002	0.00016	822
	4	6	159	2009839.50	10385	28900	33817	0.00002	0.00016	822
	5	6	198	3881196.00	16105	13354	19136	0.00001	0.00022	1010
	6	6	198	3881196.00	16105	13354	19136	0.00001	0.00022	1010
	7	6	165	2246062.50	11184	13518	19158	0.00002	0.00019	849
	8	6	239	6825959.50	23465	19771	28621	0.00001	0.00018	1221
	9	6	289	12068784.50	34310	27977	39655	0.00001	0.00016	1476
16	1	8	94	553722.67	4840	7600	9279	0.00004	0.00033	642
	2	8	104	749909.33	5924	8781	10400	0.00003	0.00032	709
	3	8	104	749909.33	5924	8781	10400	0.00003	0.00032	709
17	1	6	122	907924.00	6114	5305	7704	0.00002	0.00036	622
	2	6	70	171500.00	2013	2067	2810	0.00004	0.0006	356
	3	6	159	2009839.50	10385	28900	33817	0.00002	0.00016	822
	4	6	159	2009839.50	10385	28900	33817	0.00002	0.00016	822
	5	6	198	3881196.00	16105	13354	19136	0.00001	0.00022	1010
	6	6	198	3881196.00	16105	13354	19136	0.00001	0.00022	1010
	7	6	165	2246062.50	11184	13518	19158	0.00002	0.00019	849
	8	6	239	6825959.50	23465	19771	28621	0.00001	0.00018	1221
	9	6	289	12068784.50	34310	27977	39655	0.00001	0.00016	1476
	10	6	289	12068784.50	34310	27977	39655	0.00001	0.00016	1476
18	1	8	94	553722.67	4840	7600	9279	0.00004	0.00033	642
	2	8	104	749909.33	5924	8781	10400	0.00003	0.00032	709
	3	8	104	749909.33	5924	8781	10400	0.00003	0.00032	709
19	1	5	165	1871718.75	9320	9747	13918	0.00002	0.0003	704
	2	5	165	1871718.75	9320	9747	13918	0.00002	0.0003	704
	3	5	165	1871718.75	9320	9747	13918	0.00002	0.0003	704
	4	5	165	1871718.75	9320	9747	13918	0.00002	0.0003	704
20	1	5	432	33592320.00	63886	64242	90277	0.00001	0.00009	1850

Table 7-3 Continuation

Model	Section	b(in)	h(in)	Inertia (in^4)	M_{CR} (kip-in)	M_y (kip-in)	M_u (kip-in)	ϕ_y (1/in)	ϕ_u (1/in)	A_{sh} (in^2)
21	1	6	174	2634012.00	12437	10386	14833	0.00001	0.00035	888
	2	6	174	2634012.00	12437	10386	14833	0.00001	0.00035	888
	3	6	174	2634012.00	12437	10386	14833	0.00001	0.00035	888
	4	6	174	2634012.00	12437	10386	14833	0.00001	0.00035	888
	5	6	66	143748.00	1789	1624	2296	0.00004	0.00104	335
	6	6	451	45866925.50	83555	68380	97783	0.00001	0.00014	2307
	7	6	451	45866925.50	83555	68380	97783	0.00001	0.00014	2307
	8	6	451	45866925.50	83555	68380	97783	0.00001	0.00014	2307
	9	6	451	45866925.50	83555	68380	97783	0.00001	0.00014	2307
22	1	6	78	237276.00	2499	2223	3153	0.00003	0.00061	397
	2	6	78	237276.00	2499	2223	3153	0.00003	0.00061	397
	3	6	78	237276.00	2499	2223	3153	0.00003	0.00061	397
23	1	6	342	20000844.00	48048	39584	56617	0.00001	0.00013	1749
	2	6	132	1149984.00	7158	6247	9069	0.00002	0.00033	673
	3	6	132	1149984.00	7158	6247	9069	0.00002	0.00033	673
	4	6	132	1149984.00	7158	6247	9069	0.00002	0.00033	673
	5	6	132	1149984.00	7158	6247	9069	0.00002	0.00033	673
	6	6	132	1149984.00	7158	6247	9069	0.00002	0.00033	673
	7	6	132	1149984.00	7158	6247	9069	0.00002	0.00033	673
	8	6	42	37044.00	725	705	974	0.00006	0.00122	213
	9	6	42	37044.00	725	705	974	0.00006	0.00122	213
	10	6	42	37044.00	725	705	974	0.00006	0.00122	213
	11	6	42	37044.00	725	705	974	0.00006	0.00122	213
	12	6	42	37044.00	725	705	974	0.00006	0.00122	213
	13	6	42	37044.00	725	705	974	0.00006	0.00122	213
	14	6	216	5038848.00	19166	16225	23424	0.00001	0.0002	1103
24	1	6	126	1000188.00	6522	5590	7990	0.00002	0.00051	635
	2	6	156	1898208.00	9997	8620	12444	0.00002	0.0004	796
25	1	5	134	1002543.33	6147	8337	12564	0.00002	0.0003	576
	2	5	285	9645468.75	27805	37154	56458	0.00001	0.00014	1233
	3	5	226	4809656.67	17485	22680	34662	0.00001	0.00017	975
	4	5	226	4809656.67	17485	22680	34662	0.00001	0.00017	975
	5	5	152	1463253.33	7909	10892	16734	0.00002	0.00025	655
	6	5	152	1463253.33	7909	10892	16734	0.00002	0.00025	655
	7	5	92	324453.33	2897	4429	6044	0.00004	0.0004	394
	8	5	290	10162083.33	28790	38654	59008	0.00001	0.00013	1255
	9	5	174	2195010.00	10364	13795	20989	0.00002	0.00022	750
	10	5	216	4199040.00	15972	21696	33270	0.00001	0.00018	933
	11	5	191	2903279.58	12488	17082	26256	0.00001	0.0002	825
26	1	8	102	707472.00	5699	14677	18128	0.00003	0.00032	701
	2	8	102	707472.00	5699	14677	18128	0.00003	0.00032	701
	3	8	165	2994750.00	14912	29455	38849	0.00002	0.00022	1136

The shear properties of the wall sections are presented in Table 7-4. The parameters that define the typical Shear Stress-Strain behavior of these sections is presented first. Columns three to five contain the cracking shear stress, the shear reinforcement ratio, the product of reinforcement ratio and yield stress of the reinforcing bars that defines the yield shear stress, as seen in Chapter 4. Column six identifies the yielding shear stress assigned to the section. If the contribution of the steel is less than the cracking shear stress, a yielding shear equal to the cracking shear is assigned, and the contribution of steel reinforcement is neglected. Columns eight to ten define the contribution of shear forces to the displacement, V_{cr} and V_y are the cracking shear force and the yielding shear force respectively. The last column contains the yielding shear deformation of the section.

Table 7-4. Shear Properties Multistory Models

Model	Section	v_{cr}(ksi)	ρ_y	$\rho\ f_y$(ksi)	v_y(ksi)	γ_y	V_{CR} (kip)	V_Y (kip)	δ_{shy} (in)
1	1	0.22	0.0068	0.41	0.41	0.0054	457.22	849.37	0.61
	2	0.22	0.0066	0.40	0.40	0.0054	503.36	915.34	0.61
	3	0.22	0.0078	0.47	0.47	0.0054	90.08	193.08	0.61
	4	0.22	0.0087	0.52	0.52	0.0054	53.94	128.49	0.61
2	1	0.22	0.0070	0.42	0.42	0.0054	64.43	123.51	0.61
	2	0.22	0.0070	0.42	0.42	0.0054	158.29	303.45	0.61
	3	0.22	0.0070	0.42	0.42	0.0054	189.97	364.18	0.61
	4	0.22	0.0070	0.42	0.42	0.0054	189.97	364.18	0.61
	5	0.22	0.0070	0.42	0.42	0.0054	174.66	334.84	0.61
	6	0.22	0.0070	0.42	0.42	0.0054	211.20	404.88	0.61
	7	0.22	0.0070	0.42	0.42	0.0054	211.20	404.88	0.61
	8	0.22	0.0070	0.42	0.42	0.0054	94.54	181.23	0.61
	9	0.22	0.0070	0.42	0.42	0.0054	173.18	331.98	0.61
	10	0.22	0.0070	0.42	0.42	0.0054	217.69	417.31	0.61
	11	0.22	0.0070	0.42	0.42	0.0054	280.19	537.14	0.61
3	1	0.22	0.0020	0.12	0.22	0.0054	453.82	248.57	0.56
	2	0.22	0.0020	0.12	0.22	0.0054	453.82	248.57	0.56
	3	0.22	0.0020	0.12	0.22	0.0054	453.82	248.57	0.56
	4	0.22	0.0020	0.12	0.22	0.0054	453.82	248.57	0.56
	5	0.22	0.0020	0.12	0.22	0.0054	453.82	248.57	0.56
	6	0.22	0.0020	0.12	0.22	0.0054	453.82	248.57	0.56
	7	0.22	0.0020	0.12	0.22	0.0054	453.82	248.57	0.56
	8	0.22	0.0020	0.12	0.22	0.0054	453.82	248.57	0.56
4	1	0.22	0.0024	0.14	0.22	0.0054	813.35	534.59	0.56
	2	0.22	0.0024	0.14	0.22	0.0054	416.64	273.84	0.56
	3	0.22	0.0024	0.14	0.22	0.0054	622.21	408.96	0.56
	4	0.22	0.0024	0.14	0.22	0.0054	231.91	152.42	0.56
	5	0.22	0.0024	0.14	0.22	0.0054	163.33	107.35	0.56
5	1	0.22	0.0028	0.17	0.22	0.0054	520.03	398.76	0.55
	2	0.22	0.0031	0.19	0.22	0.0054	146.38	124.27	0.55
	3	0.22	0.0034	0.20	0.22	0.0054	33.36	31.06	0.55
	4	0.22	0.0029	0.17	0.22	0.0054	232.67	184.79	0.55
	5	0.22	0.0029	0.17	0.22	0.0054	376.48	299.00	0.55
6	1	0.22	0.0044	0.26	0.26	0.0054	306.66	369.52	0.55
7	1	0.22	0.0020	0.12	0.22	0.0054	371.79	203.64	0.52
	2	0.22	0.0020	0.12	0.22	0.0054	154.07	84.39	0.52
	3	0.22	0.0020	0.12	0.22	0.0054	65.58	35.92	0.52
	4	0.22	0.0020	0.12	0.22	0.0054	33.36	18.27	0.52
	5	0.22	0.0020	0.12	0.22	0.0054	344.76	188.83	0.52
8	1	0.22	0.0040	0.24	0.24	0.0054	396.42	434.26	0.55
9	1	0.22	0.0020	0.12	0.22	0.0054	407.81	223.37	0.52
	2	0.22	0.0020	0.12	0.22	0.0054	407.81	223.37	0.52
	3	0.22	0.0020	0.12	0.22	0.0054	407.81	223.37	0.52
	4	0.22	0.0020	0.12	0.22	0.0054	407.81	223.37	0.52
	5	0.22	0.0020	0.12	0.22	0.0054	407.81	223.37	0.52
10	1	0.22	0.0040	0.24	0.24	0.0054	459.65	503.52	0.52

Table 7-4 Continuation

Model	Section	v_{cr}(ksi)	ρ_y	$\rho\ f_y$(ksi)	v_y(ksi)	γ_y	V_{CR} (kip)	V_Y (kip)	δ_{shy} (in)
11	1	0.22	0.0060	0.36	0.36	0.0054	348.61	572.83	0.54
	2	0.22	0.0060	0.36	0.36	0.0054	348.61	572.83	0.54
	3	0.22	0.0060	0.36	0.36	0.0054	348.61	572.83	0.54
	4	0.22	0.0060	0.36	0.36	0.0054	348.61	572.83	0.54
	5	0.22	0.0060	0.36	0.36	0.0054	348.61	572.83	0.54
	6	0.22	0.0060	0.36	0.36	0.0054	348.61	572.83	0.54
	7	0.22	0.0060	0.36	0.36	0.0054	348.61	572.83	0.54
	8	0.22	0.0060	0.36	0.36	0.0054	348.61	572.83	0.54
	9	0.22	0.0060	0.36	0.36	0.0054	348.61	572.83	0.54
	10	0.22	0.0060	0.36	0.36	0.0054	348.61	572.83	0.54
	11	0.22	0.0060	0.36	0.36	0.0054	348.61	572.83	0.54
	12	0.22	0.0060	0.36	0.36	0.0054	348.61	572.83	0.54
	13	0.22	0.0060	0.36	0.36	0.0054	348.61	572.83	0.54
	14	0.22	0.0060	0.36	0.36	0.0054	348.61	572.83	0.54
	15	0.22	0.0060	0.36	0.36	0.0054	348.61	572.83	0.54
	16	0.22	0.0060	0.36	0.36	0.0054	348.61	572.83	0.54
12	1	0.22	0.0060	0.36	0.36	0.0054	272.66	448.02	0.54
	2	0.22	0.0060	0.36	0.36	0.0054	272.66	448.02	0.54
	3	0.22	0.0060	0.36	0.36	0.0054	272.66	448.02	0.54
	4	0.22	0.0060	0.36	0.36	0.0054	135.44	222.56	0.54
	5	0.22	0.0060	0.36	0.36	0.0054	548.56	901.37	0.54
13	1	0.22	0.0050	0.30	0.30	0.0054	444.55	608.73	0.57
	2	0.22	0.0050	0.30	0.30	0.0054	444.55	608.73	0.57
	3	0.22	0.0030	0.18	0.22	0.0054	201.32	165.40	0.57
	4	0.22	0.0030	0.18	0.22	0.0054	201.32	165.40	0.57
	5	0.22	0.0030	0.18	0.22	0.0054	201.32	165.40	0.57
	6	0.22	0.0030	0.18	0.22	0.0054	228.27	187.54	0.57
14	1	0.22	0.0050	0.30	0.30	0.0054	226.10	309.60	0.57
	2	0.22	0.0050	0.30	0.30	0.0054	53.42	73.15	0.57
	3	0.22	0.0050	0.30	0.30	0.0054	53.42	73.15	0.57
	4	0.22	0.0050	0.30	0.30	0.0054	107.90	147.74	0.57
	5	0.22	0.0050	0.30	0.30	0.0054	107.90	147.74	0.57
15	1	0.22	0.0030	0.18	0.22	0.0054	136.21	111.91	0.52
	2	0.22	0.0030	0.18	0.22	0.0054	78.02	64.10	0.52
	3	0.22	0.0030	0.18	0.22	0.0054	180.15	148.01	0.52
	4	0.22	0.0030	0.18	0.22	0.0054	180.15	148.01	0.52
	5	0.22	0.0030	0.18	0.22	0.0054	221.35	181.85	0.52
	6	0.22	0.0030	0.18	0.22	0.0054	221.35	181.85	0.52
	7	0.22	0.0030	0.18	0.22	0.0054	186.04	152.85	0.52
	8	0.22	0.0030	0.18	0.22	0.0054	267.55	219.82	0.52
	9	0.22	0.0030	0.18	0.22	0.0054	323.38	265.68	0.52
16	1	0.22	0.0050	0.30	0.30	0.0054	140.61	192.53	0.52
	2	0.22	0.0050	0.30	0.30	0.0054	155.40	212.79	0.52
	3	0.22	0.0050	0.30	0.30	0.0054	155.40	212.79	0.52
17	1	0.22	0.0030	0.18	0.22	0.0054	136.21	111.91	0.52
	2	0.22	0.0030	0.18	0.22	0.0054	78.02	64.10	0.52
	3	0.22	0.0030	0.18	0.22	0.0054	180.15	148.01	0.52
	4	0.22	0.0030	0.18	0.22	0.0054	180.15	148.01	0.52
	5	0.22	0.0030	0.18	0.22	0.0054	221.35	181.85	0.52
	6	0.22	0.0030	0.18	0.22	0.0054	221.35	181.85	0.52
	7	0.22	0.0030	0.18	0.22	0.0054	186.04	152.85	0.52
	8	0.22	0.0030	0.18	0.22	0.0054	267.55	219.82	0.52
	9	0.22	0.0030	0.18	0.22	0.0054	323.38	265.68	0.52
	10	0.22	0.0030	0.18	0.22	0.0054	323.38	265.68	0.52
18	1	0.22	0.0050	0.30	0.30	0.0054	140.61	192.53	0.52
	2	0.22	0.0050	0.30	0.30	0.0054	155.40	212.79	0.52
	3	0.22	0.0050	0.30	0.30	0.0054	155.40	212.79	0.52
19	1	0.22	0.0020	0.12	0.22	0.0054	154.27	84.50	0.56
	2	0.22	0.0020	0.12	0.22	0.0054	154.27	84.50	0.56
	3	0.22	0.0020	0.12	0.22	0.0054	154.27	84.50	0.56
	4	0.22	0.0020	0.12	0.22	0.0054	154.27	84.50	0.56
20	1	0.22	0.0020	0.12	0.22	0.0054	405.21	221.94	0.56

Table 7-4 Continuation

Model	Section	v_{cr}(ksi)	ρ_y	$\rho\ f_y$(ksi)	v_y(ksi)	γ_y	V_{CR} (kip)	V_Y (kip)	δ_{shy} (in)
21	1	0.22	0.0030	0.18	0.22	0.0054	194.46	159.77	0.56
	2	0.22	0.0030	0.18	0.22	0.0054	194.46	159.77	0.56
	3	0.22	0.0030	0.18	0.22	0.0054	194.46	159.77	0.56
	4	0.22	0.0030	0.18	0.22	0.0054	194.46	159.77	0.56
	5	0.22	0.0030	0.18	0.22	0.0054	73.48	60.37	0.56
	6	0.22	0.0030	0.18	0.22	0.0054	505.50	415.31	0.56
	7	0.22	0.0030	0.18	0.22	0.0054	505.50	415.31	0.56
	8	0.22	0.0030	0.18	0.22	0.0054	505.50	415.31	0.56
	9	0.22	0.0030	0.18	0.22	0.0054	505.50	415.31	0.56
22	1	0.22	0.0030	0.18	0.22	0.0054	86.91	71.41	0.56
	2	0.22	0.0030	0.18	0.22	0.0054	86.91	71.41	0.56
	3	0.22	0.0030	0.18	0.22	0.0054	86.91	71.41	0.56
23	1	0.22	0.0030	0.18	0.22	0.0054	383.08	314.73	0.54
	2	0.22	0.0030	0.18	0.22	0.0054	147.45	121.14	0.54
	3	0.22	0.0030	0.18	0.22	0.0054	147.45	121.14	0.54
	4	0.22	0.0030	0.18	0.22	0.0054	147.45	121.14	0.54
	5	0.22	0.0030	0.18	0.22	0.0054	147.45	121.14	0.54
	6	0.22	0.0030	0.18	0.22	0.0054	147.45	121.14	0.54
	7	0.22	0.0030	0.18	0.22	0.0054	147.45	121.14	0.54
	8	0.22	0.0030	0.18	0.22	0.0054	46.73	38.39	0.54
	9	0.22	0.0030	0.18	0.22	0.0054	46.73	38.39	0.54
	10	0.22	0.0030	0.18	0.22	0.0054	46.73	38.39	0.54
	11	0.22	0.0030	0.18	0.22	0.0054	46.73	38.39	0.54
	12	0.22	0.0030	0.18	0.22	0.0054	46.73	38.39	0.54
	13	0.22	0.0030	0.18	0.22	0.0054	46.73	38.39	0.54
	14	0.22	0.0030	0.18	0.22	0.0054	241.72	198.59	0.54
24	1	0.22	0.0030	0.18	0.22	0.0054	139.12	114.30	0.54
	2	0.22	0.0030	0.18	0.22	0.0054	174.39	143.28	0.54
25	1	0.22	0.0030	0.18	0.22	0.0054	126.16	103.65	0.54
	2	0.22	0.0030	0.18	0.22	0.0054	270.09	221.90	0.54
	3	0.22	0.0030	0.18	0.22	0.0054	213.59	175.48	0.54
	4	0.22	0.0030	0.18	0.22	0.0054	213.59	175.48	0.54
	5	0.22	0.0030	0.18	0.22	0.0054	143.46	117.86	0.54
	6	0.22	0.0030	0.18	0.22	0.0054	143.46	117.86	0.54
	7	0.22	0.0030	0.18	0.22	0.0054	86.33	70.93	0.54
	8	0.22	0.0030	0.18	0.22	0.0054	274.98	225.92	0.54
	9	0.22	0.0030	0.18	0.22	0.0054	164.21	134.91	0.54
	10	0.22	0.0030	0.18	0.22	0.0054	204.45	167.98	0.54
	11	0.22	0.0030	0.18	0.22	0.0054	180.66	148.43	0.54
26	1	0.22	0.0050	0.30	0.30	0.0054	153.51	210.20	0.54
	2	0.22	0.0050	0.30	0.30	0.0054	153.51	210.20	0.54
	3	0.22	0.0050	0.30	0.30	0.0054	248.95	340.89	0.54

8 FRAGILITY CURVES USING ALGAN LIMIT STATES

8.1 INTRODUCTION

This chapter explains the methodology followed to develop the analytical fragility curves, using Algan limit states, for the models described in Chapters 6 and 7 . Also the results of the seismic damage prediction of each type of structure expressed in terms of these fragility curves are plotted and compared. Also fragility curve parameters (log-median and log-standard deviation) are summarized. PGA units used in this chapter are (%g).

8.2 DEVELOPMENT

First, a nonlinear time history analysis of all the models subjected to each of the earthquake ground motions described in Chapter 5 was carried out. From the analysis, the damage parameters defined by Algan (1982) : maximum drift ratio for frames, and both drift ratio and tangential deviation for walls, as explained in Section 2.5, are obtained and the damage states of the models are calculated based on the limit states presented in Table 2-2. The damage states considered were: "Minor", "Moderate", "Substantial" and "Major" damage states. The database of the analysis results for each model type and each earthquake is present in Appendix C.

After creating a database of peak ground acceleration versus damage state for each model, the next step was to filter the data to take into account only the models that comply with direction and lateral resisting system for each set of fragility curve types. Then the number of models that reached or exceeded each damage state for each earthquake record was counted and the results presented in "Cumulative damage-state occurrence" tables.

Next, the input data damage-state probability was calculated by dividing the number of data points that are in or exceed a particular damage state by the number of data points of the whole sample as proposed by Shinozuka (2003). This value represents the cumulative distribution functions of each damage state, thus a data point for fragility curves generation. With this information lognormal functions with two parameters (log-median and log-standard deviation) were fitted and fragility curves were developed.

The same procedure was used for each of the structural types to obtain a set of thirteen fragility curves for each damage state. One and two-story reinforced concrete frame and wall models were studied considering the whole sample, the shaking in the weak direction and in the strong direction of the columns or walls. Multistory reinforced concrete walls were considered only in the strong direction because these models have plenty of walls in both directions.

The parameters of the fragility curves developed are summarized in Table 8-1 and Table 8-2. The first table corresponds to Moment Resisting Frame models and the second table to Shear Wall models. The first column of the tables describes the fragility curves type, the second column defines the damage state and the third and fourth columns are the log-median and log-standard deviation of each models type for each damage state.

Table 8-1. Fragility curve parameters using Algan limits state for Reinforced Concrete Frame models

Model Type	Damage state	μ_{ln}	σ_{ln}
1 Story Frames. Whole Sample	Minor	-1.81	1.03
	Moderate	-1.37	0.87
	Substantial	-1.18	0.82
	Major	-1.04	0.78
1 Story Frames. Weak Direction	Minor	-2.39	0.24
	Moderate	-1.96	0.23
	Substantial	-1.74	0.25
	Major	-1.58	0.32
1 Story Frames. Strong Direction	Minor	-1.38	0.88
	Moderate	-1.01	0.80
	Substantial	-0.83	0.72
	Major	-0.72	0.70
2 Story Frames. Whole Sample	Minor	-1.86	0.57
	Moderate	-1.46	0.55
	Substantial	-1.23	0.53
	Major	-1.06	0.49
2 Story Frames. Weak Direction	Minor	-2.36	0.23
	Moderate	-1.98	0.33
	Substantial	-1.77	0.32
	Major	-1.54	0.38
2 Story Frames. Strong Direction	Minor	-1.59	0.34
	Moderate	-1.25	0.48
	Substantial	-1.02	0.41
	Major	-0.84	0.40

Table 8-2. Fragility curve parameters using Algan limits state for Reinforced Concrete Shear Wall models

Model Type	Damage state	μ_{ln}	σ_{ln}
1 Story Shear Wall. Whole Sample	Minor	-1.95	1.62
	Moderate	-1.67	1.30
	Substantial	-1.49	1.22
	Major	-1.33	1.10
1 Story Shear Wall. Weak Direction	Minor	-3.43	0.60
	Moderate	-3.25	0.85
	Substantial	-2.70	0.64
	Major	-2.52	0.62
1 Story Shear Wall. Strong Direction	Minor	-1.18	1.15
	Moderate	-1.03	1.02
	Substantial	-0.91	0.90
	Major	-0.80	0.85
2 Story Shear Wall. Whole Sample	Minor	-2.05	0.72
	Moderate	-1.69	0.70
	Substantial	-1.43	0.68
	Major	-1.29	0.66
2 Story Shear Wall. Weak Direction	Minor	-2.58	0.25
	Moderate	-2.37	0.37
	Substantial	-2.05	0.41
	Major	-1.85	0.38
2 Story Shear Wall. Strong Direction	Minor	-1.64	0.51
	Moderate	-1.31	0.46
	Substantial	-1.08	0.44
	Major	-0.96	0.43
Multistory Shear Wall Building	Minor	-0.18	0.98
	Moderate	0.13	0.90
	Substantial	0.29	0.89
	Major	0.38	0.80

8.3 MOMENT RESISTANT FRAME MODELS

In this section the fragility curve results for the one and two-story moment resistant frame models described in Chapter 6 are developed and plotted.

8.3.1 ONE-STORY MODELS

One-story reinforced concrete moment resistant frame models fragility curves are studied by considering three different scenarios. First all models are considered to create general fragility curves for this type of models. Then two set of fragility curves are developed by filtering the data and considering only the models with columns oriented in the weak direction of shaking, and another set considering models with columns oriented in the direction of shaking.

8.3.1.1 ONE-STORY REINFORCED CONCRETE FRAMES: ALL MODELS

One-story reinforced concrete models described in Chapter 6 were subjected to 5 different earthquake records normalized to different peak ground acceleration values. In all, for each peak ground acceleration considered a sample size of 90 (18 by 5) is obtained. Values of damage state occurrence for each earthquake are added and the results summarized in Table 8-3.

Table 8-3 presents the number of buildings that reach or exceed each damage state at each PGA. For example, if the peak ground acceleration considered is 0.3g, a total of 64 buildings shows at least minor damages and 55, more than half of the sample, present damage greater than Moderate damage state. Even at low peak ground acceleration, considerable damages are obtained. At 0.1g two structures reach the Moderate damage state, and at 0.2 g almost half of the sample reach this damage state. The occurrence distribution is presented graphically in Figure 8-1.

Table 8-3. Cumulative damage-state occurrence using Algan limits state: All Earthquakes for One-Story Reinforced Concrete Frames: All Models

PGA	None	Minor	Moderate	Substantial	Major
0.1	90	27	2	0	0
0.2	90	57	44	27	15
0.3	90	64	55	50	43
0.4	90	69	62	59	57
0.5	90	76	69	64	61
0.6	90	79	73	68	66
0.7	90	83	77	73	68
0.8	90	85	80	79	76
0.9	90	86	83	79	79
1	90	87	83	82	79
1.1	90	88	85	84	83
1.2	90	89	85	84	84
1.3	90	90	88	88	85
1.4	90	90	89	89	87
1.5	90	90	89	89	89

The cumulative distribution function obtained is summarized in Table 8-4. It is obtained by dividing the cumulative damage-state occurrence by the sample size, in this case 90. This table represents the probability of being in or exceeding each damage state at each PGA. For example at 0.3g there is a 61% probability of reaching or exceeding the Moderate damage state. These values are data points of the fragility curves. Figure 8-2 plots the input data points and the lognormal function fitted for minor, moderate, Substantial and Major damage. The log-median and log-standard deviation obtained is presented in Table 8-1. The set of fragility curves as a function of PGA proposed for this population is plotted in Figure 8-3.

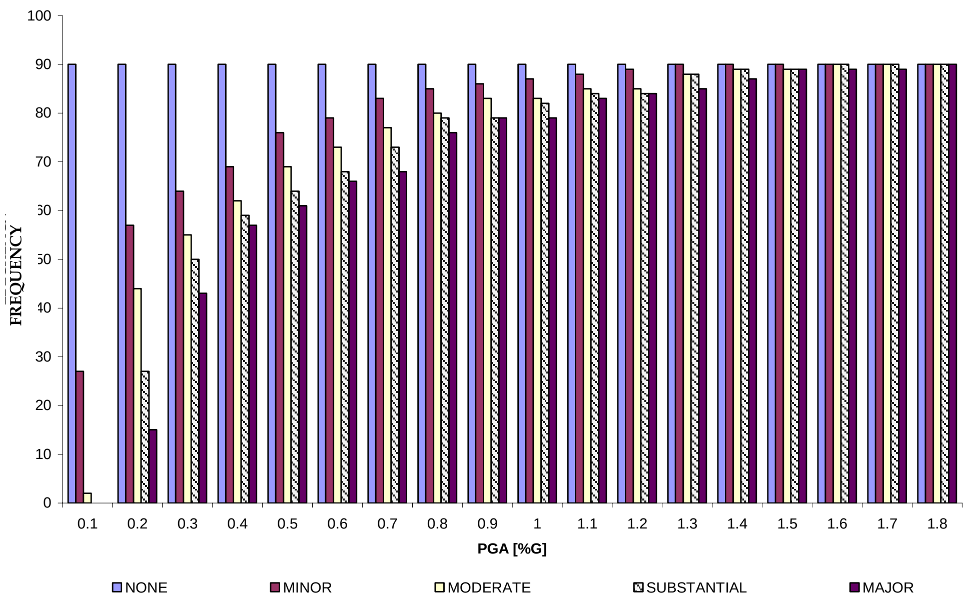


Figure 8-1. Cumulative Distribution using Algan limits state for One-Story Reinforced Concrete Frames: All Models

Table 8-4. Input data damage-state probability using Algan limits state: All Earthquakes for One-Story Reinforced Concrete Frames: All Models

PGA	None	Minor	Moderate	Substantial	Major
0.1	1.00	0.30	0.02	0.00	0.00
0.2	1.00	0.63	0.49	0.30	0.17
0.3	1.00	0.71	0.61	0.56	0.48
0.4	1.00	0.77	0.69	0.66	0.63
0.5	1.00	0.84	0.77	0.71	0.68
0.6	1.00	0.88	0.81	0.76	0.73
0.7	1.00	0.92	0.86	0.81	0.76
0.8	1.00	0.94	0.89	0.88	0.84
0.9	1.00	0.96	0.92	0.88	0.88
1	1.00	0.97	0.92	0.91	0.88
1.1	1.00	0.98	0.94	0.93	0.92
1.2	1.00	0.99	0.94	0.93	0.93
1.3	1.00	1.00	0.98	0.98	0.94
1.4	1.00	1.00	0.99	0.99	0.97
1.5	1.00	1.00	0.99	0.99	0.99

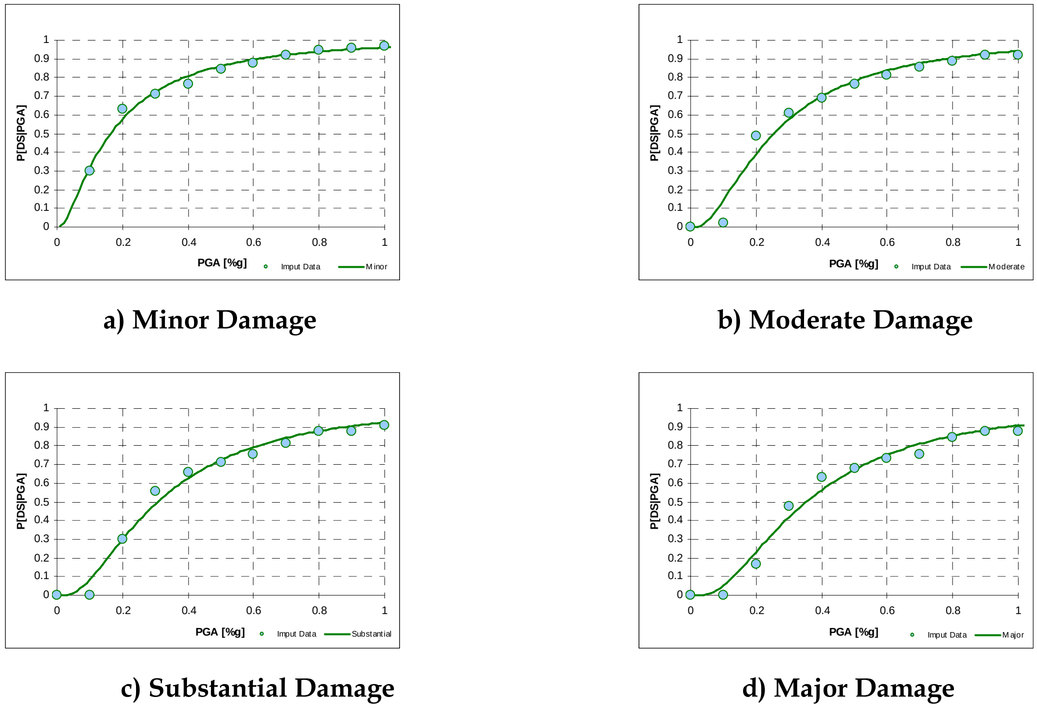


Figure 8-2. Damage Fragility curves using Algan limits state for One-Story Reinforced Concrete Frames: All Models

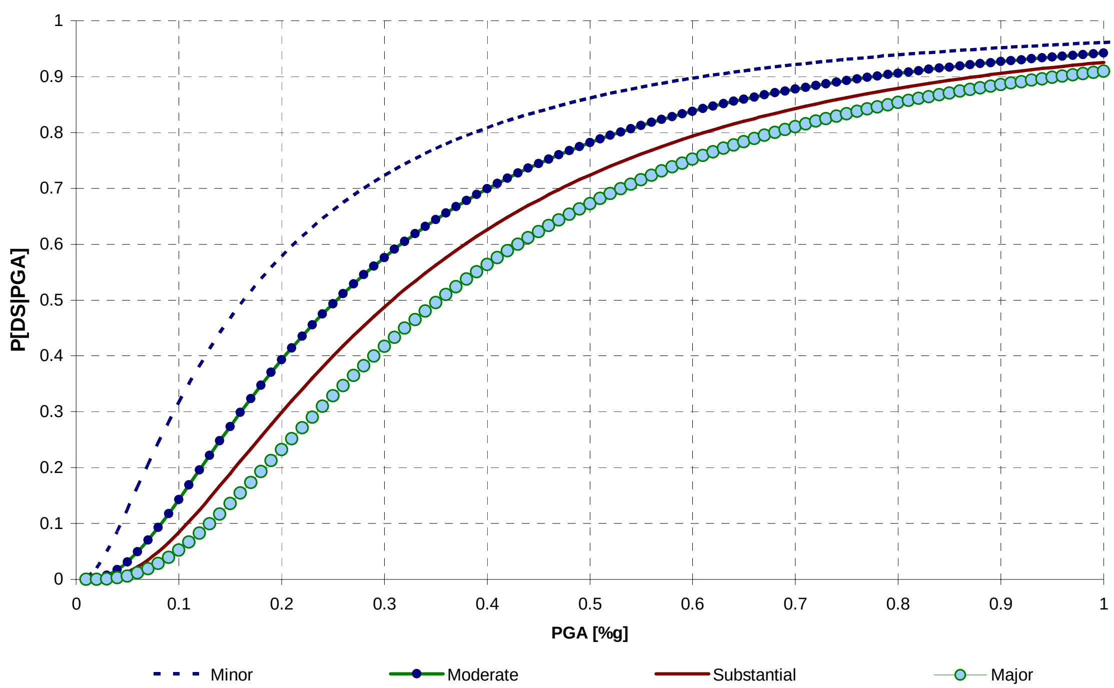


Figure 8-3. Set of Damage Fragility curves using Algan limits state for One-Story Reinforced Concrete Frames: All Models

8.3.1.2 ONE-STORY REINFORCED CONCRETE FRAMES: WEAK DIRECTION.

A total of 6 models of the 18 reinforced concrete one-story frames have all columns oriented in the weak direction. The database of frame models was filtered and only those data points that correspond to columns oriented in the weak direction were taken into account. A total sample size of 30 is obtained for each PGA. The damage state occurrence of these models are presented in Table 8-5. It can be seen from this table that for a PGA of 0.3g the whole sample reach or exceed Moderate damage state and 26 out of 30 buildings reach Major damage state. At a low value of PGA, 0.1g, 2 models present moderate damage, and for 0.2g 21 models reach or exceed Moderate damage state. The occurrence distribution is presented graphically in Figure 8-4.

Table 8-5. Cumulative damage-state occurrence using Algan limits state: All Earthquakes for One-Story Reinforced Concrete Frames: Weak Direction

PGA	None	Minor	Moderate	Substantial	Major
0.1	30	19	2	0	0
0.2	30	30	28	21	14
0.3	30	30	30	29	26
0.4	30	30	30	30	30
0.5	30	30	30	30	30
0.6	30	30	30	30	30
0.7	30	30	30	30	30
0.8	30	30	30	30	30
0.9	30	30	30	30	30
1	30	30	30	30	30
1.1	30	30	30	30	30
1.2	30	30	30	30	30
1.3	30	30	30	30	30
1.4	30	30	30	30	30
1.5	30	30	30	30	30

The data point values of the fragility curves are shown in Table 8-6, they are obtained by dividing the cumulative damage-state occurrence by the sample size, in this case 30. At 0.3g there is a 100% chance of reaching or exceeding Moderate damage state. Figure 8-5 presents graphically the input data points and fragility curves fitted for each damage state. The parameters of these fragility curves are summarized in Table 8-1. Finally, the set of fragility curves as a function of PGA developed for this case is plotted in Figure 8-6.

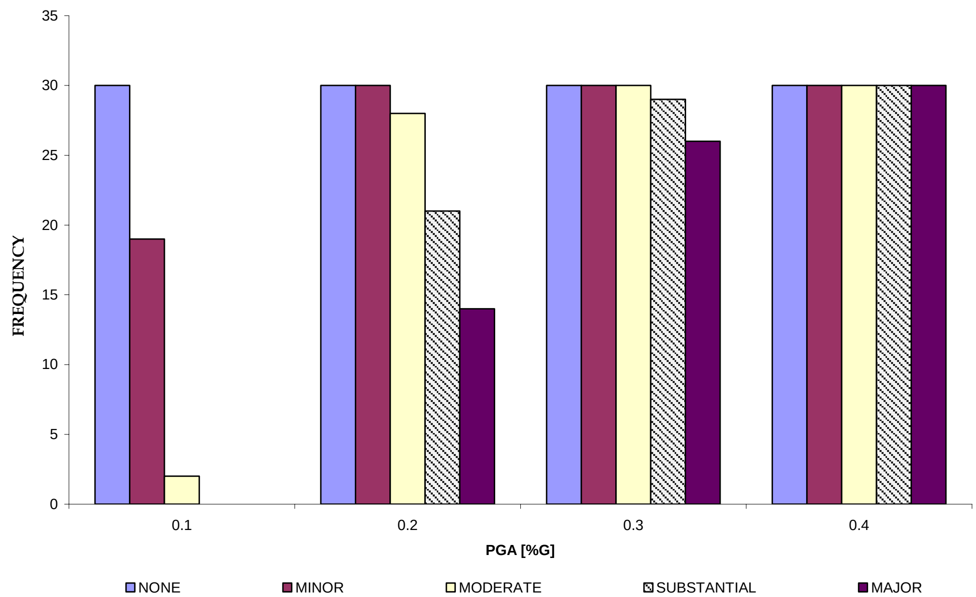
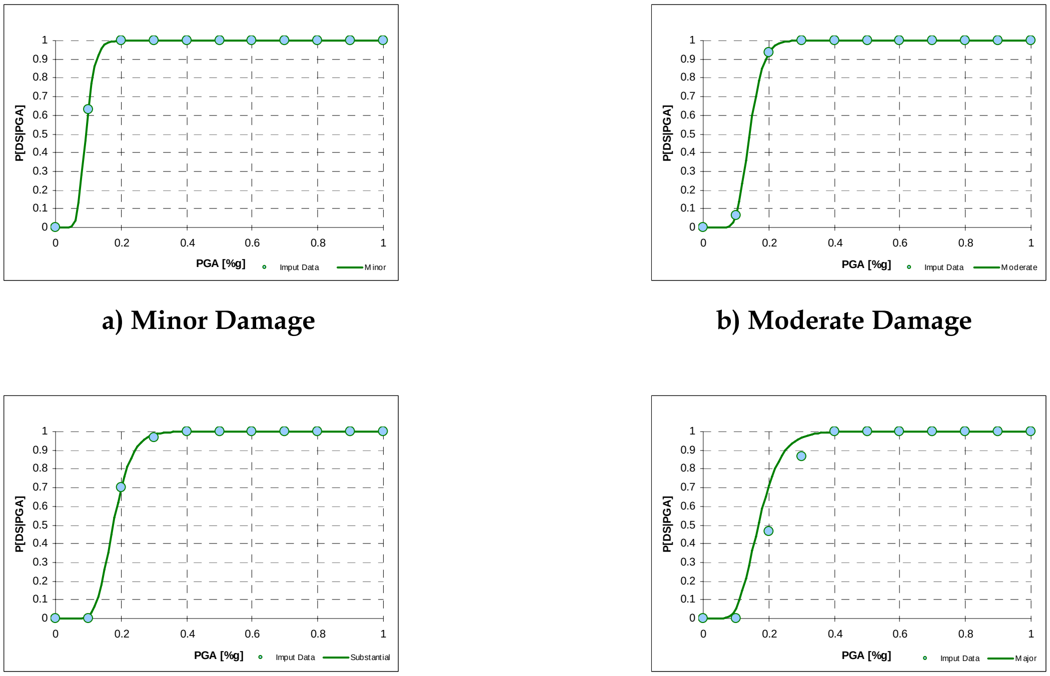


Figure 8-4. Cumulative Distribution using Algan limits state for One-Story Reinforced Concrete Frames: Weak Direction

Table 8-6. Input data damage-state probability using Algan limits state: All Earthquakes for One-Story Reinforced Concrete Frames: Weak Direction

PGA	None	Minor	Moderate	Substantial	Major
0.1	1.00	0.63	0.07	0.00	0.00
0.2	1.00	1.00	0.93	0.70	0.47
0.3	1.00	1.00	1.00	0.97	0.87
0.4	1.00	1.00	1.00	1.00	1.00
0.5	1.00	1.00	1.00	1.00	1.00
0.6	1.00	1.00	1.00	1.00	1.00
0.7	1.00	1.00	1.00	1.00	1.00
0.8	1.00	1.00	1.00	1.00	1.00
0.9	1.00	1.00	1.00	1.00	1.00
1	1.00	1.00	1.00	1.00	1.00
1.1	1.00	1.00	1.00	1.00	1.00
1.2	1.00	1.00	1.00	1.00	1.00
1.3	1.00	1.00	1.00	1.00	1.00
1.4	1.00	1.00	1.00	1.00	1.00
1.5	1.00	1.00	1.00	1.00	1.00



a) Minor Damage

b) Moderate Damage

c) Substantial Damage

d) Major Damage

Figure 8-5. Damage Fragility curves using Algan limits state for One-Story Reinforced Concrete Frames: Weak Direction

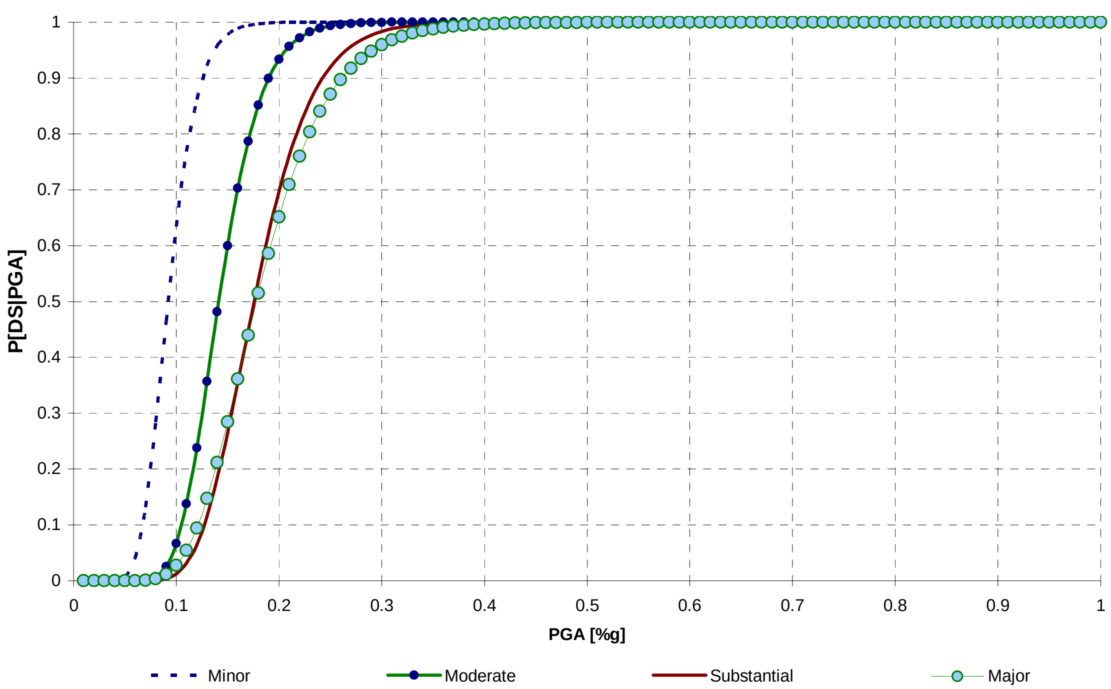


Figure 8-6. Set of Damage Fragility curves using Algan limits state for One-Story Reinforced Concrete Frames: Weak Direction

8.3.1.3 ONE-STORY REINFORCED CONCRETE FRAMES. STRONG DIRECTION

In this section, the last scenario for one-story frame houses is studied: models with columns oriented in the direction of shaking. These models comprise models with all columns oriented in the strong direction and columns oriented in both directions. A total of 12 models comply with this characteristic. From the database of frame models a sample size of 60 is obtained for each PGA. The damage state occurrence of these models is presented in Table 8-7. It can be observed from this table that for a PGA of 0.3g, more than half of the sample, 34 models, reach or exceed the Moderate damage state and 17 from 60 buildings, 28% of the sample, reach the Major damage state. The occurrence distribution is presented graphically in Figure 8-7.

Table 8-7. Cumulative damage-state occurrence using Algan limits state: All Earthquakes for One-Story Reinforced Concrete Frames: Strong Direction

PGA	None	Minor	Moderate	Substantial	Major
0.1	60	8	0	0	0
0.2	60	27	16	6	1
0.3	60	34	25	21	17
0.4	60	39	32	29	27
0.5	60	46	39	34	31
0.6	60	49	43	38	36
0.7	60	53	47	43	38
0.8	60	55	50	49	46
0.9	60	56	53	49	49
1	60	57	53	52	49
1.1	60	58	55	54	53
1.2	60	59	55	54	54
1.3	60	60	58	58	55
1.4	60	60	59	59	57
1.5	60	60	59	59	59

The probability of being in or exceeding each damage state at each PGA is summarized in Table 8-8. At 0.3g there is 57% chance of reaching or exceeding Minor damages, 42% of reaching or exceeding Moderate damage, 35% probability of suffering damage larger than or equal to Substantial damage and 28% probability of reaching the Major damage scale. The fragility curve parameters are summarized in Table 8-1. In Figure 8-8 the input data points and fragility curves fitted for each damage state are plotted. Finally, the set of fragility curves as a function of PGA developed for this case is plotted in Figure 8-9.

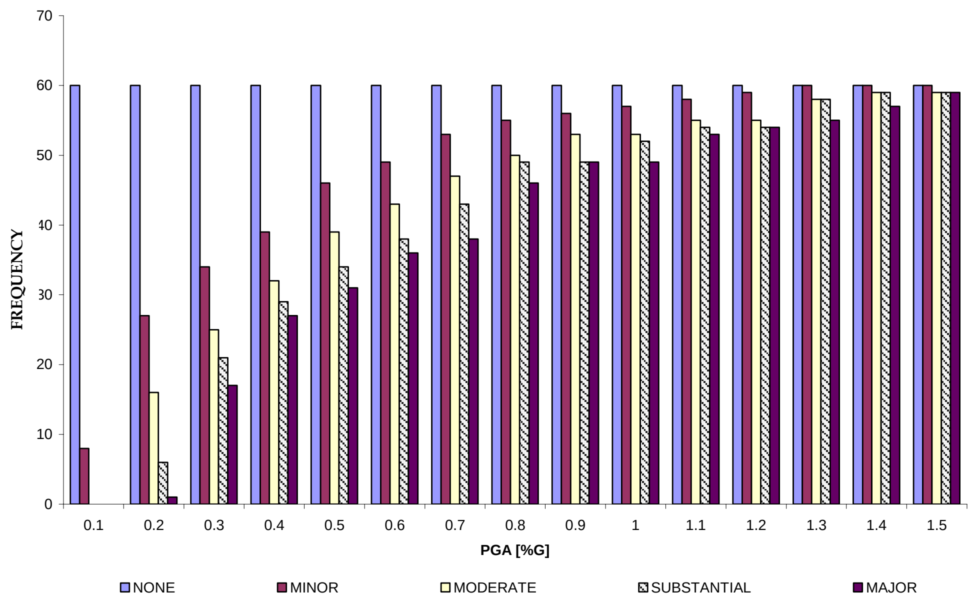
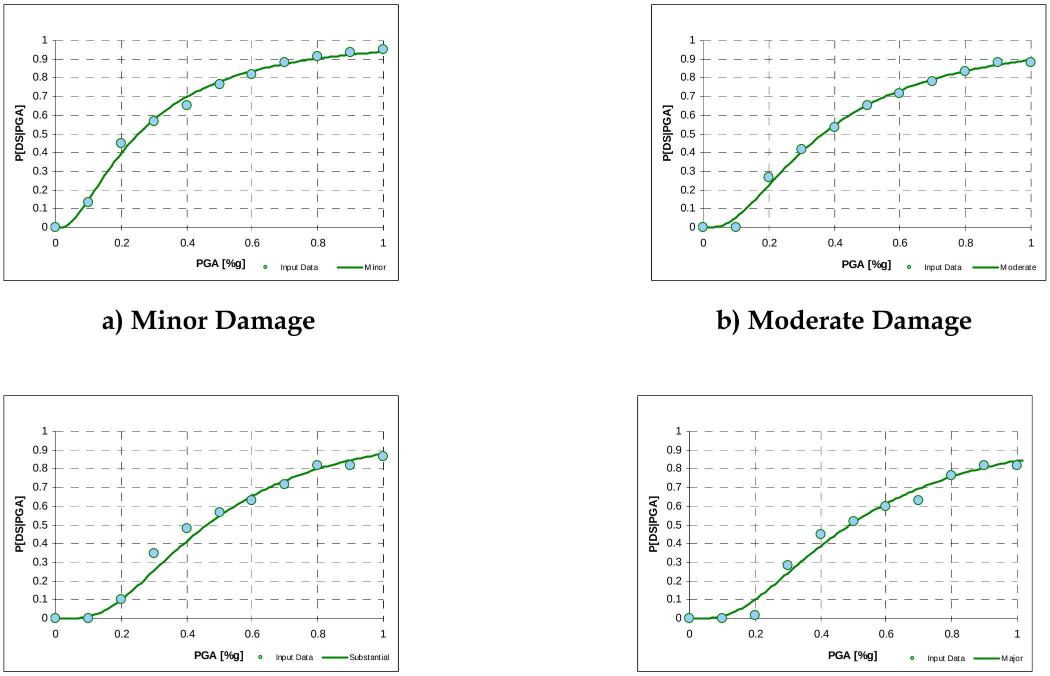


Figure 8-7. Cumulative Distribution using Algan limits state for One-Story Reinforced Concrete Frames: Strong Direction

Table 8-8. Input data damage-state probability using Algan limits state: All Earthquakes for One-Story Reinforced Concrete Frames: Strong Direction

PGA	None	Minor	Moderate	Substantial	Major
0.1	1.00	0.13	0.00	0.00	0.00
0.2	1.00	0.45	0.27	0.10	0.02
0.3	1.00	0.57	0.42	0.35	0.28
0.4	1.00	0.65	0.53	0.48	0.45
0.5	1.00	0.77	0.65	0.57	0.52
0.6	1.00	0.82	0.72	0.63	0.60
0.7	1.00	0.88	0.78	0.72	0.63
0.8	1.00	0.92	0.83	0.82	0.77
0.9	1.00	0.93	0.88	0.82	0.82
1	1.00	0.95	0.88	0.87	0.82
1.1	1.00	0.97	0.92	0.90	0.88
1.2	1.00	0.98	0.92	0.90	0.90
1.3	1.00	1.00	0.97	0.97	0.92
1.4	1.00	1.00	0.98	0.98	0.95
1.5	1.00	1.00	0.98	0.98	0.98



a) Minor Damage

b) Moderate Damage

c) Substantial Damage

d) Major Damage

Figure 8-8. Damage Fragility curves using Algan limits state for One-Story Reinforced Concrete Frames: Strong Direction

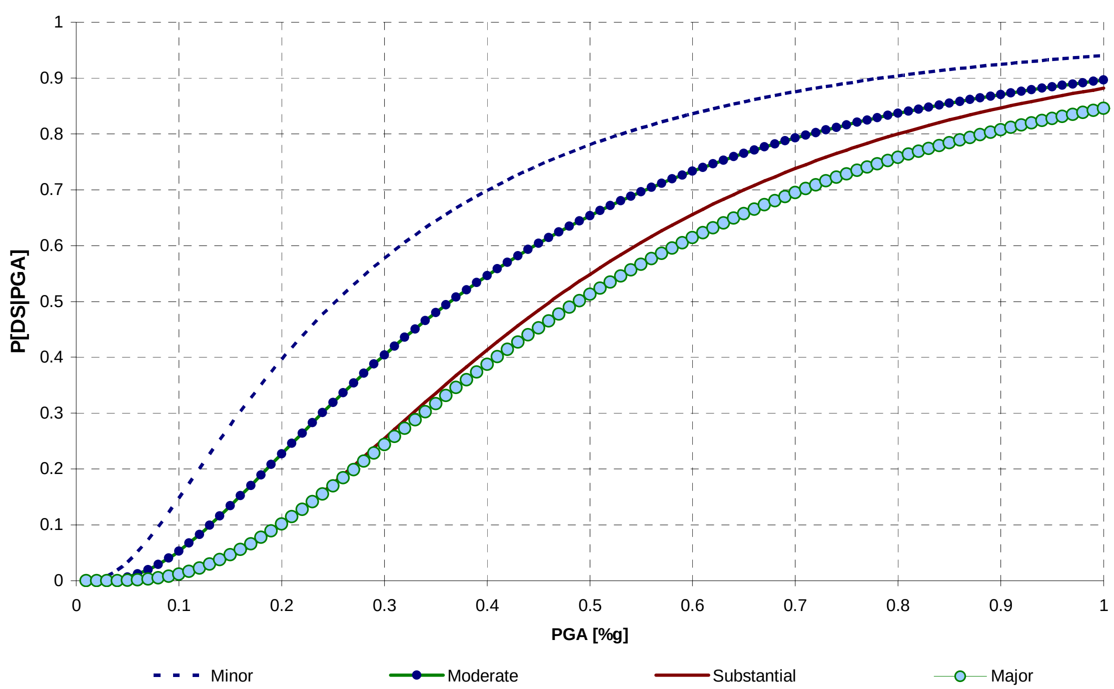


Figure 8-9. Set of Damage Fragility curves using Algan limits state for One-Story Reinforced Concrete Frames: Strong Direction

8.3.2 TWO-STORY MODELS

For the development of fragility curves of Two-Story Reinforced Concrete Frame models, the same scenarios considered for the One-Story Reinforced concrete moment resistant Frame models are studied. The results are presented below.

8.3.2.1 TWO-STORY REINFORCED CONCRETE FRAMES: ALL MODELS

The population of Two-Story Frames for each peak ground acceleration value is 90 data points. The damage state occurrence results are presented in Table 8-9. This table shows the number of buildings that reach or exceed each damage state at each PGA. For a peak ground acceleration of 0.3g, a total of 78 building shows at least Minor damages and 60, two third of the sample, present damage greater than Moderate damage state. Damage are observed at a low peak ground acceleration: at 0.1g, 5 structures reach Moderate damage state, and at 0.2 g, 42 models reach Moderate damage state and 16 models reach Major damage. The occurrence distribution is presented graphically in Figure 8-10.

The input damage-state probability obtained by dividing the cumulative damage state occurrence by the sample size is summarized in Table 8-10. This table shows the probability of being in or exceeding each damage state at each PGA. For example at 0.3g there is a 67% probability of reaching or exceeding Moderate damage state, and for 0.2g there is a 49% of reaching or exceeding Moderate damage. These data points are plotted in Figure 8-11 with the respective fragility curve fitted for each damage scale. The log-median and log-standard deviation obtained is presented in Table 8-1. The set of fragility curves as a function of PGA proposed for this population is plotted in Figure 8-12.

Table 8-9. Cumulative damage-state occurrence using Algan limits state: All Earthquakes for Two-Story Reinforced Concrete Frames: All Models

PGA	None	Minor	Moderate	Substantial	Major
0.1	90	21	5	1	1
0.2	90	61	42	29	16
0.3	90	78	60	44	33
0.4	90	89	75	68	57
0.5	90	90	83	75	67
0.6	90	90	88	85	77
0.7	90	90	90	88	85
0.8	90	90	90	89	85
0.9	90	90	90	90	88
1	90	90	90	90	88
1.1	90	90	90	90	90
1.2	90	90	90	90	90
1.3	90	90	90	90	90
1.4	90	90	90	90	90
1.5	90	90	90	90	90

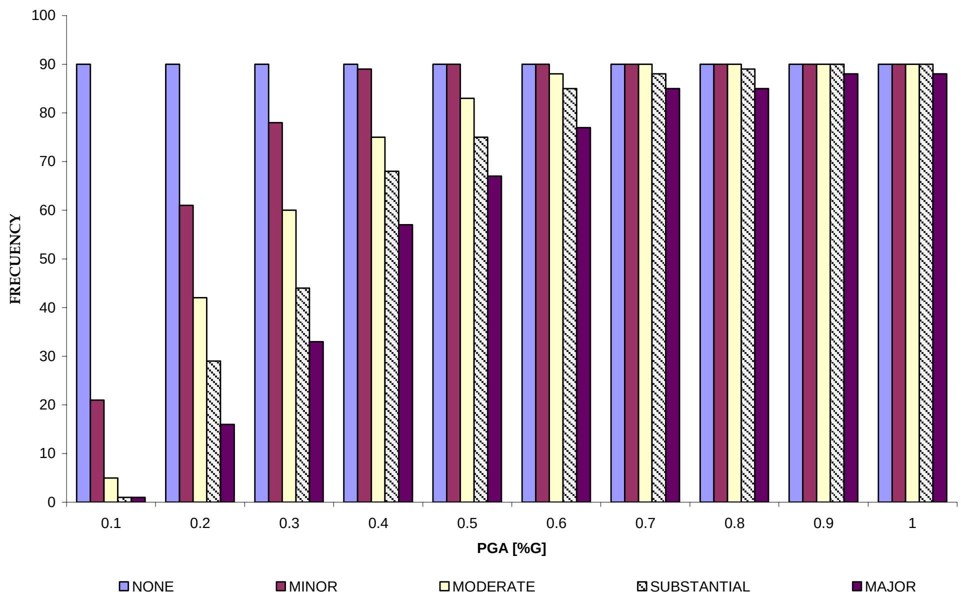
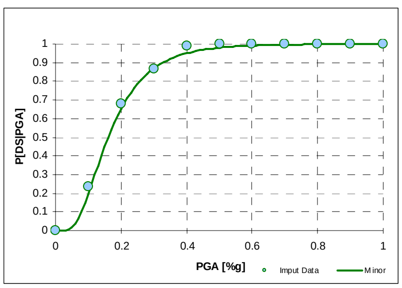


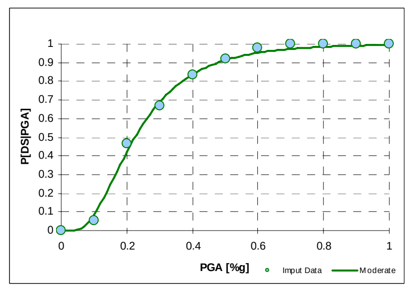
Figure 8-10. Cumulative Distribution using Algan limits state for Two-Story Reinforced Concrete Frames: All Models

Table 8-10. Input data damage-state probability using Algan limits state: All Earthquakes for Two-Story Reinforced Concrete Frames: All Models

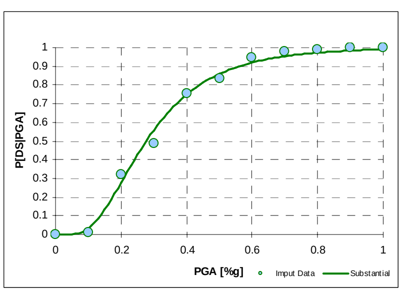
PGA	None	Minor	Moderate	Substantial	Major
0.1	1.00	0.23	0.06	0.01	0.01
0.2	1.00	0.68	0.47	0.32	0.18
0.3	1.00	0.87	0.67	0.49	0.37
0.4	1.00	0.99	0.83	0.76	0.63
0.5	1.00	1.00	0.92	0.83	0.74
0.6	1.00	1.00	0.98	0.94	0.86
0.7	1.00	1.00	1.00	0.98	0.94
0.8	1.00	1.00	1.00	0.99	0.94
0.9	1.00	1.00	1.00	1.00	0.98
1	1.00	1.00	1.00	1.00	0.98
1.1	1.00	1.00	1.00	1.00	1.00
1.2	1.00	1.00	1.00	1.00	1.00
1.3	1.00	1.00	1.00	1.00	1.00
1.4	1.00	1.00	1.00	1.00	1.00
1.5	1.00	1.00	1.00	1.00	1.00



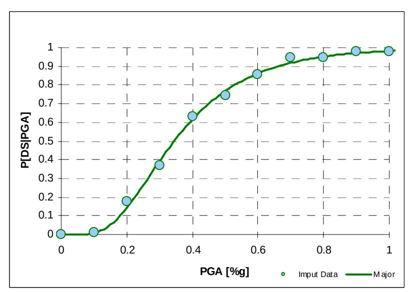
a) Minor Damage



b) Moderate Damage



c) Substantial Damage



d) Major Damage

Figure 8-11. Damage Fragility curves using Algan limits state for Two-Story Reinforced Concrete Frames: All Models

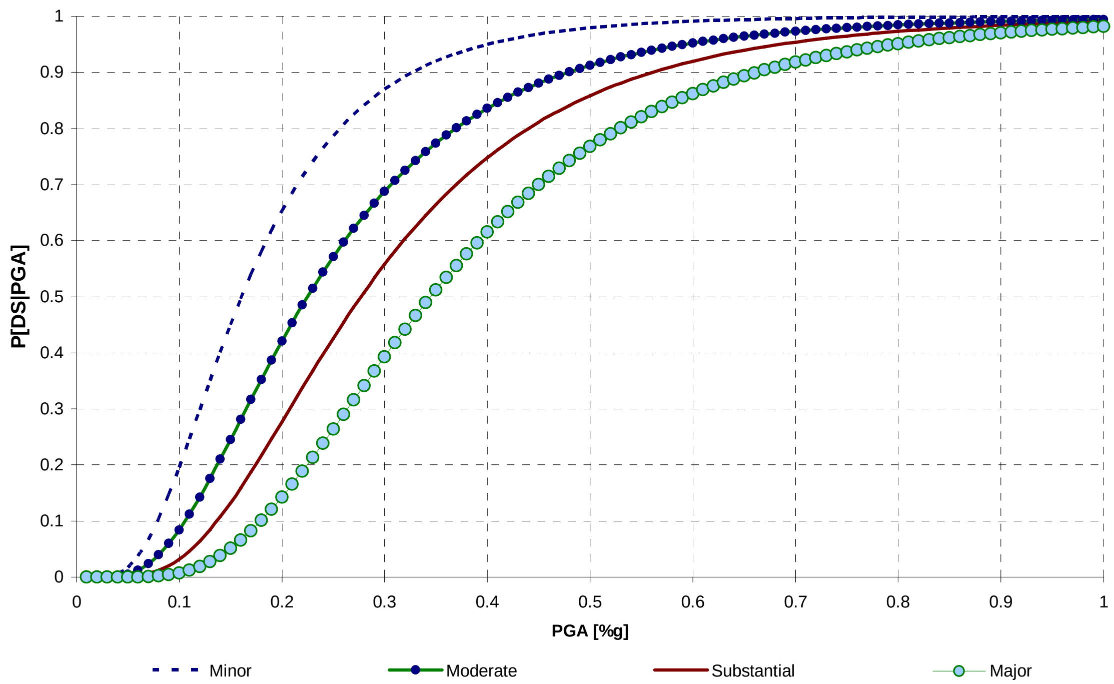


Figure 8-12. Set of Damage Fragility curves using Algan limits state for Two-Story Reinforced Concrete Frames: All Models

8.3.2.2 TWO-STORY REINFORCED CONCRETE FRAMES: WEAK DIRECTION

As in the to previously considered one-story weak direction models, there are 6 reinforced concrete two-story frame models having all columns oriented in the weak direction. The resulting sample size is 30 for each PGA. Damage state occurrences of these models are presented in Table 8-11 For a PGA value of 0.3g the whole sample reach or exceed Moderate damage state and 24 from 30 buildings reach Major damage state. In a similar way as the one-story frames oriented in the weak direction wich reached or exceeded Moderate damage at low values of PGA, at 0.2g, 26 models of 30 reach or exceed Moderate damage state. The occurrence distribution is presented graphically in Figure 8-13.

Table 8-11. Cumulative damage-state occurrence using Algan limits state: All Earthquakes for Two-Story Reinforced Concrete Frames: Weak Direction

PGA	None	Minor	Moderate	Substantial	Major
0.1	30	18	5	1	1
0.2	30	30	26	21	13
0.3	30	30	30	27	24
0.4	30	30	30	30	29
0.5	30	30	30	30	30
0.6	30	30	30	30	30
0.7	30	30	30	30	30
0.8	30	30	30	30	30
0.9	30	30	30	30	30
1	30	30	30	30	30
1.1	30	30	30	30	30
1.2	30	30	30	30	30
1.3	30	30	30	30	30
1.4	30	30	30	30	30
1.5	30	30	30	30	30

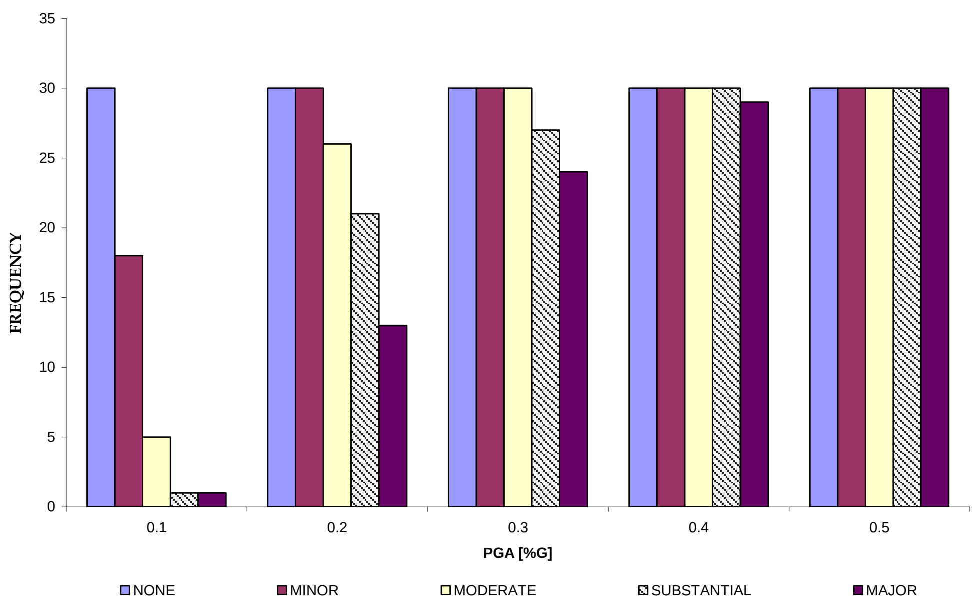


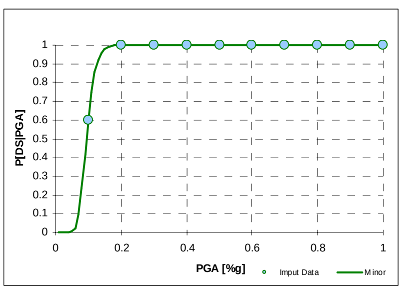
Figure 8-13. Cumulative Distribution using Algan limits state for Two-Story Reinforced Concrete Frames: Weak Direction

The data point values of the fragility curves are shown in Table 8-11. For this sample, at 0.3g there is a 100% chance of reaching or exceeding Moderate damage state. Figure 8-14 presents graphically the input data points and fragility curves fitted for each damage state. The parameters of these fragility curves are summarized in Table 8-1.

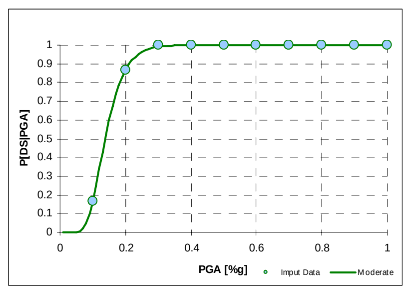
Finally, the set of fragility curves as a function of PGA developed for this case is plotted in Figure 8-15.

Table 8-12. Input data damage-state probability: All Earthquakes for Two-Story Reinforced Concrete Frames: Weak Direction

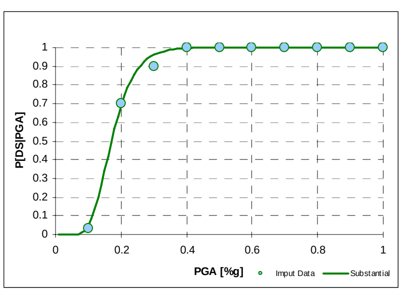
PGA	None	Minor	Moderate	Substantial	Major
0.1	1.00	0.60	0.17	0.03	0.03
0.2	1.00	1.00	0.87	0.70	0.43
0.3	1.00	1.00	1.00	0.90	0.80
0.4	1.00	1.00	1.00	1.00	0.97
0.5	1.00	1.00	1.00	1.00	1.00
0.6	1.00	1.00	1.00	1.00	1.00
0.7	1.00	1.00	1.00	1.00	1.00
0.8	1.00	1.00	1.00	1.00	1.00
0.9	1.00	1.00	1.00	1.00	1.00
1	1.00	1.00	1.00	1.00	1.00
1.1	1.00	1.00	1.00	1.00	1.00
1.2	1.00	1.00	1.00	1.00	1.00
1.3	1.00	1.00	1.00	1.00	1.00
1.4	1.00	1.00	1.00	1.00	1.00
1.5	1.00	1.00	1.00	1.00	1.00



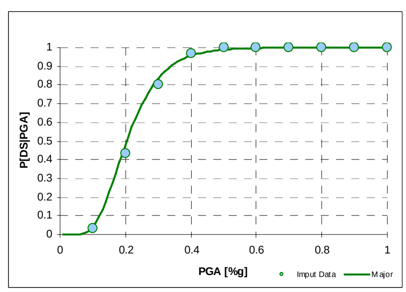
a) Minor Damage



b) Moderate Damage



c) Substantial Damage



d) Major Damage

Figure 8-14. Damage Fragility curves using Algan limits state for Two-Story Reinforced Concrete Frames: Weak Direction

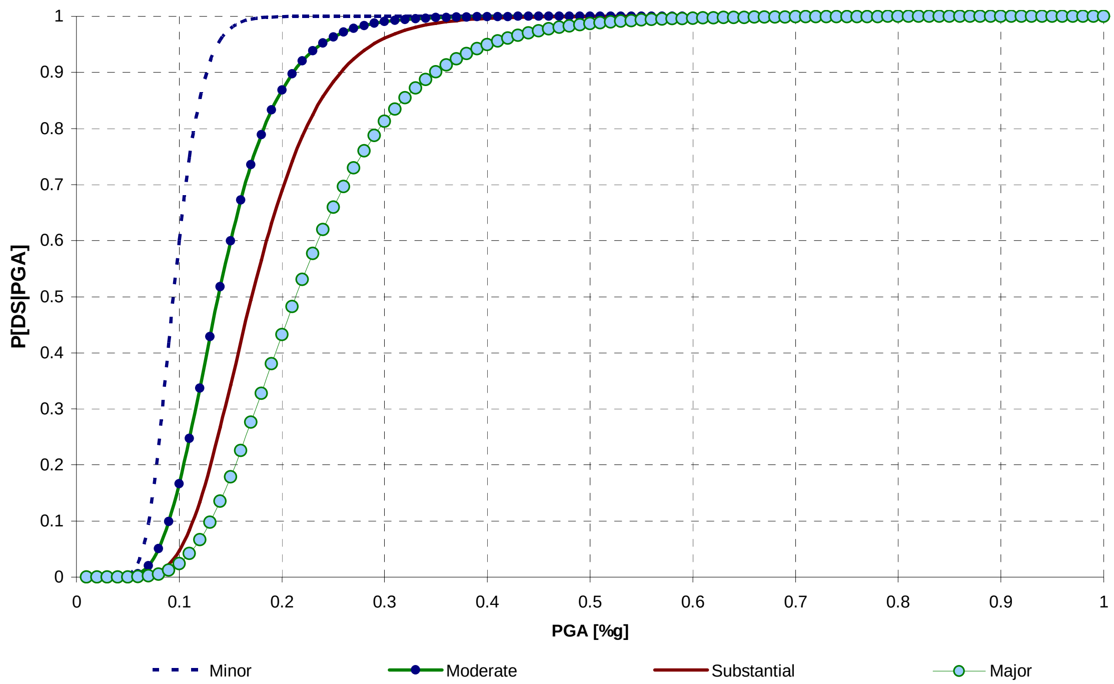


Figure 8-15. Set of Damage Fragility curves using Algan limits state for Two-Story Reinforced Concrete Frames: Weak Direction

8.3.2.3 TWO-STORY REINFORCED CONCRETE FRAMES: STRONG DIRECTION

Twelve reinforced concrete two-story frame models fit in this category. A total of 60 data points are obtained for each PGA. Similar to previous model types, the number of buildings that reach or exceed each damage state are presented in Table 8-13. For 0.3g, 30 models, half of the population, reach Moderate damage state and 9 models present Major damages. The occurrence distribution is presented graphically in Figure 8-16.

The data point values of the fragility curves are shown in Table 8-14, they are obtained by dividing the cumulative damage-state occurrence by the sample size, in this case 60. At 0.3g there is a 50% chance of reaching or exceeding Moderate damage state. Major damages appear at 0.2g with a probability of occurrence of 5%, and the whole population reach Major damage state at a PGA of 1.1g. Figure 8-17 presents graphically the input data points and fragility curves fitted for each damage state. The parameters of these fragility curves are summarized in Table 8-1. Finally, the set of fragility curves as a function of PGA developed for this case is plotted in Figure 8-18.

Table 8-13. Cumulative damage-state occurrence using Algan limits state: All Earthquakes for Two-Story Reinforced Concrete Frames: Strong Direction

PGA	None	Minor	Moderate	Substantial	Major
0.1	60	3	0	0	0
0.2	60	31	16	8	3
0.3	60	48	30	17	9
0.4	60	59	45	38	28
0.5	60	60	53	45	37
0.6	60	60	58	55	47
0.7	60	60	60	58	55
0.8	60	60	60	59	55
0.9	60	60	60	60	58
1	60	60	60	60	58
1.1	60	60	60	60	60
1.2	60	60	60	60	60
1.3	60	60	60	60	60
1.4	60	60	60	60	60
1.5	60	60	60	60	60

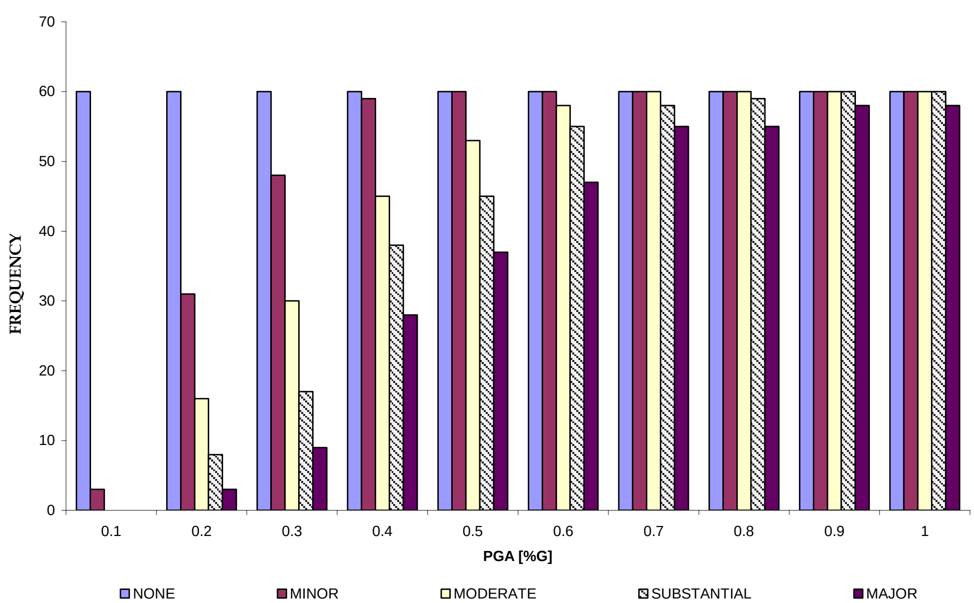
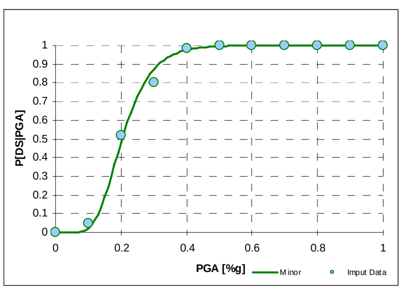


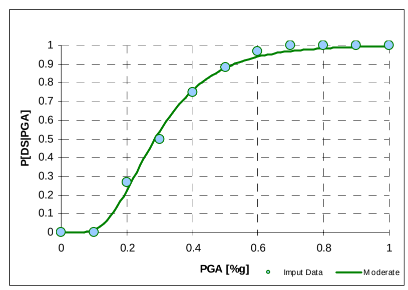
Figure 8-16. Cumulative Distribution using Algan limits state for Two-Story Reinforced Concrete Frames: Strong Direction

Table 8-14. Input data damage-state probability using Algan limits state: All Earthquakes for Two-Story Reinforced Concrete Frames: Strong Direction

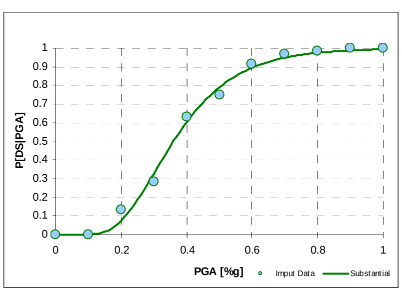
PGA	None	Minor	Moderate	Substantial	Major
0.1	1.00	0.05	0.00	0.00	0.00
0.2	1.00	0.52	0.27	0.13	0.05
0.3	1.00	0.80	0.50	0.28	0.15
0.4	1.00	0.98	0.75	0.63	0.47
0.5	1.00	1.00	0.88	0.75	0.62
0.6	1.00	1.00	0.97	0.92	0.78
0.7	1.00	1.00	1.00	0.97	0.92
0.8	1.00	1.00	1.00	0.98	0.92
0.9	1.00	1.00	1.00	1.00	0.97
1	1.00	1.00	1.00	1.00	0.97
1.1	1.00	1.00	1.00	1.00	1.00
1.2	1.00	1.00	1.00	1.00	1.00
1.3	1.00	1.00	1.00	1.00	1.00
1.4	1.00	1.00	1.00	1.00	1.00
1.5	1.00	1.00	1.00	1.00	1.00



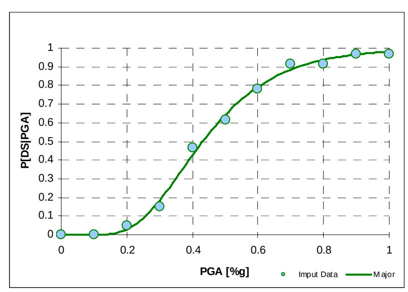
a) Minor Damage



b) Moderate Damage



c) Substantial Damage



d) Major Damage

Figure 8-17. Damage Fragility curves using Algan limits state for Two-Story Reinforced Concrete Frames: Strong Direction

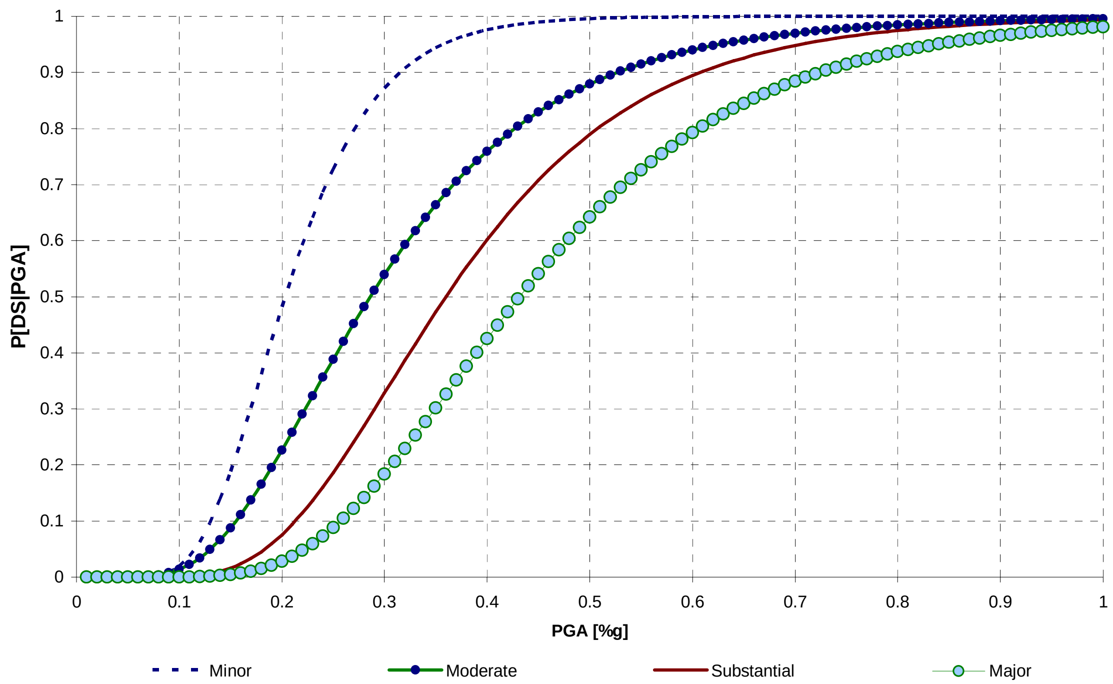


Figure 8-18. Set of Damage Fragility curves using Algan limits state for Two-Story Reinforced Concrete Frames: Strong Direction

8.4 CONCRETE SHEAR WALL MODELS

The fragility curves for one and two-story concrete shear wall models described in in this section.

8.4.1 ONE-STORY MODELS

One-story concrete shear wall models fragility curves are studied by considering three different scenarios: first all models are considered to create a general fragility curve for this type of models, then two sets of fragility curves are developed by filtering the data and considering only the models with walls oriented in the weak direction of shaking, and last models with walls oriented in the direction of shaking are considered. These models comprise models with all walls oriented in the strong direction and walls oriented in both directions.

8.4.1.1 ONE-STORY REINFORCED CONCRETE SHEAR WALLS: ALL MODELS

The same methodology followed for reinforced concrete frame models was used to develop fragility curves for one-story shear wall models. The 18 one-story shear walls prototypes described in Chapter 6 subjected to earthquake records normalized to different peak ground acceleration values described in Chapter 5 result in a sample size of 90 data points. For each peak ground acceleration the values of damage state occurrence for each earthquake are added and the results summarized in Table 8-15.

Table 8-15 presents the number of buildings that reach or exceed each damage state at each PGA. For example, if the peak ground acceleration considered is 0.3g, a total of 59 building show at least Minor damages and 57, more than half of the sample, present damage greater than Moderate damage state. Even at low peak ground acceleration, considerable damages are obtained: at 0.1g , 19 models reach the Major damage state. The occurrence distribution is presented graphically in Figure 8-19.

The input cumulative distribution function obtained is shown in Table 8-16. These values represent the probability of being in or exceeding each damage state at each PGA. For example at 0.3g there is a 63% probability of reaching or exceeding Moderate damage state. The data points of the fragility curves are plotted in Figure 8-20 together with the fragility curves fitted for each damage state. The fragility curve parameters are summarized in Table 8-2. The set of fragility curve as a function of PGA proposed for this population is plotted in Figure 8-21.

Table 8-15. Cumulative damage-state occurrence using Algan limits state: All Earthquakes for One-Story Reinforced Concrete Shear Walls: All Models

PGA	None	Minor	Moderate	Substantial	Major
0.1	90	38	29	24	19
0.2	90	56	48	42	36
0.3	90	59	57	51	48
0.4	90	63	63	62	56
0.5	90	65	65	63	63
0.6	90	74	74	73	70
0.7	90	75	75	74	73
0.8	90	78	78	78	78
0.9	90	79	79	79	79
1	90	81	81	81	81
1.1	90	82	82	82	82
1.2	90	83	83	83	83
1.3	90	83	83	83	83
1.4	90	83	83	83	83
1.5	90	85	85	85	85

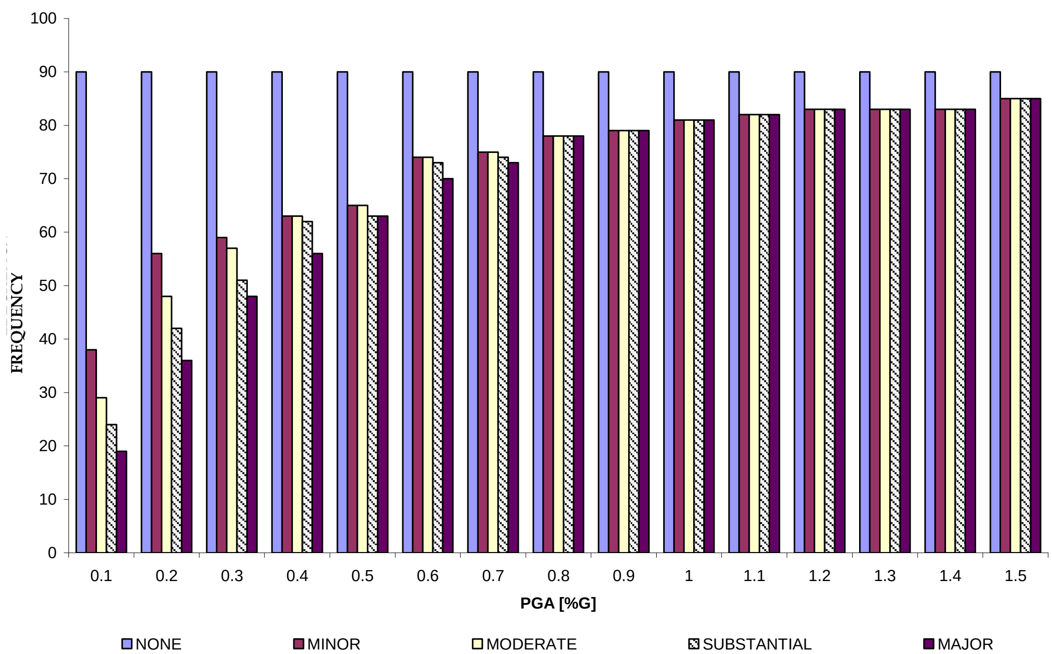
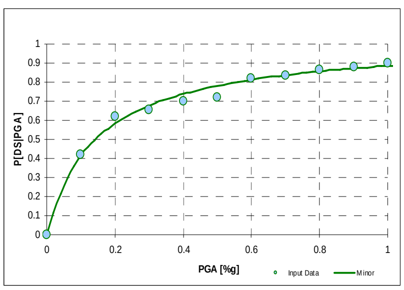


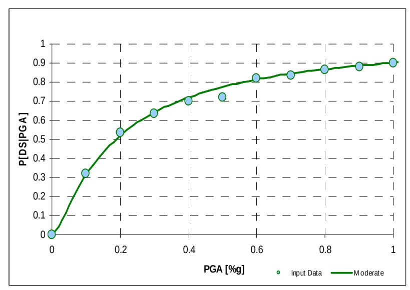
Figure 8-19. Cumulative Distribution using Algan limits state for One-Story Reinforced Concrete Shear Walls: All Models

Table 8-16. Input data damage-state probability using Algan limits state: All Earthquakes for One-Story Reinforced Concrete Shear Walls: All Models

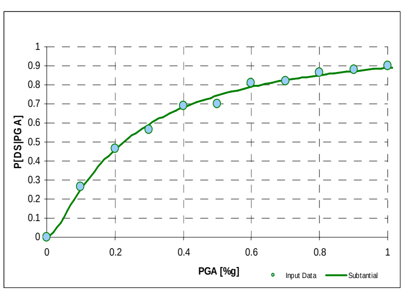
PGA	None	Minor	Moderate	Substantial	Major
0.1	1.00	0.42	0.32	0.27	0.21
0.2	1.00	0.62	0.53	0.47	0.40
0.3	1.00	0.66	0.63	0.57	0.53
0.4	1.00	0.70	0.70	0.69	0.62
0.5	1.00	0.72	0.72	0.70	0.70
0.6	1.00	0.82	0.82	0.81	0.78
0.7	1.00	0.83	0.83	0.82	0.81
0.8	1.00	0.87	0.87	0.87	0.87
0.9	1.00	0.88	0.88	0.88	0.88
1	1.00	0.90	0.90	0.90	0.90
1.1	1.00	0.91	0.91	0.91	0.91
1.2	1.00	0.92	0.92	0.92	0.92
1.3	1.00	0.92	0.92	0.92	0.92
1.4	1.00	0.92	0.92	0.92	0.92
1.5	1.00	0.94	0.94	0.94	0.94



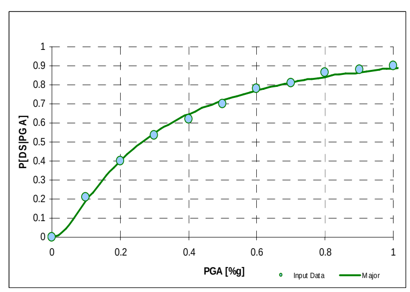
a) Minor Damage



b) Moderate Damage



c) Substantial Damage



d) Major Damage

Figure 8-20. Damage Fragility curves using Algan limits state for One-Story Reinforced Concrete Shear Walls: All Models

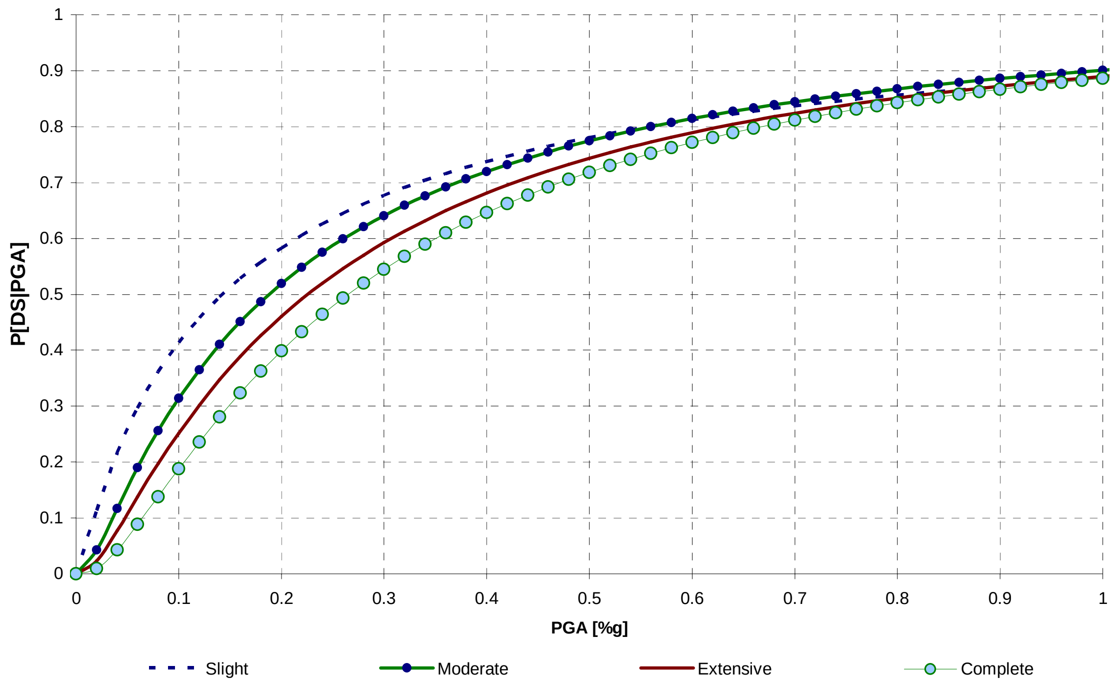


Figure 8-21. Set of Damage Fragility curves using Algan limits state for One-Story Reinforced Concrete Shear Walls: All Models

8.4.1.2 ONE-STORY REINFORCED CONCRETE SHEAR WALLS: WEAK DIRECTION

The population of shear walls with columns oriented in the weak direction is consist of 6 prototypes models. After subjection them to the 5 input ground motions defined in Chapter 5, a sample size of 30 models is obtained. Table 8-17 presents the cumulative damage state occurrence for each peak ground acceleration value. For a PGA value of 0.3g the whole sample reach or exceed Moderate damage state and 29 from 30 buildings, 97% of the models, reach Major damage state. Similar to frames with columns oriented in the weak direction, almost all models reach or exceed moderate damage at low values of PGA, at 0.2g, 29 models of 30 reach or exceed Moderate damage state and 28 presents Major damages. Figure 8-22 shows graphically the statistics of occurrence distribution.

Table 8-17. Cumulative damage-state occurrence using Algan limits state: All Earthquakes for One-Story Reinforced Concrete Shear Walls: Weak Direction

PGA	None	Minor	Moderate	Substantial	Major
0.1	30	29	26	22	19
0.2	30	30	29	29	28
0.3	30	30	30	29	29
0.4	30	30	30	30	30
0.5	30	30	30	30	30
0.6	30	30	30	30	30
0.7	30	30	30	30	30
0.8	30	30	30	30	30
0.9	30	30	30	30	30
1	30	30	30	30	30
1.1	30	30	30	30	30
1.2	30	30	30	30	30
1.3	30	30	30	30	30
1.4	30	30	30	30	30
1.5	30	30	30	30	30

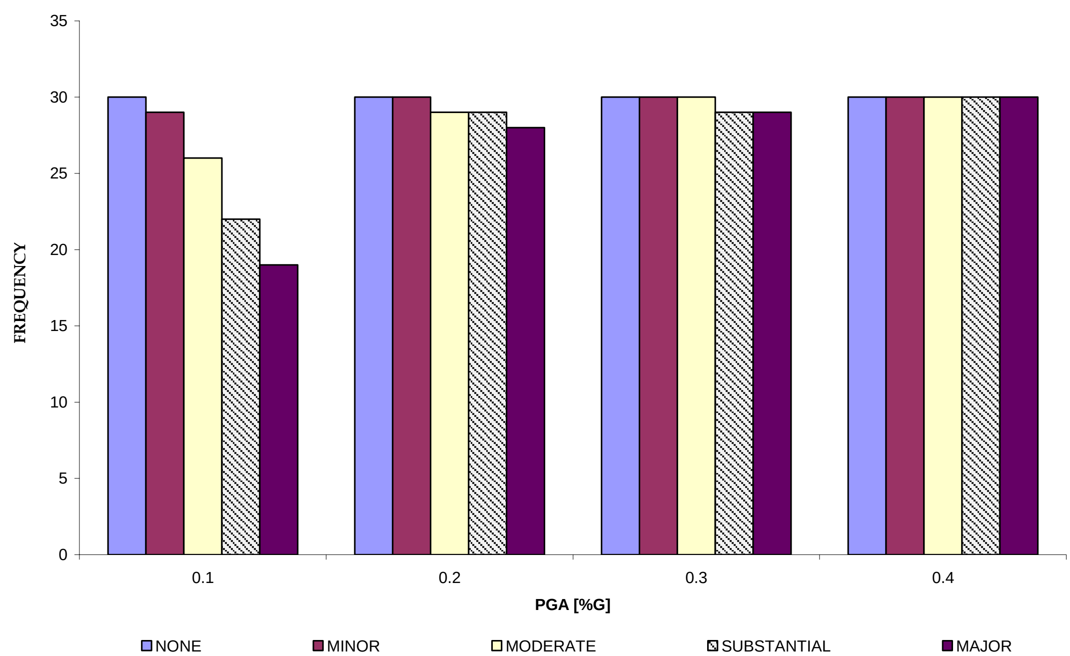
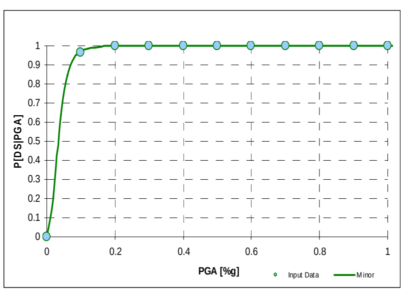


Figure 8-22. Cumulative Distribution using Algan limits state for One-Story Reinforced Concrete Shear Walls: Weak Direction

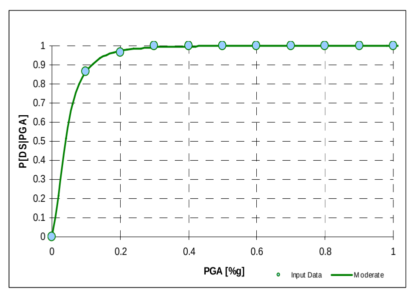
The data point values of the fragility curves are shown in Table 8-18. At 0.3g there is a 100% chance of reaching or exceeding Moderate damage state and 97% probability of reaching Major damages. Figure 8-23 presents graphically the input data points and fragility curves fitted for each damage state. The parameters of these fragility curves are summarized in Table 8-2. Finally, the set of fragility curves as a function of PGA developed for this case is plotted in Figure 8-24.

Table 8-18. Input data damage-state probability using Algan limits state: All Earthquakes for One-Story Reinforced Concrete Shear Walls: Weak Direction

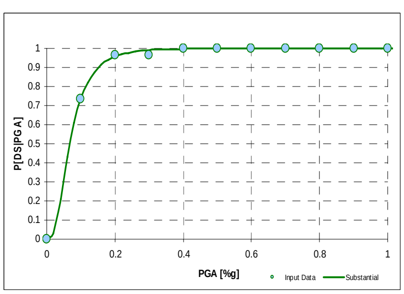
PGA	None	Minor	Moderate	Substantial	Major
0.1	1.00	0.97	0.87	0.73	0.63
0.2	1.00	1.00	0.97	0.97	0.93
0.3	1.00	1.00	1.00	0.97	0.97
0.4	1.00	1.00	1.00	1.00	1.00
0.5	1.00	1.00	1.00	1.00	1.00
0.6	1.00	1.00	1.00	1.00	1.00
0.7	1.00	1.00	1.00	1.00	1.00
0.8	1.00	1.00	1.00	1.00	1.00
0.9	1.00	1.00	1.00	1.00	1.00
1	1.00	1.00	1.00	1.00	1.00
1.1	1.00	1.00	1.00	1.00	1.00
1.2	1.00	1.00	1.00	1.00	1.00
1.3	1.00	1.00	1.00	1.00	1.00
1.4	1.00	1.00	1.00	1.00	1.00
1.5	1.00	1.00	1.00	1.00	1.00



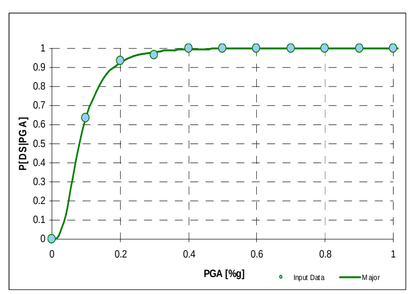
a) Minor Damage



b) Moderate Damage



c) Substantial Damage



d) Major Damage

Figure 8-23. Damage Fragility curves using Algan limits state for One-Story Reinforced Concrete Shear Walls: Weak Direction

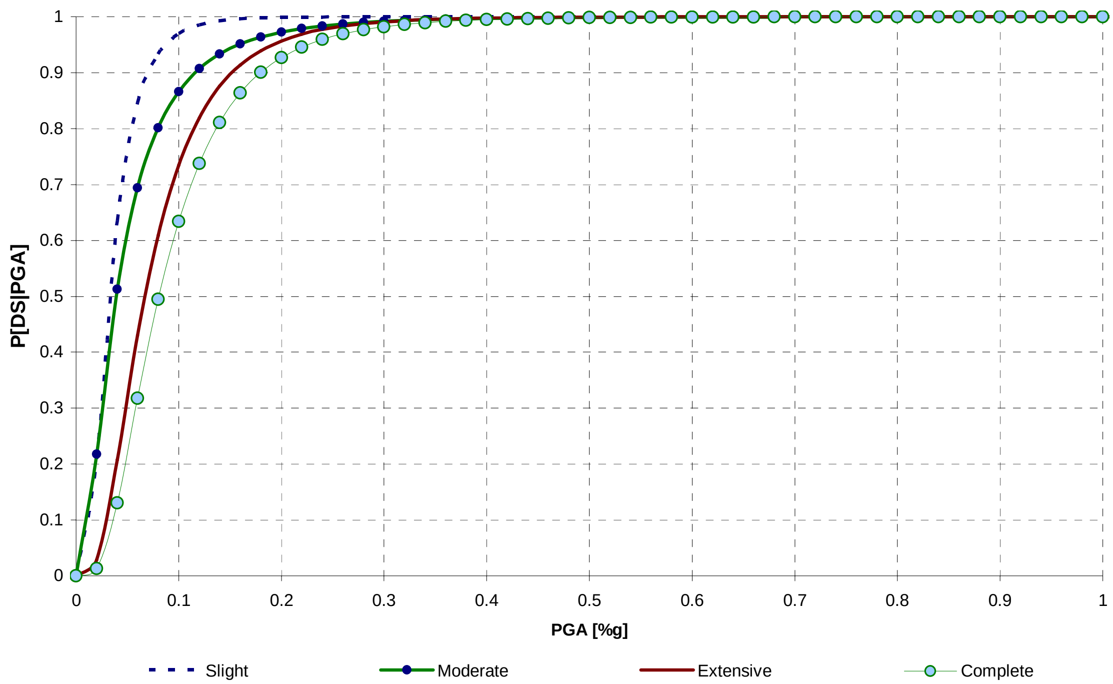


Figure 8-24. Set of Damage Fragility curves using Algan limits state for One-Story Reinforced Concrete Shear Walls: Weak Direction

8.4.1.3 ONE-STORY REINFORCED CONCRETE SHEAR WALLS: STRONG DIRECTION

From the 18 one-story reinforced concrete shear wall models, 12 have walls oriented in the strong direction. A total of 60 data points are obtained from each PGA. Similar to previous model types, the number of buildings that reach or exceed each damage state are presented in Table 8-19. For 0.3g, 27 models, approximately half of the population reach Moderate damage state and 19 models present Major damages. The occurrence distribution is presented graphically in Figure 8-25.

The input damage state probability, data point values of the fragility curves are summarized in Table 8-20. For this sample, at 0.3g there is a 45% chance of reaching or exceeding Moderate damage state and 32% of reaching Major damages. Figure 8-26 presents graphically the input data points and fragility curves fitted for each damage state. The parameters of these fragility curves are summarized in Table 8-2. The set of fragility curves as a function of PGA developed for this case is plotted in Figure 8-27.

Table 8-19. Cumulative damage-state occurrence using Algan limits state: All Earthquakes for One-Story Reinforced Concrete Shear Walls: Strong Direction

PGA	None	Minor	Moderate	Substantial	Major
0.1	60	9	3	2	0
0.2	60	26	19	13	8
0.3	60	29	27	22	19
0.4	60	33	33	32	26
0.5	60	35	35	33	33
0.6	60	44	44	43	40
0.7	60	45	45	44	43
0.8	60	48	48	48	48
0.9	60	49	49	49	49
1	60	51	51	51	51
1.1	60	52	52	52	52
1.2	60	53	53	53	53
1.3	60	53	53	53	53
1.4	60	53	53	53	53
1.5	60	55	55	55	55

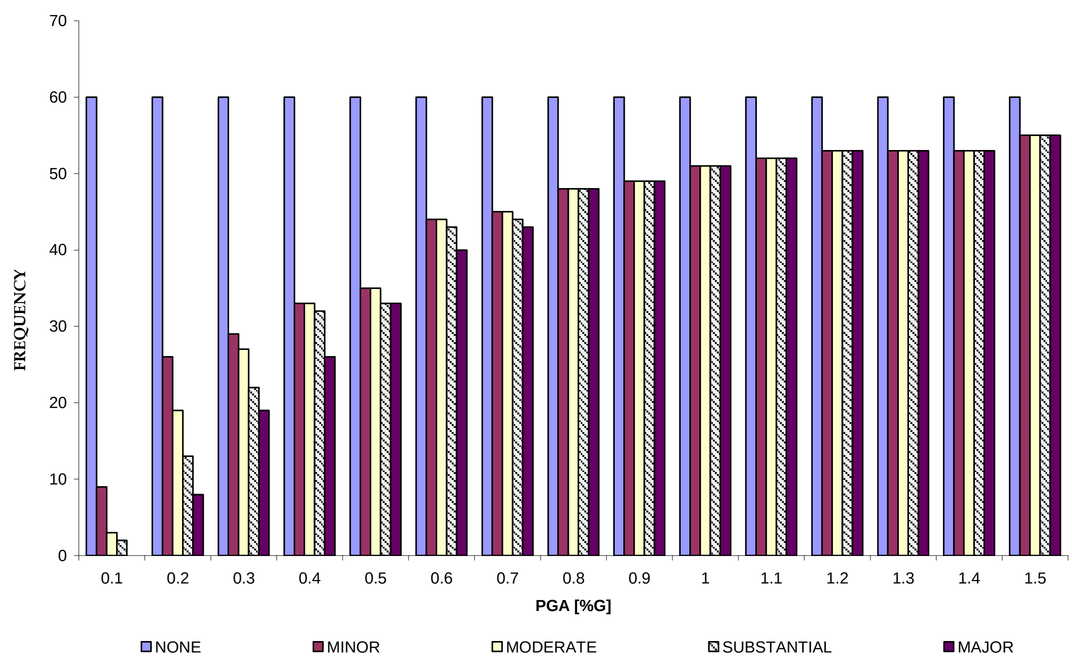
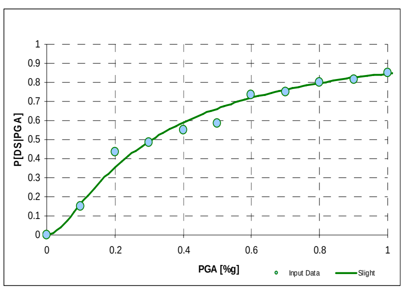


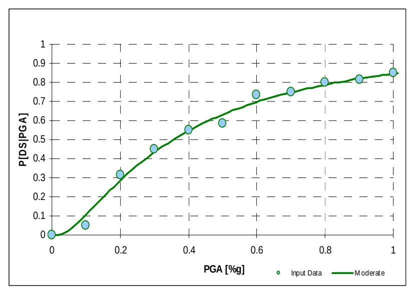
Figure 8-25. Cumulative Distribution using Algan limits state for One-Story Reinforced Concrete Shear Walls: Strong Direction

Table 8-20. Input data damage-state probability using Algan limits state: All Earthquakes for One-Story Reinforced Concrete Shear Walls: Strong Direction

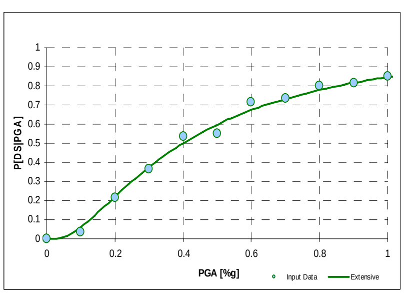
PGA	None	Minor	Moderate	Substantial	Major
0.1	1.00	0.15	0.05	0.03	0.00
0.2	1.00	0.43	0.32	0.22	0.13
0.3	1.00	0.48	0.45	0.37	0.32
0.4	1.00	0.55	0.55	0.53	0.43
0.5	1.00	0.58	0.58	0.55	0.55
0.6	1.00	0.73	0.73	0.72	0.67
0.7	1.00	0.75	0.75	0.73	0.72
0.8	1.00	0.80	0.80	0.80	0.80
0.9	1.00	0.82	0.82	0.82	0.82
1	1.00	0.85	0.85	0.85	0.85
1.1	1.00	0.87	0.87	0.87	0.87
1.2	1.00	0.88	0.88	0.88	0.88
1.3	1.00	0.88	0.88	0.88	0.88
1.4	1.00	0.88	0.88	0.88	0.88
1.5	1.00	0.92	0.92	0.92	0.92



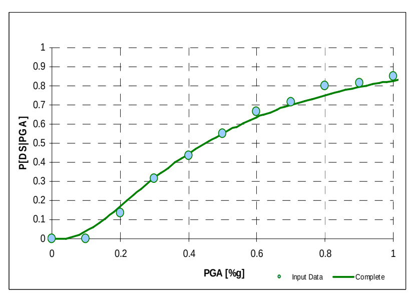
a) Minor Damage



b) Moderate Damage



c) Substantial Damage



d) Major Damage

Figure 8-26. Damage Fragility curves using Algan limits state for One-Story Reinforced Concrete Shear Walls: Strong Direction

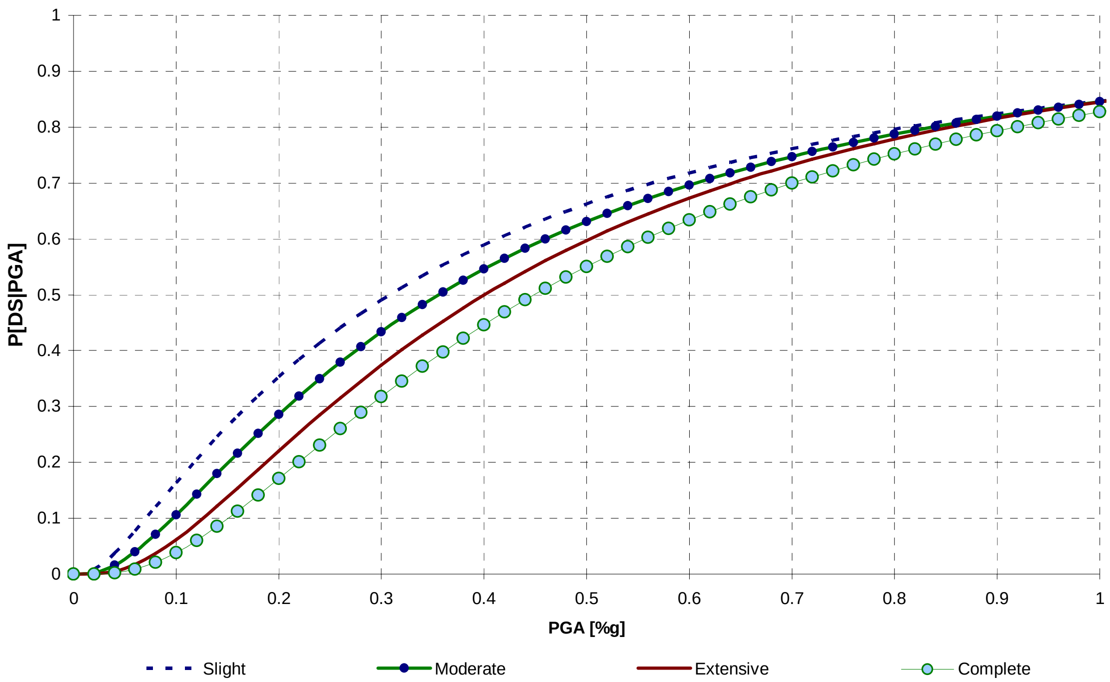


Figure 8-27. Set of Damage Fragility curves using Algan limits state for One-Story Reinforced Concrete Shear Walls: Strong Direction

8.4.2 TWO-STORY MODELS

Two-story reinforced concrete shear wall models fragility curves are studied by considering also three different scenarios: first all models are considered to create general fragility curves for this type of models, then two set of fragility curves are developed by filtering the data and considering only the models with walls oriented in the weak direction of shaking, and last models with walls oriented in the direction of shaking are considered. These models comprise models with all walls oriented in the strong direction and walls oriented in both directions.

8.4.2.1 TWO-STORY REINFORCED CONCRETE SHEAR WALLS: ALL MODELS

The 18 two-story shear walls prototypes described in Chapter 6 subjected to earthquake records normalized to different peak ground acceleration values described in Chapter 5 result in a sample size of 90 data points. For each peak ground acceleration, the values of damage state occurrence for each earthquake are added and the results summarized in Table 8-21.

Table 8-21 shows the number of buildings that reach or exceed each damage state at each PGA. For example, if the peak ground acceleration considered is 0.3g, a total of 76 buildings shows at least Minor damages and 62, more than half of the sample, present damage greater than Moderate damage state. Even at low peak ground acceleration, considerable damages are obtained: at 0.1g, 3 structures reach Moderate damage state, and at 0.2 g 51 models reach or exceed Moderate damage state and 38 reach the Major damage state. The occurrence distribution is presented graphically in Figure 8-19.

Table 8-21. Cumulative damage-state occurrence using Algan limits state: All Earthquakes for Two-Story Reinforced Concrete Shear Walls: All Models

PGA	None	Minor	Moderate	Substantial	Major
0.1	90	33	18	8	3
0.2	90	66	51	43	38
0.3	90	76	62	48	41
0.4	90	86	78	68	59
0.5	90	90	85	78	77
0.6	90	90	88	85	79
0.7	90	90	90	88	87
0.8	90	90	90	89	87
0.9	90	90	90	90	89
1	90	90	90	90	90
1.1	90	90	90	90	90
1.2	90	90	90	90	90
1.3	90	90	90	90	90
1.4	90	90	90	90	90
1.5	90	90	90	90	90

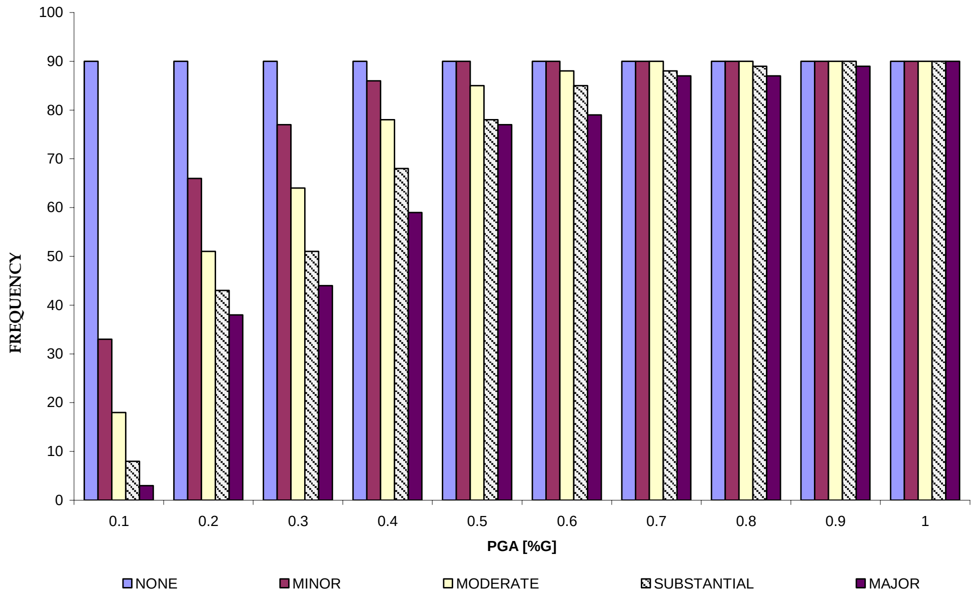
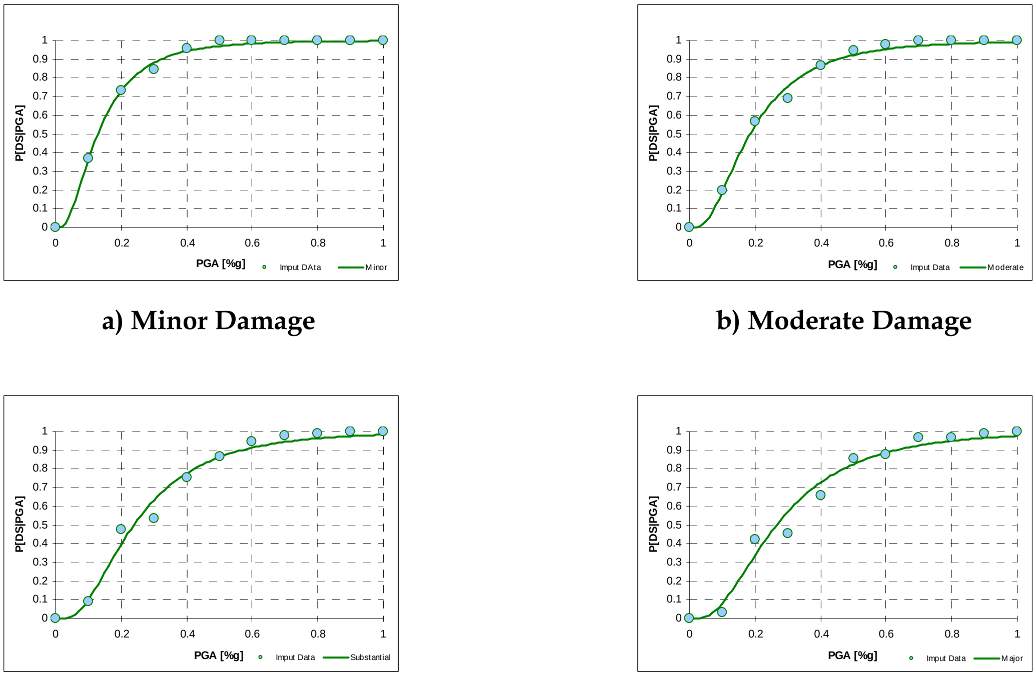


Figure 8-28. Cumulative Distribution using Algan limits state for Two-Story Reinforced Concrete Shear Walls: All Models

Table 8-22. Input data damage-state probability using Algan limits state: All Earthquakes for Two-Story Reinforced Concrete Shear Walls: All Models

PGA	None	Minor	Moderate	Substantial	Major
0.1	1.00	0.37	0.20	0.09	0.03
0.2	1.00	0.73	0.57	0.48	0.42
0.3	1.00	0.86	0.71	0.57	0.49
0.4	1.00	0.96	0.87	0.76	0.66
0.5	1.00	1.00	0.94	0.87	0.86
0.6	1.00	1.00	0.98	0.94	0.88
0.7	1.00	1.00	1.00	0.98	0.97
0.8	1.00	1.00	1.00	0.99	0.97
0.9	1.00	1.00	1.00	1.00	0.99
1	1.00	1.00	1.00	1.00	1.00
1.1	1.00	1.00	1.00	1.00	1.00
1.2	1.00	1.00	1.00	1.00	1.00
1.3	1.00	1.00	1.00	1.00	1.00
1.4	1.00	1.00	1.00	1.00	1.00
1.5	1.00	1.00	1.00	1.00	1.00

The input cumulative distribution function obtained is shown in Table 8-22. These values represent the probability of being in or exceeding each damage state at each PGA. For example at 0.3g there is a 71% probability of reaching or exceeding Moderate damage state. The input data points of the fragility curves are plotted in Figure 8-29 with the corresponding fragility curves fitted for each damage state. The fragility curve parameters are summarized in Table 8-2. The set of fragility curves as a function of PGA proposed for this population is plotted in Figure 8-30.



a) Minor Damage

b) Moderate Damage

c) Substantial Damage

d) Major Damage

Figure 8-29. Damage Fragility curves using Algan limits state for Two-Story Reinforced Concrete Shear Walls: All Models

8.4.2.2 TWO-STORY REINFORCED CONCRETE SHEAR WALLS: WEAK DIRECTION

The sample size for this type of models is 30 for each PGA. For each peak ground acceleration the values of damage state occurrence for each earthquake are added and the results summarized in Table 8-23. This table shows the number of buildings that reach or exceed each damage state at each PGA. For example, if the peak ground acceleration considered is 0.3g, the whole population shows at least moderate damages and 27 of 30 models present major damages. Even at low peak ground acceleration, considerable damages are obtained: at 0.1g, 18 structures reach Moderate damage state, 3 fall in Major damages. The occurrence distribution is presented graphically in Figure 8-31. The input cumulative distribution function obtained is shown in Table 8-24. These input data points of the fragility curves are plotted in Figure 8-32 with the corresponding fragility curves fitted for each damage state. The fragility curve parameters are summarized in Table 8-2. The set of fragility curves as a function of PGA proposed for this population is plotted in Figure 8-33.

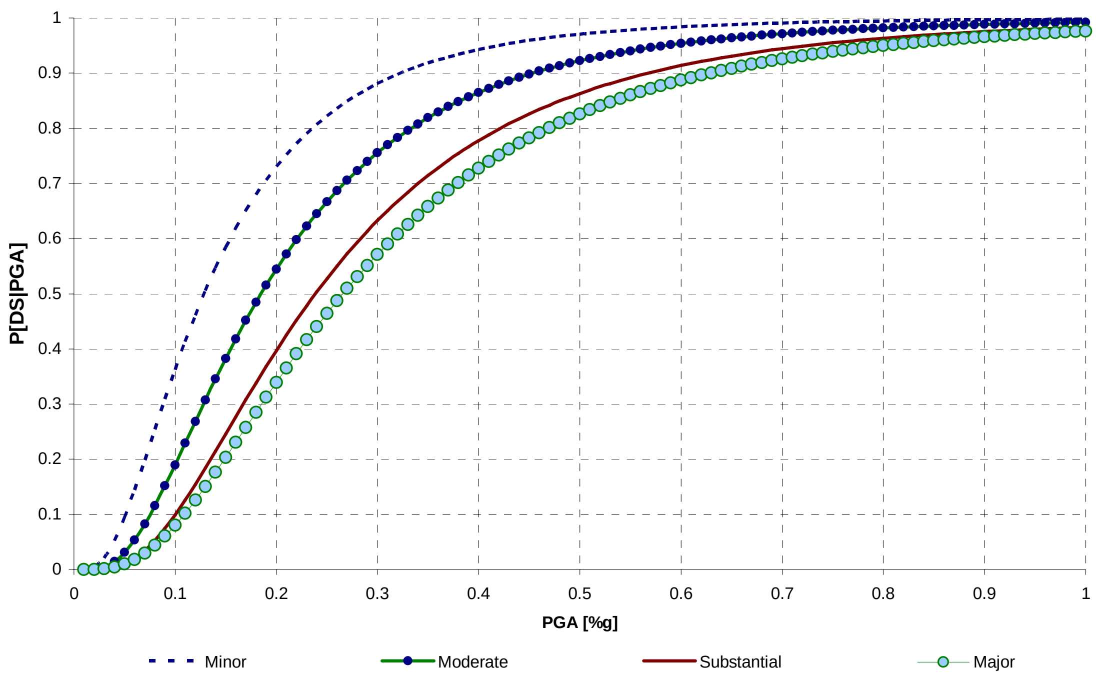


Figure 8-30. Set of Damage Fragility curves using Algan limits state for Two-Story Reinforced Concrete Shear Walls: All Models

Table 8-23. Cumulative damage-state occurrence using Algan limits state: All Earthquakes for Two-Story Reinforced Concrete Shear Walls: Weak Direction

PGA	None	Minor	Moderate	Substantial	Major
0.1	30	26	18	8	3
0.2	30	30	29	26	23
0.3	30	30	30	29	27
0.4	30	30	30	30	29
0.5	30	30	30	30	30
0.6	30	30	30	30	30
0.7	30	30	30	30	30
0.8	30	30	30	30	30
0.9	30	30	30	30	30
1	30	30	30	30	30
1.1	30	30	30	30	30
1.2	30	30	30	30	30
1.3	30	30	30	30	30
1.4	30	30	30	30	30
1.5	30	30	30	30	30

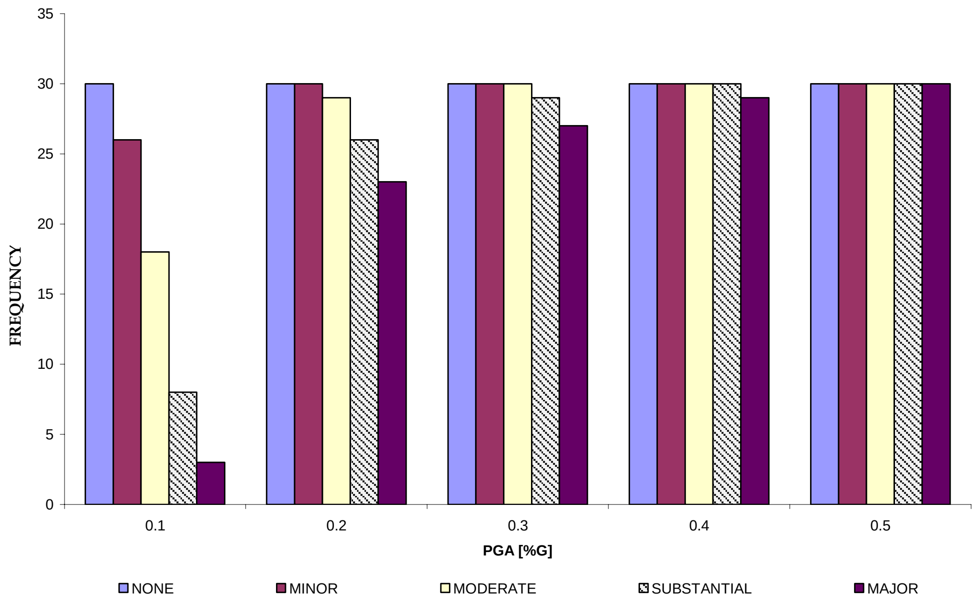
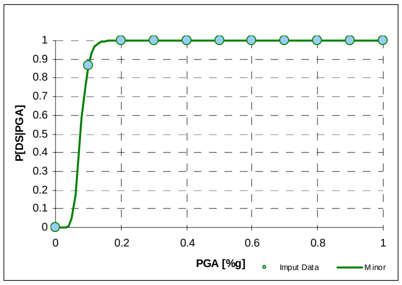


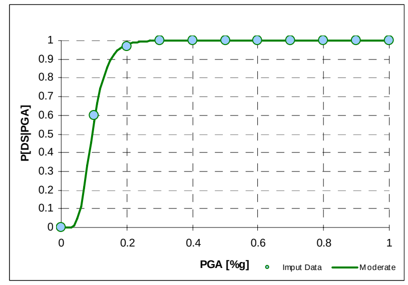
Figure 8-31. Cumulative Distribution using Algan limits state for Two-Story Reinforced Concrete Shear Walls: Weak Direction

Table 8-24. Input data damage-state probability using Algan limits state: All Earthquakes for Two-Story Reinforced Concrete Shear Walls: Weak Direction

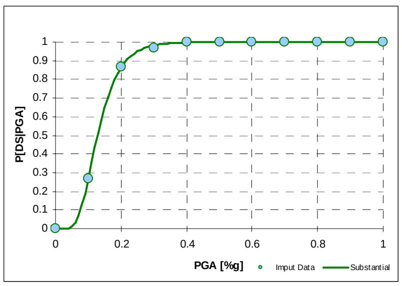
PGA	None	Minor	Moderate	Substantial	Major
0.1	1.00	0.87	0.60	0.27	0.10
0.2	1.00	1.00	0.97	0.87	0.77
0.3	1.00	1.00	1.00	0.97	0.90
0.4	1.00	1.00	1.00	1.00	0.97
0.5	1.00	1.00	1.00	1.00	1.00
0.6	1.00	1.00	1.00	1.00	1.00
0.7	1.00	1.00	1.00	1.00	1.00
0.8	1.00	1.00	1.00	1.00	1.00
0.9	1.00	1.00	1.00	1.00	1.00
1	1.00	1.00	1.00	1.00	1.00
1.1	1.00	1.00	1.00	1.00	1.00
1.2	1.00	1.00	1.00	1.00	1.00
1.3	1.00	1.00	1.00	1.00	1.00
1.4	1.00	1.00	1.00	1.00	1.00
1.5	1.00	1.00	1.00	1.00	1.00



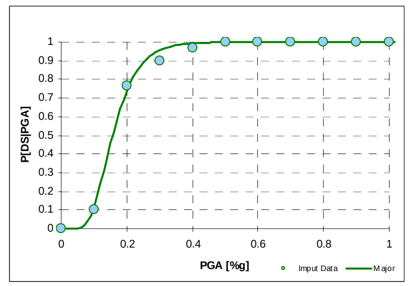
a) Minor Damage



b) Moderate Damage



c) Substantial Damage



d) Major Damage

Figure 8-32. Damage Fragility curves using Algan limits state for Two-Story Reinforced Concrete Shear Walls: Weak Direction

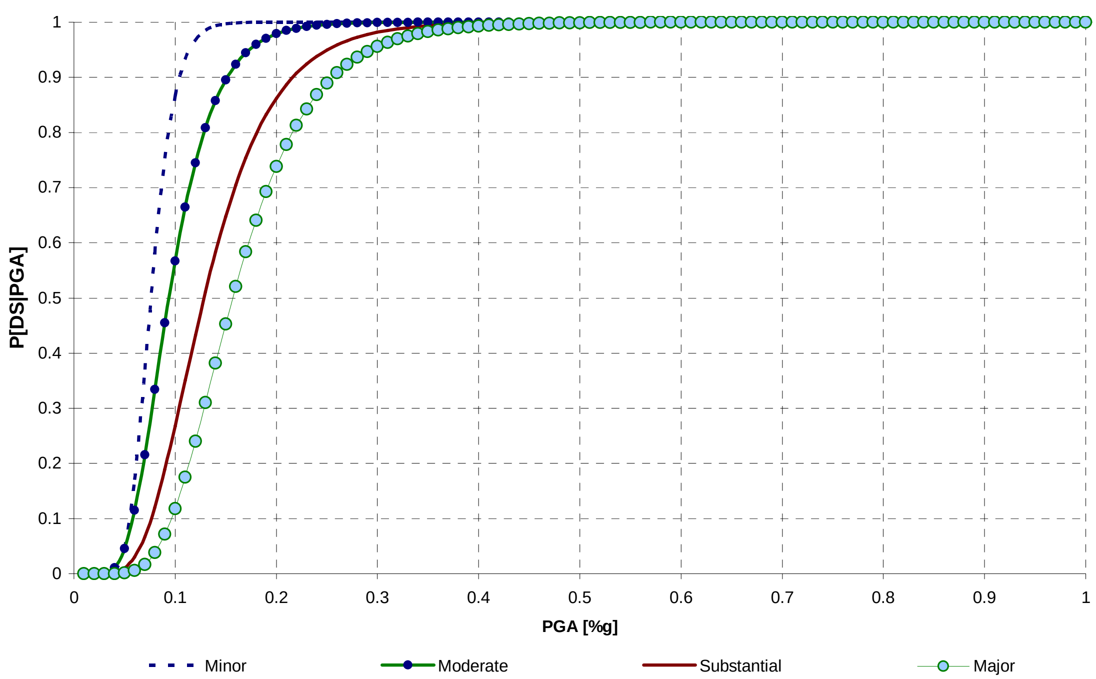


Figure 8-33. Set of Damage Fragility curves using Algan limits state for Two-Story Reinforced Concrete Shear Walls: Weak Direction

8.4.2.3 TWO-STORY REINFORCED CONCRETE SHEAR WALLS: STRONG DIRECTION

The sample size for this type of models is 60 for each PGA. For each peak ground acceleration, the values of damage state occurrence for each earthquake are added and the results summarized in Table 8-25. This table shows the number of buildings that reach or exceed each damage state at each PGA. For example, if the peak ground acceleration considered is 0.3g, 34 models, about half of the population, shows at least moderate damages and 17 of 60 models present major damages. Even at low peak ground acceleration, considerable damages are obtained: at 0.2g, 17 structures reach Moderate damage state, and 7 present Major damages. The occurrence distribution is presented graphically in Figure 8-34. The input cumulative distribution function obtained is shown in Table 8-26. These input data points of the fragility curves are plotted in Figure 8-35 with the corresponding fragility curves fitted for each damage state. The fragility curve parameters are summarized in Table 8-2. The set of fragility curves as a function of PGA proposed for this population is plotted in Figure 8-36.

Table 8-25. Cumulative damage-state occurrence using Algan limits state: All Earthquakes for Two-Story Reinforced Concrete Shear Walls: Strong Direction

PGA	None	Minor	Moderate	Substantial	Major
0.1	60	7	0	0	0
0.2	60	31	17	9	7
0.3	60	47	34	22	17
0.4	60	56	48	38	30
0.5	60	60	55	48	47
0.6	60	60	58	55	49
0.7	60	60	60	58	57
0.8	60	60	60	59	57
0.9	60	60	60	60	59
1	60	60	60	60	60
1.1	60	60	60	60	60
1.2	60	60	60	60	60
1.3	60	60	60	60	60
1.4	60	60	60	60	60
1.5	60	60	60	60	60

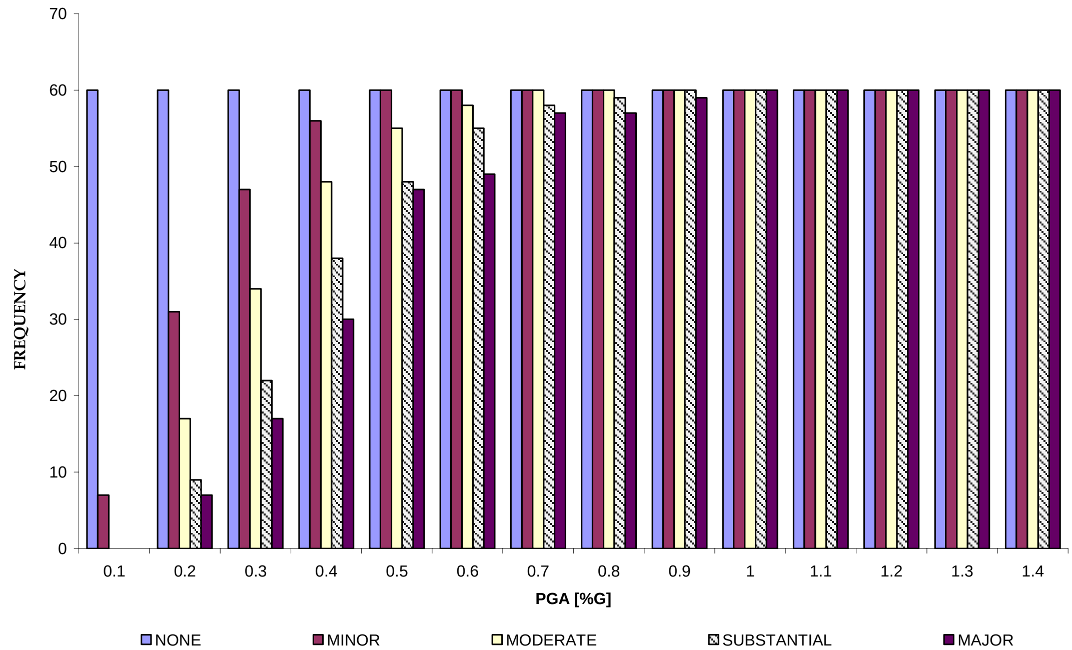
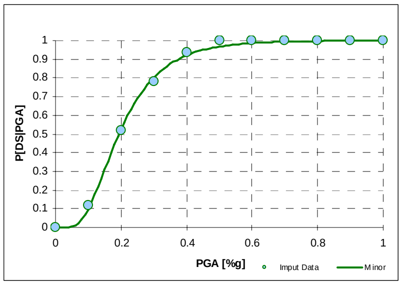


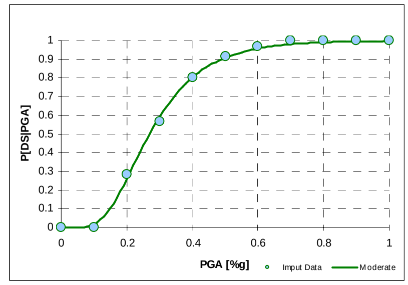
Figure 8-34. Cumulative Distribution using Algan limits state for Two-Story Reinforced Concrete Shear Walls: Strong Direction

Table 8-26. Input data damage-state probability using Algan limits state: All Earthquakes for Two-Story Reinforced Concrete Shear Walls: Strong Direction

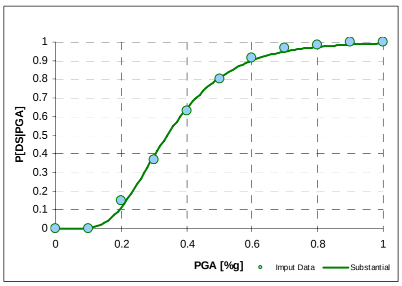
PGA	None	Minor	Moderate	Substantial	Major
0.1	1.00	0.12	0.00	0.00	0.00
0.2	1.00	0.52	0.28	0.15	0.12
0.3	1.00	0.78	0.57	0.37	0.28
0.4	1.00	0.93	0.80	0.63	0.50
0.5	1.00	1.00	0.92	0.80	0.78
0.6	1.00	1.00	0.97	0.92	0.82
0.7	1.00	1.00	1.00	0.97	0.95
0.8	1.00	1.00	1.00	0.98	0.95
0.9	1.00	1.00	1.00	1.00	0.98
1	1.00	1.00	1.00	1.00	1.00
1.1	1.00	1.00	1.00	1.00	1.00
1.2	1.00	1.00	1.00	1.00	1.00
1.3	1.00	1.00	1.00	1.00	1.00
1.4	1.00	1.00	1.00	1.00	1.00
1.5	1.00	1.00	1.00	1.00	1.00



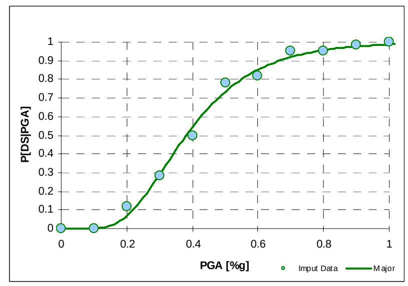
a) Minor Damage



b) Moderate Damage



c) Substantial Damage



d) Major Damage

Figure 8-35. Damage Fragility curves using Algan limits state for Two-Story Reinforced Concrete Shear Walls: Strong Direction

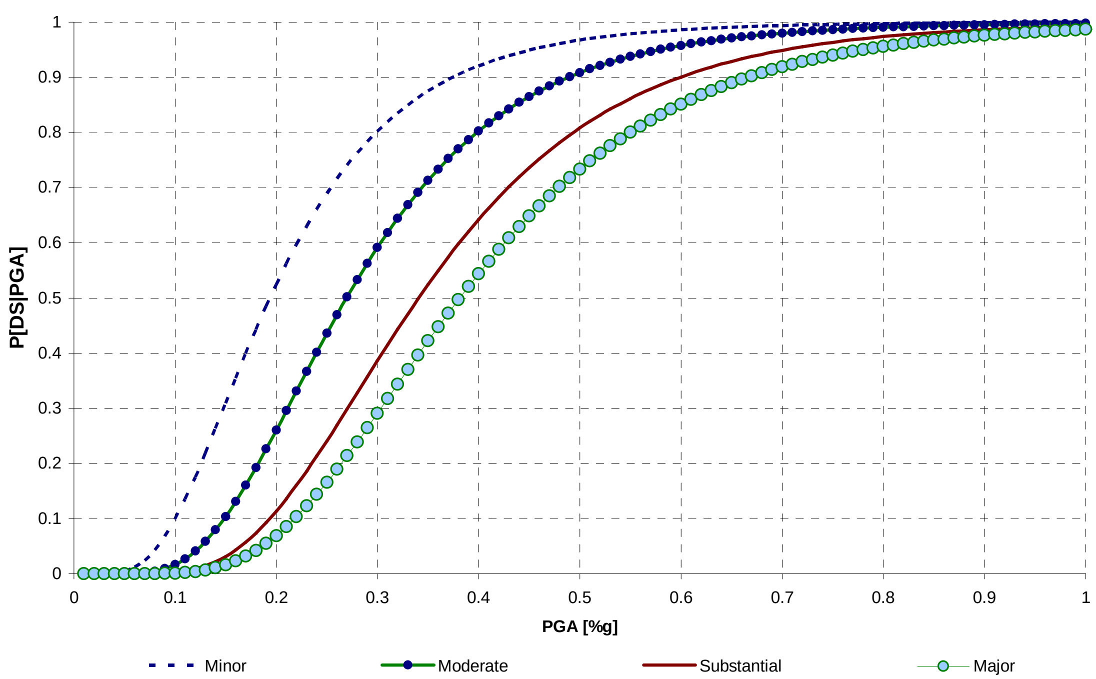


Figure 8-36. Set of Damage Fragility curves using Algan limits state for Two-Story Reinforced Concrete Shear Walls: Strong Direction

8.4.3 MULTISTORY MODELS

This section deals with the generation of the fragility curves for the multistory reinforced concrete shear wall models described in Chapter 7. Medium rise multistory residential buildings are studied by considering the whole sample, because all models presents walls in both directions, thus one set of fragility curves are developed for this type of models.

The whole population of 26 multistory models was subjected to the five earthquake records defined in Chapter 5 normalized to different peak ground acceleration values. For each peak ground acceleration considered a sample size of 130 is obtained. The values of damage state occurrence considering all earthquakes are presented in Table 8-27. The third row of the table shows that for a peak ground acceleration of 0.3g, a total of 16 building shows at least Minor damages and only 9 models present damage greater than Moderate damage state. Even at high peak ground acceleration, 1g, most of the buildings remain with almost no damage, only 55 buildings (around 42% of the whole sample) reach or exceed Moderate damage state. The occurrence distribution is presented graphically in Figure 8-37.

The cumulative distribution function obtained is summarized in Table 8-28. For example at 0.3g there is a 7% probability of reaching or exceeding Moderate damage state. These values are data point of the fragility curves. Figure 8-38 plots the input data points and the lognormal function fitted for Minor, Moderate, Substantial and Major damage. The log-median and log-standard deviation obtained is included in Table 8-2. The set of fragility curves as a function of PGA proposed for this population is plotted in Figure 8-39.

Table 8-27. Cumulative damage-state occurrence using Algan limits state: All Earthquakes for Multistory Reinforced Concrete Shear Walls: All Models

PGA	None	Minor	Moderate	Substantial	Major
0.1	130	4	2	2	1
0.2	130	5	4	4	3
0.3	130	16	9	7	5
0.4	130	32	11	9	7
0.5	130	42	23	13	11
0.6	130	53	33	23	14
0.7	130	54	39	31	23
0.8	130	61	47	37	26
0.9	130	64	54	46	34
1	130	72	55	51	44
1.1	130	78	61	54	49
1.2	130	86	65	58	55
1.3	130	90	72	63	60
1.4	130	90	77	65	60
1.5	130	96	82	71	62

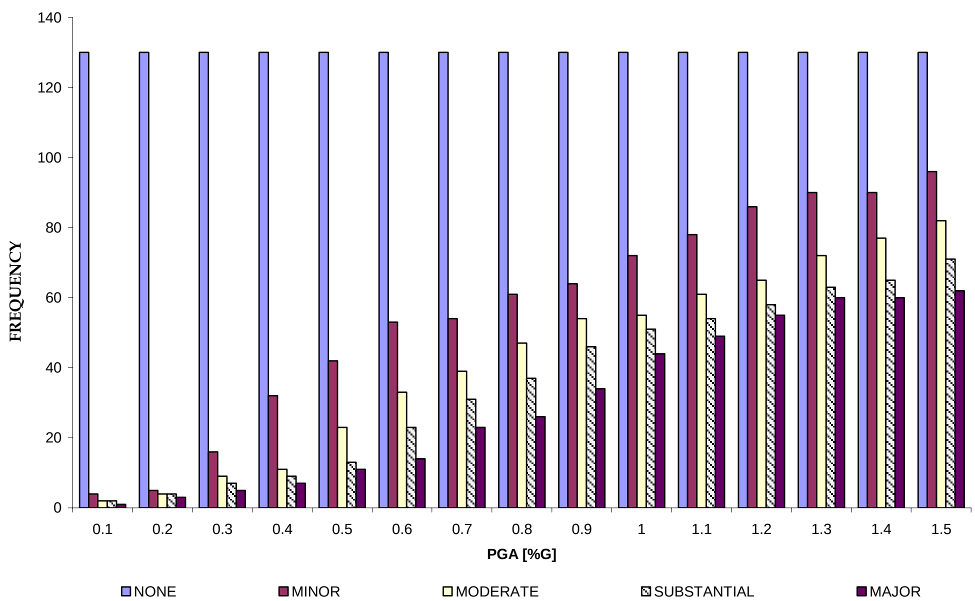
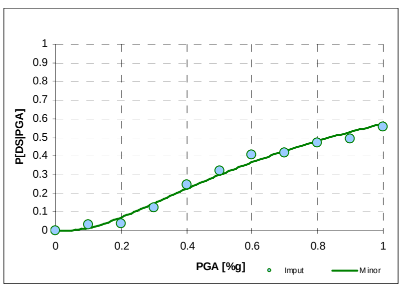


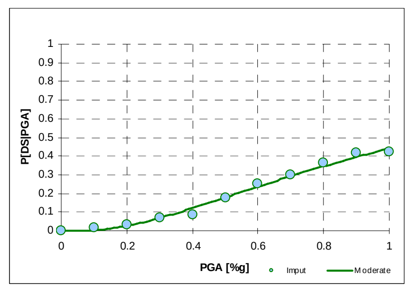
Figure 8-37. Cumulative Distribution using Algan limits state for Multistory Reinforced Concrete Shear Walls: All Models

Table 8-28. Input data damage-state probability using Algan limits state: All Earthquakes for Multistory Reinforced Concrete Shear Walls: All Models

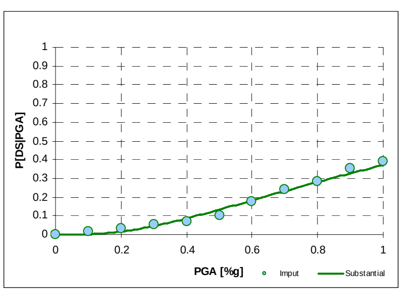
PGA	None	Minor	Moderate	Substantial	Major
0.1	1.00	0.03	0.02	0.02	0.01
0.2	1.00	0.04	0.03	0.03	0.02
0.3	1.00	0.12	0.07	0.05	0.04
0.4	1.00	0.25	0.08	0.07	0.05
0.5	1.00	0.32	0.18	0.10	0.08
0.6	1.00	0.41	0.25	0.18	0.11
0.7	1.00	0.42	0.30	0.24	0.18
0.8	1.00	0.47	0.36	0.28	0.20
0.9	1.00	0.49	0.42	0.35	0.26
1	1.00	0.55	0.42	0.39	0.34
1.1	1.00	0.60	0.47	0.42	0.38
1.2	1.00	0.66	0.50	0.45	0.42
1.3	1.00	0.69	0.55	0.48	0.46
1.4	1.00	0.69	0.59	0.50	0.46
1.5	1.00	0.74	0.63	0.55	0.48



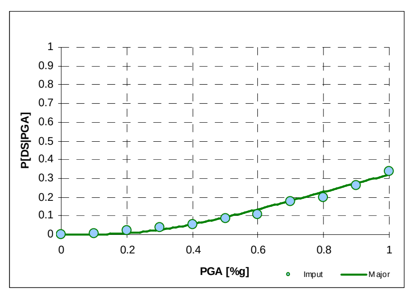
a) Minor Damage



b) Moderate Damage



c) Substantial Damage



d) Major Damage

Figure 8-38. Damage Fragility curves using Algan limits state for Multistory Reinforced Concrete Shear Walls: All Models

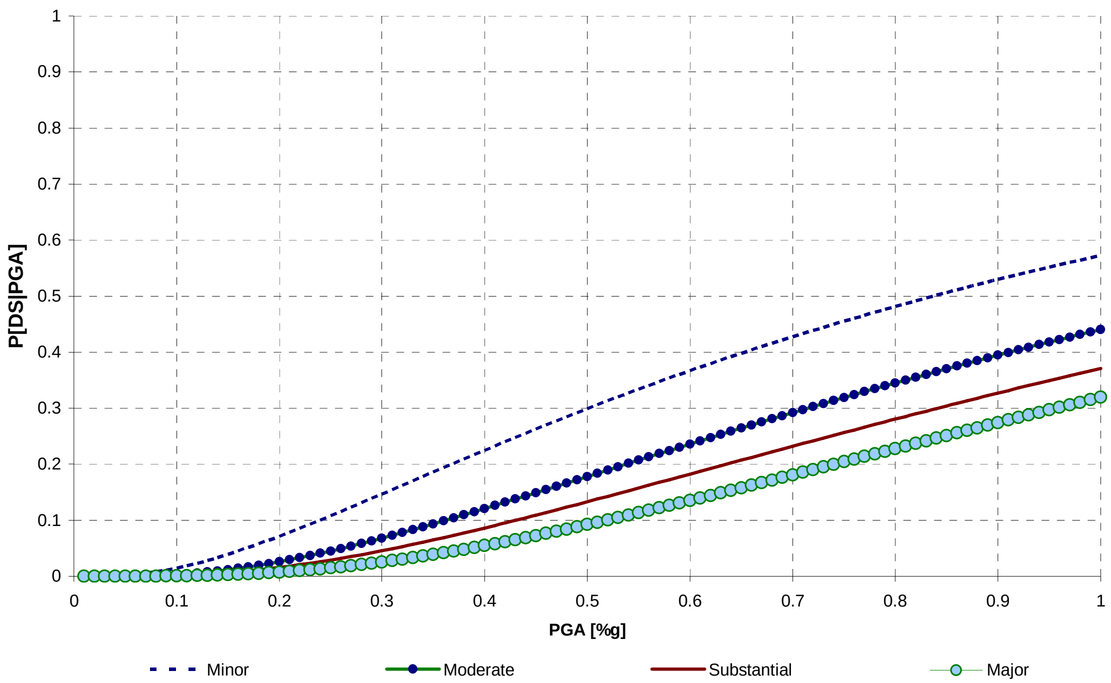


Figure 8-39. Set of Damage Fragility curves using Algan limits state for Multistory Reinforced Concrete Shear Walls: All Models

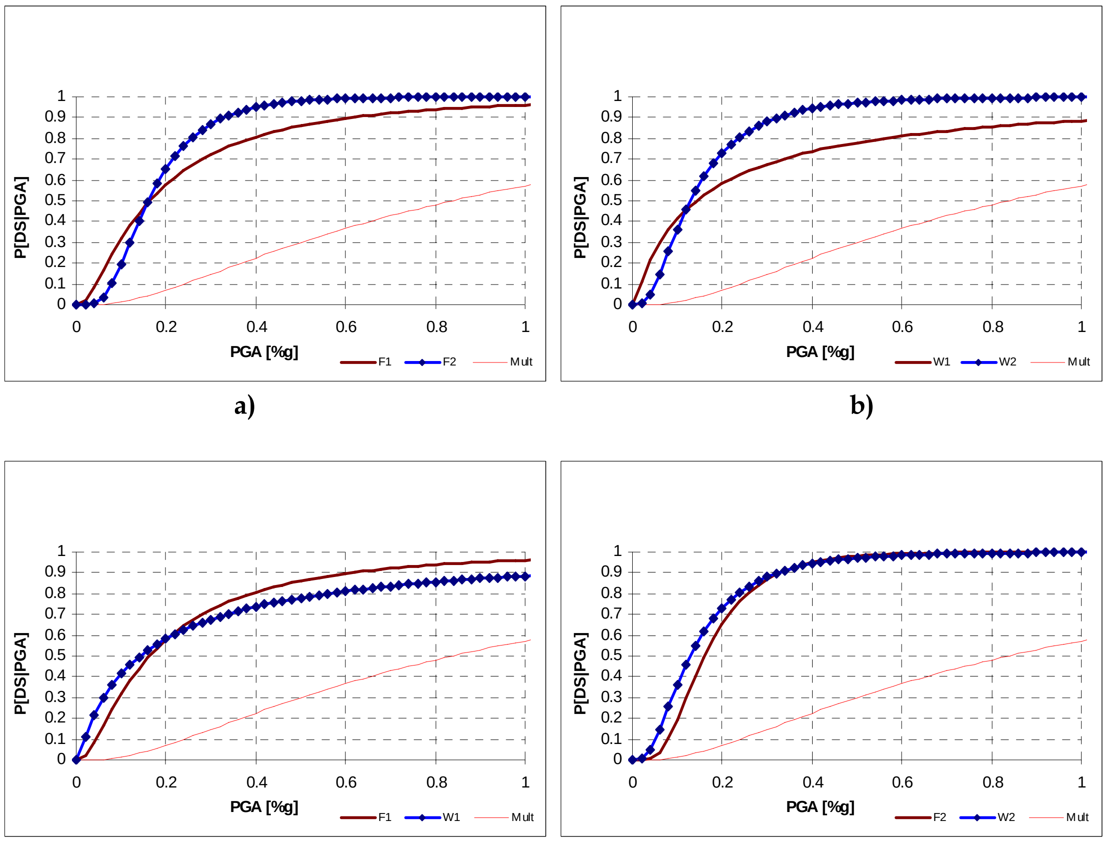
8.5 COMPARISONS OF FRAGILITY CURVES

In this section the fragility curves obtained for each case studied are compared. For better understanding of the plots, the legend used to name each model type is presented next. The code name is composed of three parts: The first one refers to the lateral resisting system, it can have one or two characters, "F" for Frames, "W" for shear walls. In the second part, a numerical value shows the number of story of the models and last a character that describe de direction of the walls or column, "W" for columns or walls oriented in the weak direction, "S" for columns or walls oriented in the strong direction. To refer to the whole population, only the first two characters are used. This code legend is only valid for one and two-story models, for multistory the word "Mult" refers to these models. For example: "W1S" refers to one-story shear wall models with walls oriented in the strong direction, “F2W”refers to two-story frame models with columns oriented in the weak direction, “F1” refers to the whole population of one-story frames.

Figure 8-40 to Figure 8-43 present the comparisons, taking into account all models of one and two-story frame, and multistory models; one and two story shear wall, and multistory models; and last, one-story models and multistory models; and two-story models and multistory models. Each damage state is compared individually.

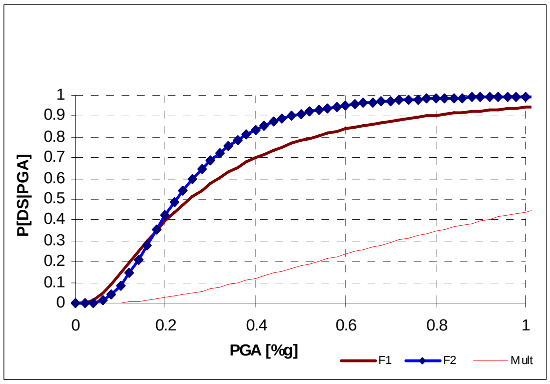
From these curves it can be inferred that multistory reinforced concrete wall models behave better than other types of models analyzed. Multistory models have only around 5% of probability of reaching major damage and 10% probability of reaching or exceeding moderate damage at 0.4g. These low probability of damage, even at high PGA values makes multistory residential models the least vulnerable structures studied and shows that they behave well when subjected to earthquake forces. This result is reasonable, because multistory models have better reinforcement details than low rise residence that allow them to develop moment resistance greater than cracking moment and also higher ductility ratio ($\frac{\varphi_u}{\varphi_y}$).

This fact can be verified also by looking at the log-mean values of multistory building from Table 8-2. For all levels of damages states, the median fragility values for multistory building are larger that the corresponding for another type of models. This implies that if the number of structure suffering from a certain state of damage is counted, on average, the damage is smaller when the structure is a multistory residential building.

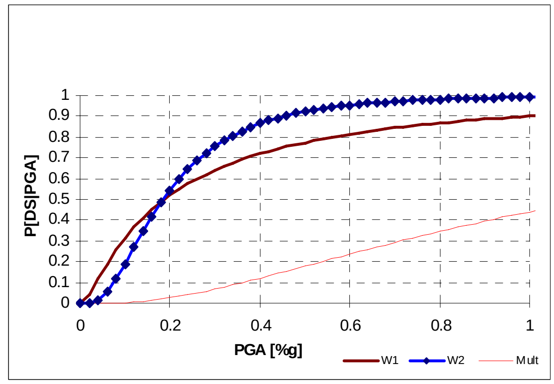


a) b) c) d)

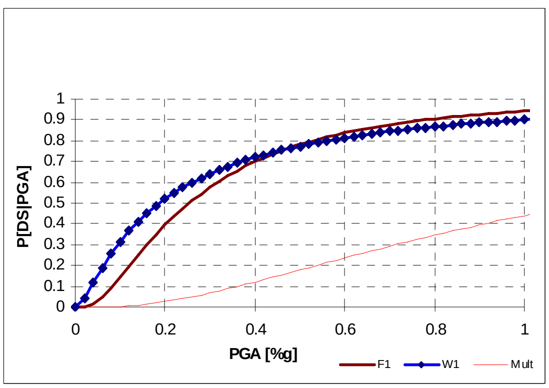
Figure 8-40. Minor damage fragility curves using Algan limits comparisons. a) One and Two-Story Frame, and Multistory Models: All Directions, b) One and Two-Story Shear Wall, and Multistory: All Directions, c) One-Story Models: All Models, and Multistory; and d) Two-Story Models, and Multistory: All Directions



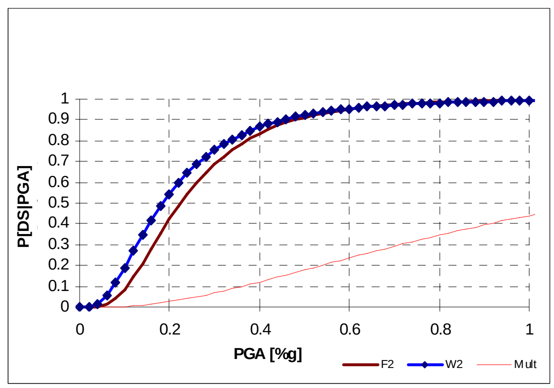
a)



b)



c)



d)

Figure 8-41. Moderate damage fragility curves using Algan limits comparisons. a) One and Two-Story Frame, and Multistory Models: All Directions, b) One and Two-Story Shear Wall, and Multistory: All Directions, c) One-Story Models: All Directions, and Multistory; and d) Two-Story Models, and Multistory: All Directions

When frame models are compared, the following trend is found for all damage states: For peak ground acceleration greather than 0.3g, two-story frame models are more susceptible to damages than one-story frame models.

Comparing one and two-story shear wall models, two-story shear walls models are more susceptible to damages than one-story shear wall models.

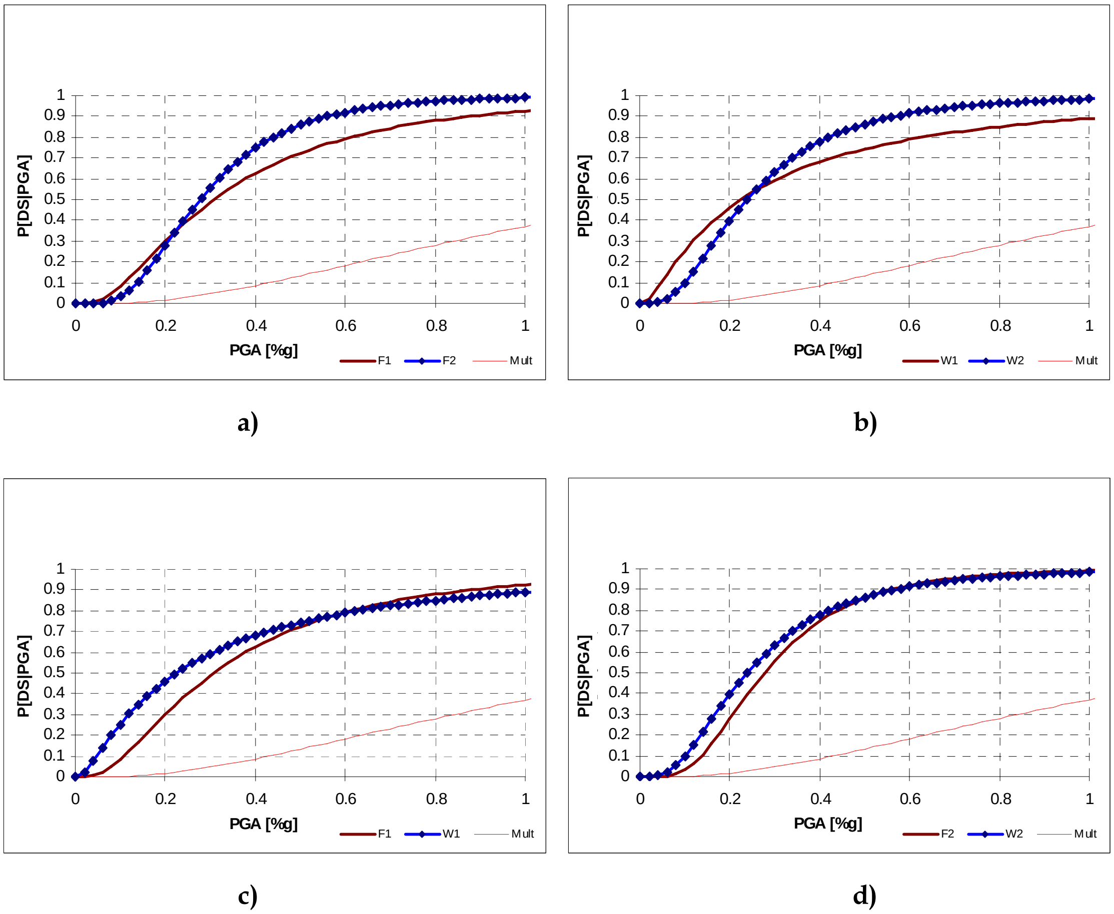


Figure 8-42. Substantial damage fragility curves using Algan limits comparisons. a) One and Two-Story Frame, and Multistory Models: All Directions, b) One and Two-Story Shear Wall, and Multistory: All Directions, c) One-Story Models: All Models, and Multistory; and d) Two-Story Models, and Multistory: All Directions

Comparing lateral resisting systems, shear wall models are more susceptible to Moderate and Substantial damage state than frame models for PGA smaller than 0.4g. For values of PGA greater than 0.4g, damage-state probability for Moderate and Substantial damages are very similar for both lateral resisting sytems. Looking at Major damage states plots it can be seen that shear wall models are more susceptible to Major damages than frame models.

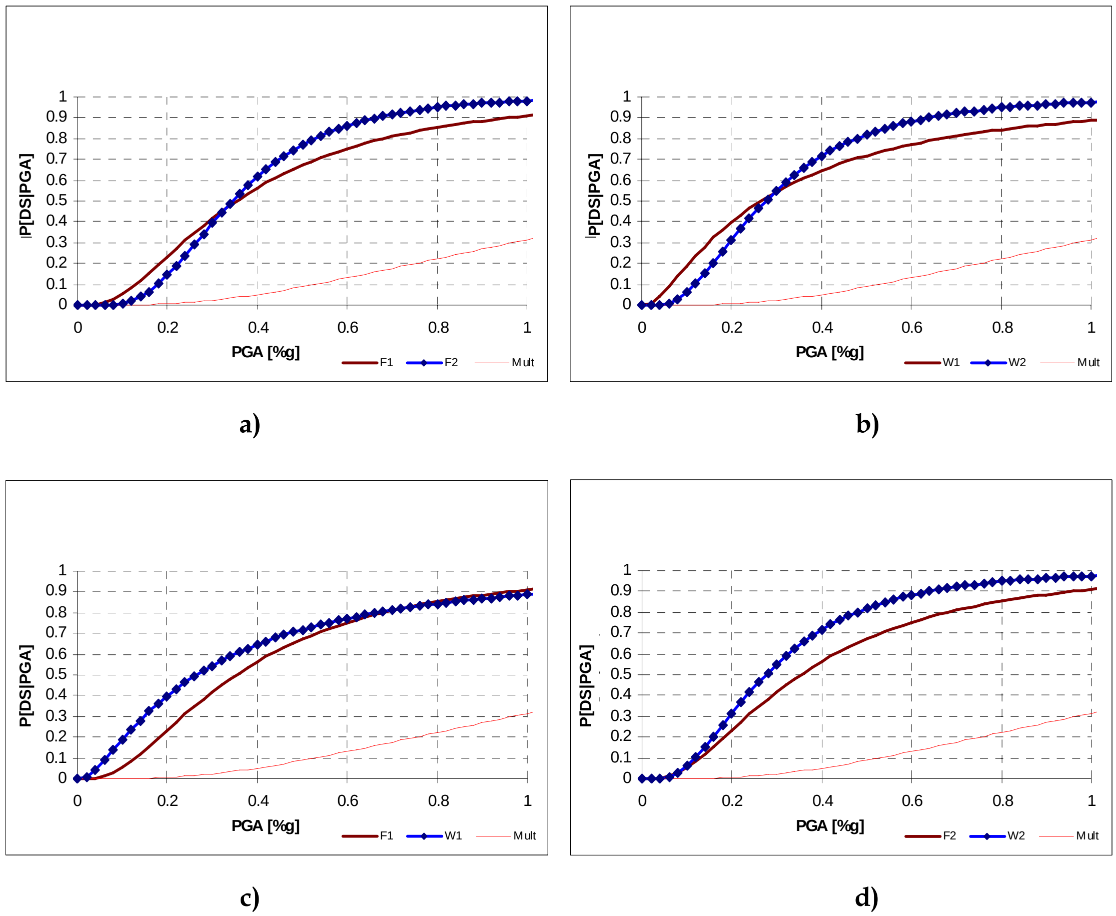
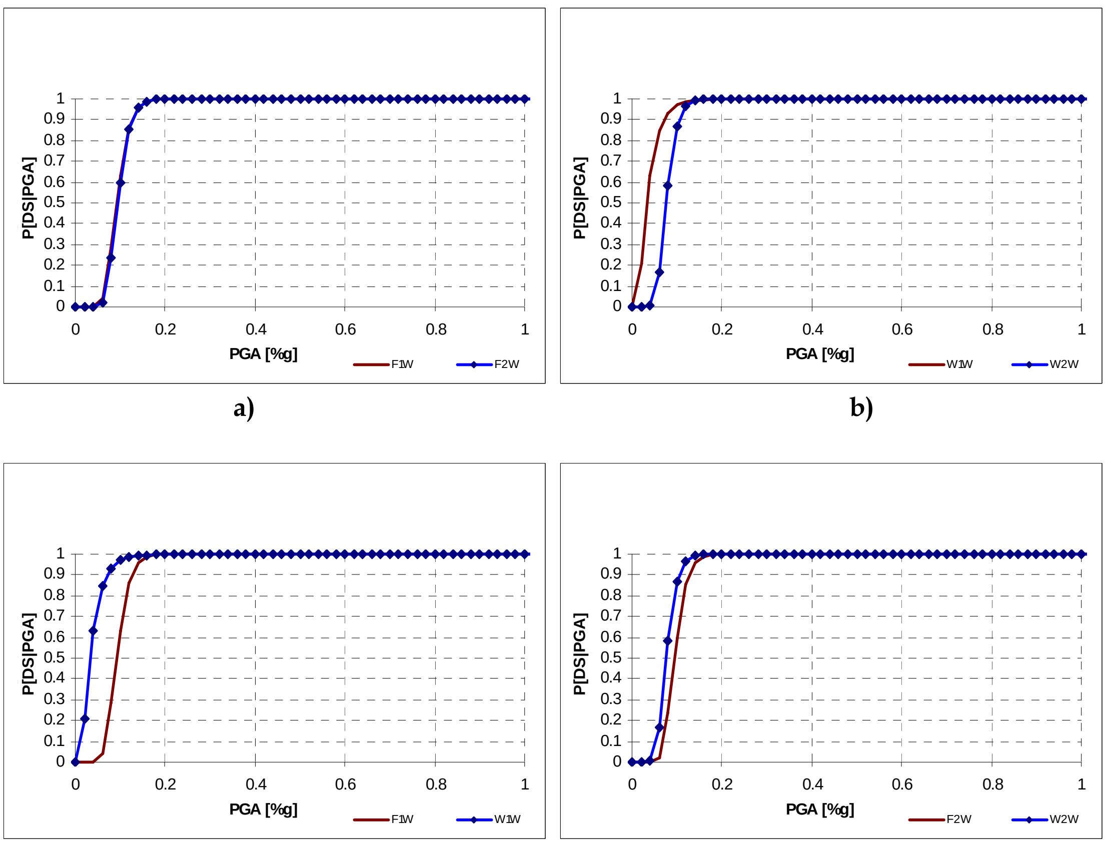


Figure 8-43. Major damage fragility curves using Algan limits comparisons. a) One and Two-Story Frame, and Multistory Models: All Directions, b) One and Two-Story Shear Wall, and Multistory: All Models, c) One-Story Models: All Directions, and Multistory; and d) Two-Story Models, and Multistory: All Directions

Figure 8-44 to Figure 8-47 makes comparisons, taking into account models with lateral resistant system oriented in the weak direction, of one and two-story frame, one and two-story shear wall models, and last, one and two-story models.

A common trend can be seen among these curves, the very low slope of these fragility curves indicates that these models as a very susceptible for damage: there is more than 80% probability that all types of models reach Major damage state at a peak ground acceleration of 0.3g.



c) d)

Figure 8-44. Minor damage fragility curves using Algan limits comparisons. a) One and Two-Story Frames: Weak Direction, b) One and Two-Story Shear Walls: Weak Direction, c) One-Story Model: Weak Direction; and d) Two-Story Models: Weak Direction

For all cases, comparing lateral resisting system in the weak direction, moment frame models are less susceptible to damage than shear wall system. This is reasonable because of the orientation of the columns and walls, moment of inertia plays an insignificant roll in the strength of the section, thus the main responsible for the flexural capacity is the reinforcement of the sections, and the two layers of reinforcement present in column sections provides more strength to section compared with that provided by the small reinforcement of the walls.

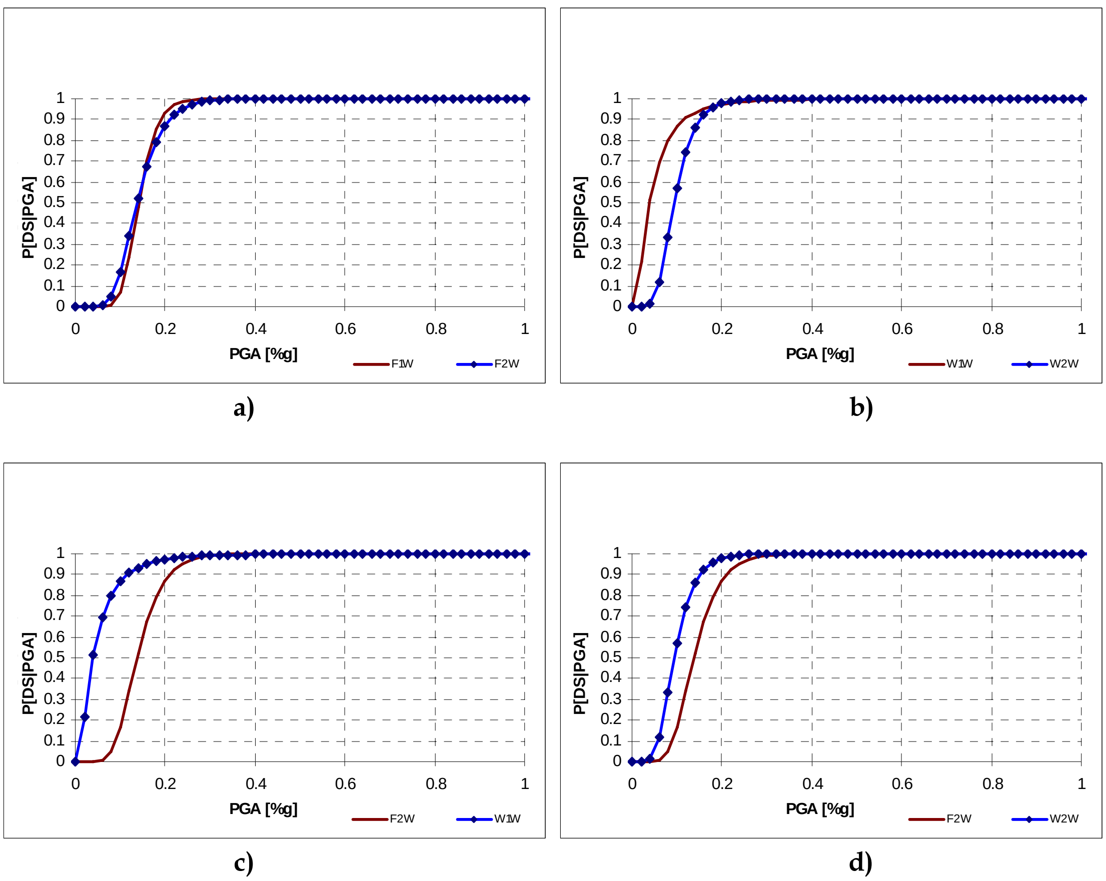


Figure 8-45. Moderate damage fragility curves using Algan limits comparisons. a) One and Two-Story Frames: Weak Direction, b) One and Two-Story Shear Walls: Weak Direction, c) One-Story Model: Weak Direction; and d) Two-Story Models: Weak Direction

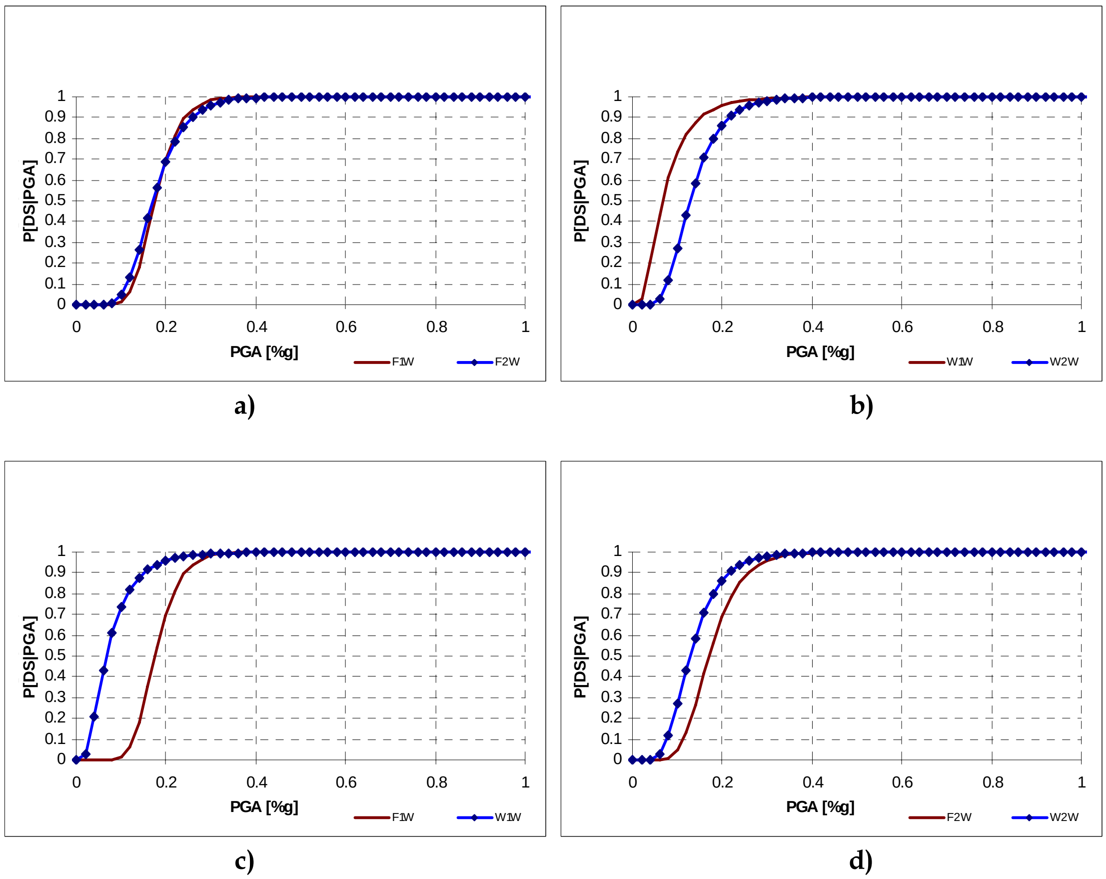
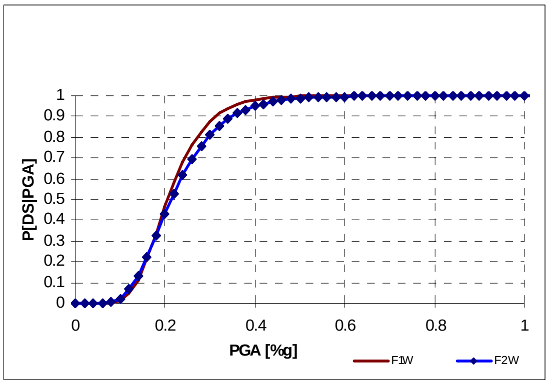
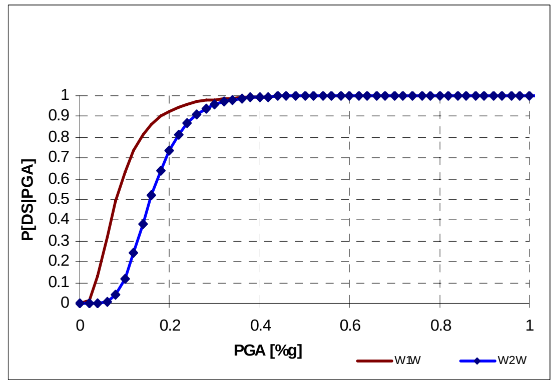


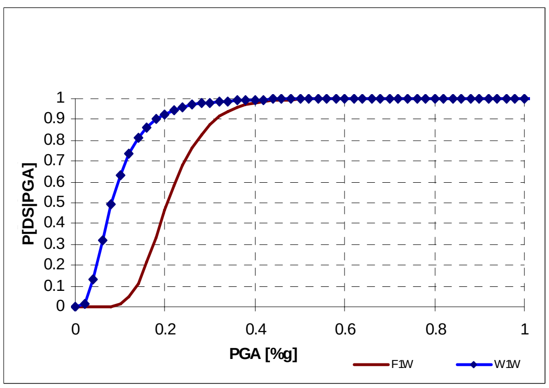
Figure 8-46. Substantial damage fragility curves using Algan limits comparisons. a) One and Two-Story Frames: Weak Direction, b) One and Two-Story Shear Walls: Weak Direction, c) One-Story Model: Weak Direction; and d) Two-Story Models: Weak Direction



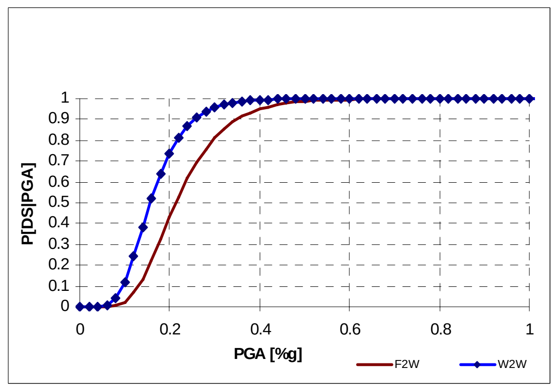
a)



b)



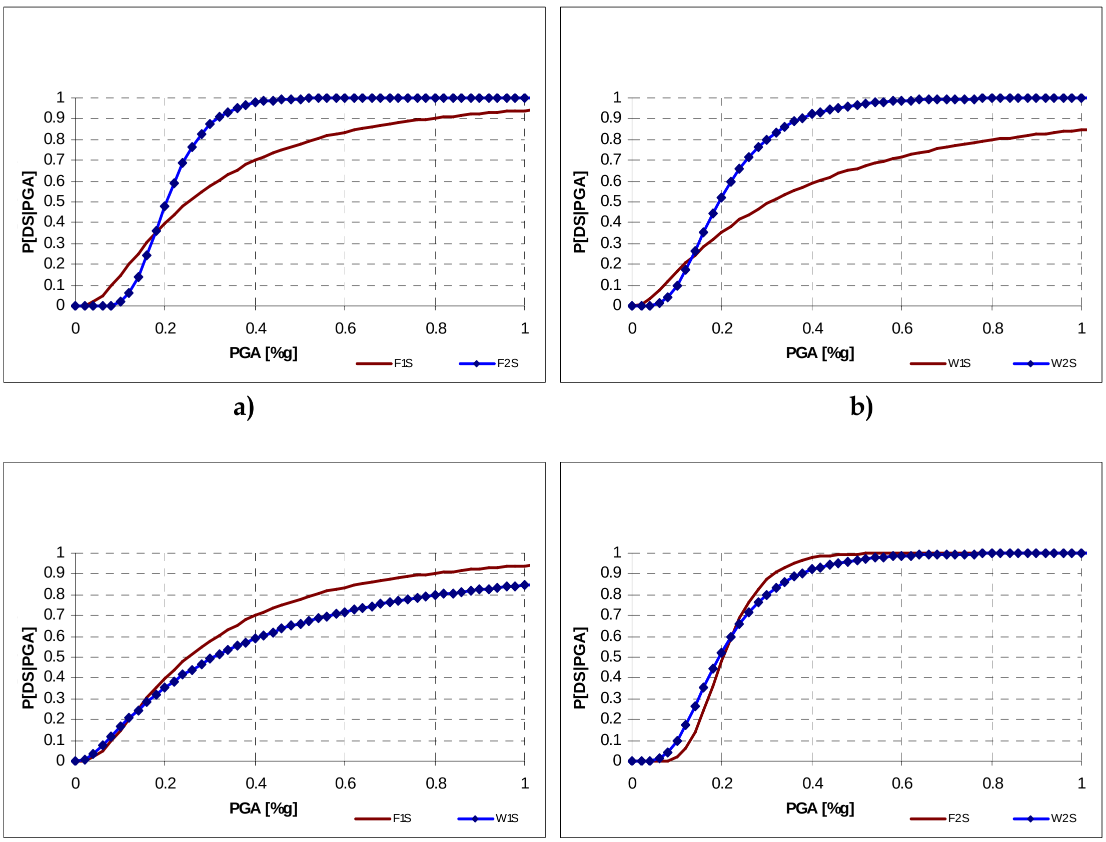
c)



d)

Figure 8-47. Major damage fragility curves using Algan limits comparisons. a) One and Two-Story Frames: Weak Direction, b) One and Two-Story Shear Walls: Weak Direction, c) One-Story Model: Weak Direction; and d) Two-Story Models: Weak Direction

Figure 8-48 to Figure 8-51 compares the one and two story models with lateral resisting system oriented in the strong direction. From these curves it can be inferred that for a PGA greater than 0,3g, two-story models are more susceptible to damages than one-story models.



a) b)

c) d)

Figure 8-48. Minor damage fragility curves using Algan limits comparisons. a) One and Two-Story Frames: Strong Direction, b) One and Two-Story Shear Walls: Strong Direction, c) One-Story Model: Strong Direction; and d) Two-Story Models: Strong Direction

Fragility curves of models with the same number of story are very similar, thus the probability of being in or exceding each damage state is almost the same for one-story shear wall models and one-story frames; and for two-story shear wall models and two-story frame models. The biggest difference is found in Major damage-states comparisons of two-story models, for a PGA of 0.4g there is a difference of 10% of reaching Major damage between shear walls and frames.

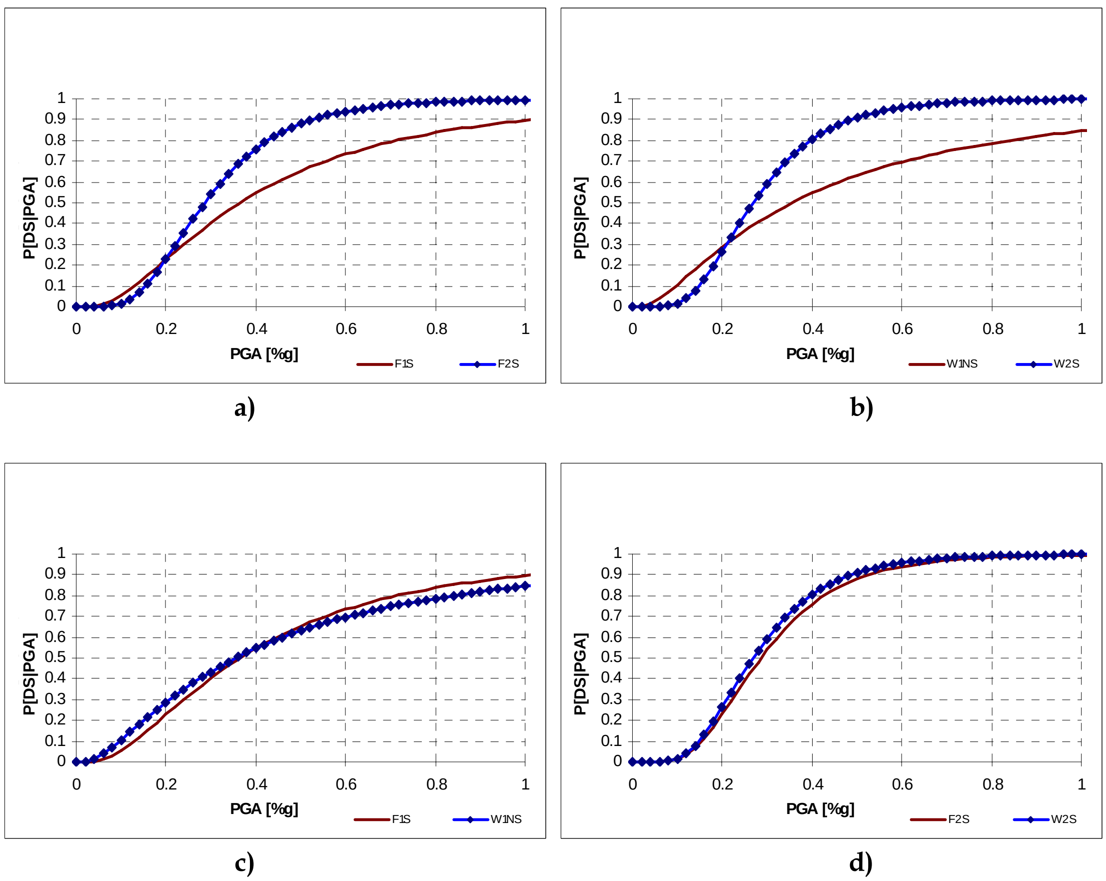
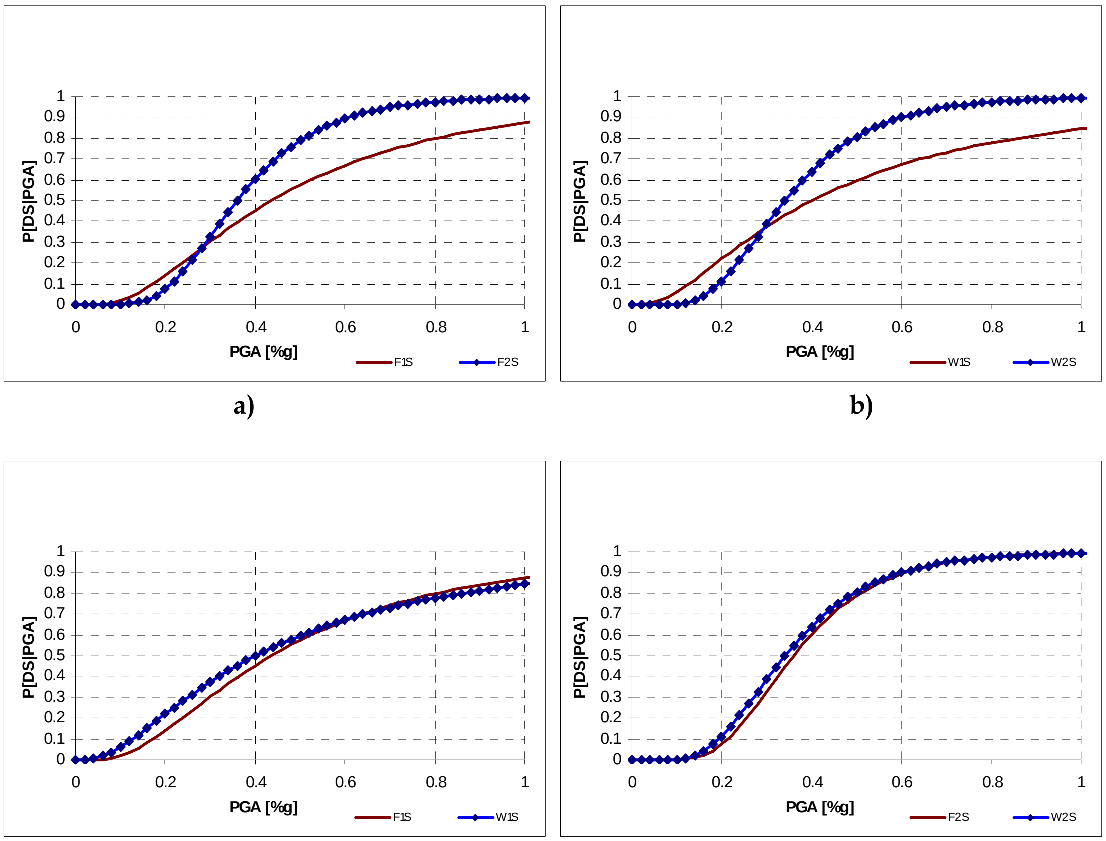
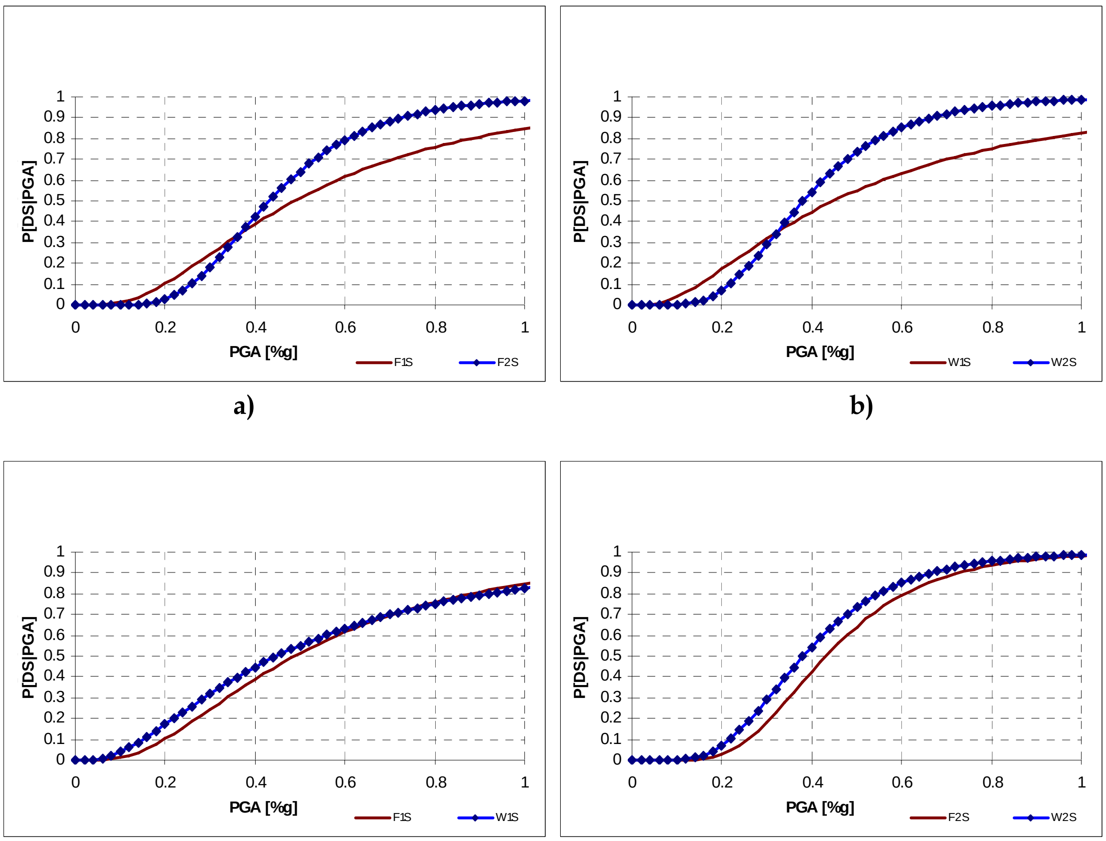


Figure 8-49. Moderate damage fragility curves using Algan limits comparisons. a) One and Two-Story Frames: Strong Direction, b) One and Two-Story Shear Walls: Strong Direction, c) One-Story Model: Strong Direction; and d) Two-Story Models: Strong Direction



a) b) c) d)

Figure 8-50. Substantial damage fragility curves using Algan limits comparisons. a) One and Two-Story Frames: Strong Direction, b) One and Two-Story Shear Walls: Strong Direction, c) One-Story Model: Strong Direction; and d) Two-Story Models: Strong Direction



a) b)

c) d)

Figure 8-51. Major damage fragility curves using Algan limits comparisons. a) One and Two-Story Frames: Strong Direction, b) One and Two-Story Shear Walls: Strong Direction, c) One-Story Model: Strong Direction; and d) Two-Story Models: Strong Direction

9 FRAGILITY CURVES USING HAZUS LIMITS

9.1 INTRODUCTION

The scope of this chapter is to obtain fragility curves using HAZUS damage limit state. The results are compared with those obtained using Algan limit states. PGA units used in this chapter are (%g).

9.2 DEVELOPMENT

The same procedures followed in the previous chapter were used to obtain a new set of fragility curves based on HAZUS drift limits presented in Table 2-4 to quantify the damage. The damage states considered were: "Slight", "Moderate", "Extensive" and "Complete" damage states. Because the brittle behavior of low rise shear wall models and geometric characteristics of reinforced concrete moment frames, low code was deemed adequate to represent these models, and for multistory shear walls frames, moderate code have been chosen.

Fragility curve parameters of the fragility curves developed are summarized in Table 9-1 and Table 9-2. The first table corresponds to Moment Resisting Frame models and the second table to Shear Wall models. The first column of the tables describes the fragility curves type, the second columns defines the damage state and the third and four columns are the log-median and log-standard deviation of each model type for each damage state.

Table 9-1. Fragility curve parameters using HAZUS limits state for Reinforced Concrete Frame models

Model Type	Damage state	μ_{ln}	σ_{ln}
1 Story Frames. Whole Sample	Minor	-1.91	1.05
	Moderate	-1.53	0.86
	Substantial	-0.92	0.69
	Major	-0.23	0.57
1 Story Frames. Weak Direction	Minor	-2.88	0.90
	Moderate	-2.00	0.47
	Substantial	-1.35	0.25
	Major	-0.66	0.29
1 Story Frames. Strong Direction	Minor	-1.53	0.93
	Moderate	-1.23	0.83
	Substantial	-0.63	0.63
	Major	0.00	0.55
2 Story Frames. Whole Sample	Minor	-1.99	0.55
	Moderate	-1.65	0.54
	Substantial	-0.84	0.44
	Major	-0.12	0.40
2 Story Frames. Weak Direction	Minor	-2.42	0.30
	Moderate	-2.03	0.37
	Substantial	-1.26	0.40
	Major	-0.50	0.28
2 Story Frames. Strong Direction	Minor	-1.73	0.41
	Moderate	-1.44	0.48
	Substantial	-0.66	0.34
	Major	0.05	0.30

Table 9-2. Fragility curve parameters using HAZUS limits state for Reinforced Concrete Shear Wall models

Model Type	Damage state	μ_{ln}	σ_{ln}
1 Story Shear Wall. Whole Sample	Minor	-2.02	1.69
	Moderate	-1.85	1.54
	Substantial	-1.16	1.00
	Major	-0.45	0.74
1 Story Shear Wall. Weak Direction	Minor	-3.43	0.60
	Moderate	-3.43	0.73
	Substantial	-2.36	0.67
	Major	-1.54	0.61
1 Story Shear Wall. Strong Direction	Minor	-1.20	1.00
	Moderate	-1.12	1.00
	Substantial	-0.68	0.70
	Major	-0.11	0.39
2 Story Shear Wall. Whole Sample	Minor	-2.90	0.90
	Moderate	-2.50	0.75
	Substantial	-1.46	0.70
	Major	-0.67	0.62
2 Story Shear Wall. Weak Direction	Minor	-3.43	0.60
	Moderate	-3.43	0.73
	Substantial	-2.26	0.63
	Major	-1.44	0.59
2 Story Shear Wall. Strong Direction	Minor	-2.43	0.72
	Moderate	-2.01	0.54
	Substantial	-1.15	0.46
	Major	-0.39	0.41
Multistory Shear Wall Building	Minor	-0.63	1.04
	Moderate	-0.23	0.95
	Substantial	0.37	0.82
	Major	1.54	1.12

9.3 MOMENT RESISTANT FRAME MODELS

In this section the fragility curves results for the one and two story moment resistant frame models described in Chapter 6 are developed and plotted.

9.3.1 ONE-STORY MODELS

One-story reinforced concrete moment resistant frame models fragility curves are studied by considering three different scenarios. First all models are considered to create general fragility curves for this type of models. Then two set of fragility curves are developed by filtering the data and considering only the models with columns oriented in the weak direction of shaking, and another set considering models with columns oriented in the direction of shaking.

9.3.1.1 ONE-STORY REINFORCED CONCRETE FRAMES: ALL MODELS

The 18 one-story reinforced models described in Chapter 6 were subjected to the 5 different earthquake records normalized to different peak ground acceleration values. For each peak ground acceleration considered a sample size of 90 is obtained. Values of damage state occurrence for each earthquake were added and the results summarized in Table 9-3.

Table 9-3 presents the number of buildings that reach or exceed each damage state at each PGA. For example, if the peak ground acceleration considered is 0.3g, a total of 66 buildings shows at least Slight damages and 67% of the sample present damage greater than or equal to Moderate damage state. Even at low peak ground acceleration, considerable damages are obtained. At 0.1g , 9 structures , 10% of the sample, reach the Moderate damage state, and at 0.2 g two third of the sample reaches this damage state.

Table 9-3. Cumulative damage-state occurrence using HAZUS limits state: All Earthquakes for One-Story Reinforced Concrete Frames: All Models

PGA	No Damage	Slight	Moderate	Extensive	Complete
0	90	0	0	0	0
0.1	90	32	9	0	0
0.2	90	58	50	7	0
0.3	90	66	60	31	0
0.4	90	70	67	52	5
0.5	90	77	70	60	15
0.6	90	80	76	63	25
0.7	90	86	83	69	44
0.8	90	86	85	73	51
0.9	90	88	85	77	56
1	90	89	88	81	62
1.1	90	89	88	82	66
1.2	90	89	88	85	67
1.3	90	90	89	86	69
1.4	90	90	90	87	72
1.5	90	90	90	88	73

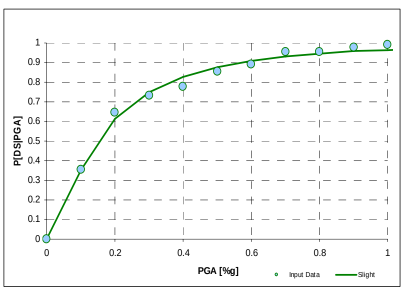
The cumulative distribution function obtained is summarized in Table 9-4. It is obtained by dividing the cumulative damage-state occurrence by the sample size, in this case 90. This table represents the probability of being in or exceeding each damage state at each PGA. For example at 0.3g there is a 67% probability of reaching or exceeding Moderate damage state. Figure 9-1 plots the input data points and the lognormal function fitted for Slight, Moderate, Extensive and Complete damage. The log-median and log-standard deviation obtained is presented in Table 9-1. The set of fragility curves as a function of PGA proposed for this population is plotted in Figure 9-2.

9.3.1.2 ONE-STORY REINFORCED CONCRETE FRAMES: WEAK DIRECTION.

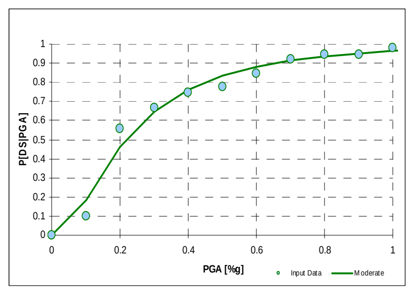
The damage state occurrence of these models are presented in Table 9-5. It can be read from this table that for a PGA of 0.3g the whole sample reaches or exceed Moderate damage state and 21 out of 30 buildings reach Extensive damage state. At very low value of PGA, 0.1g, 8 models present moderate damage, and for 0.2g almost all models reach or exceed Moderate damage state. Complete damage state appears at 0.4g.

Table 9-4. Input data damage-state probability using HAZUS limits state: All Earthquakes for One-Story Reinforced Concrete Frames: All Models

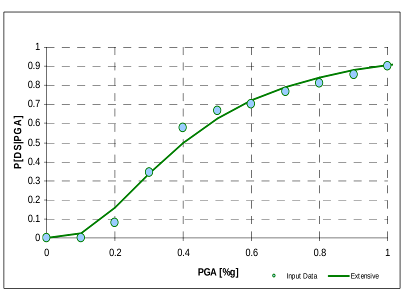
PGA	No Damage	Slight	Moderate	Extensive	Complete
0	1.00	0.00	0.00	0.00	0.00
0.1	1.00	0.36	0.10	0.00	0.00
0.2	1.00	0.64	0.56	0.08	0.00
0.3	1.00	0.73	0.67	0.34	0.00
0.4	1.00	0.78	0.74	0.58	0.06
0.5	1.00	0.86	0.78	0.67	0.17
0.6	1.00	0.89	0.84	0.70	0.28
0.7	1.00	0.96	0.92	0.77	0.49
0.8	1.00	0.96	0.94	0.81	0.57
0.9	1.00	0.98	0.94	0.86	0.62
1	1.00	0.99	0.98	0.90	0.69
1.1	1.00	0.99	0.98	0.91	0.73
1.2	1.00	0.99	0.98	0.94	0.74
1.3	1.00	1.00	0.99	0.96	0.77
1.4	1.00	1.00	1.00	0.97	0.80
1.5	1.00	1.00	1.00	0.98	0.81



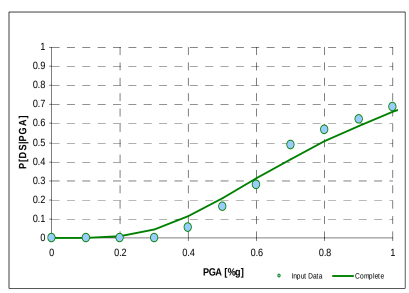
a) Slight Damage



b) Moderate Damage



c) Extensive Damage



d) Complete Damage

Figure 9-1. Damage Fragility curves using HAZUS limits state for One-Story Reinforced Concrete Frames: All Models

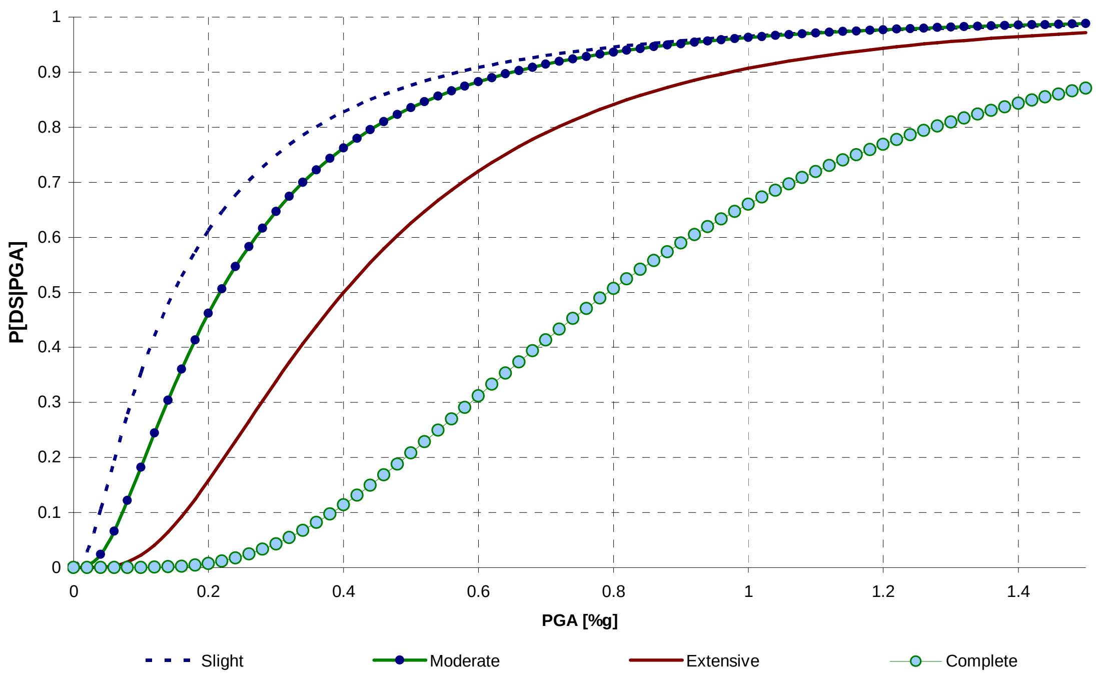


Figure 9-2. Set of Damage Fragility curves using HAZUS limits state for One-Story Reinforced Concrete Frames: All Models

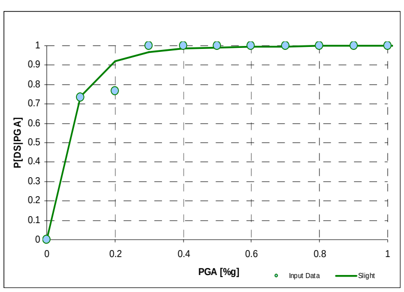
Table 9-5. Cumulative damage-state occurrence using HAZUS limits state: All Earthquakes for One-Story Reinforced Concrete Frames: Weak Direction

PGA	No Damage	Slight	Moderate	Extensive	Complete
0	30	0	0	0	0
0.1	30	22	8	0	0
0.2	30	23	23	5	0
0.3	30	30	30	21	0
0.4	30	30	30	30	5
0.5	30	30	30	30	15
0.6	30	30	30	30	20
0.7	30	30	30	30	25
0.8	30	30	30	30	28
0.9	30	30	30	30	30
1	30	30	30	30	30
1.1	30	30	30	30	30
1.2	30	30	30	30	30
1.3	30	30	30	30	30
1.4	30	30	30	30	30
1.5	30	30	30	30	30

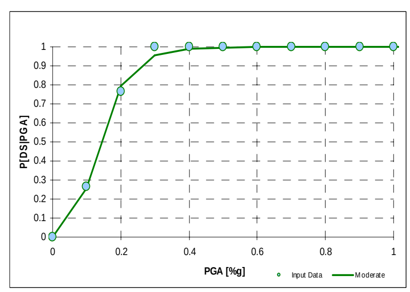
The data point values of the fragility curves are shown in Table 9-6. At 0.3g there is a 100% chance of reaching or exceeding Moderate damage state. Figure 9-3 presents graphically the input data points and fragility curves fitted for each damage state. The parameters of these fragility curves are summarized in Table 9-1. Finally, the set of fragility curves as a function of PGA developed for this case is plotted in Figure 9-4.

Table 9-6. Input data damage-state probability using HAZUS limits state: All Earthquakes for One-Story Reinforced Concrete Frames: Weak Direction

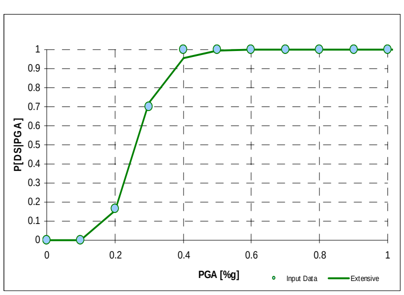
PGA	No Damage	Slight	Moderate	Extensive	Complete
0	1.00	0.00	0.00	0.00	0.00
0.1	1.00	0.73	0.27	0.00	0.00
0.2	1.00	0.77	0.77	0.17	0.00
0.3	1.00	1.00	1.00	0.70	0.00
0.4	1.00	1.00	1.00	1.00	0.17
0.5	1.00	1.00	1.00	1.00	0.50
0.6	1.00	1.00	1.00	1.00	0.67
0.7	1.00	1.00	1.00	1.00	0.83
0.8	1.00	1.00	1.00	1.00	0.93
0.9	1.00	1.00	1.00	1.00	1.00
1	1.00	1.00	1.00	1.00	1.00
1.1	1.00	1.00	1.00	1.00	1.00
1.2	1.00	1.00	1.00	1.00	1.00
1.3	1.00	1.00	1.00	1.00	1.00
1.4	1.00	1.00	1.00	1.00	1.00
1.5	1.00	1.00	1.00	1.00	1.00



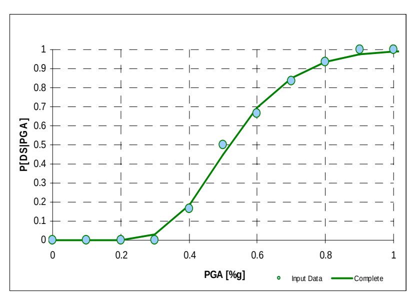
a) Slight Damage



b) Moderate Damage



c) Extensive Damage



d) Complete Damage

Figure 9-3. Damage Fragility curves using HAZUS limits state for One-Story Reinforced Concrete Frames: Weak Direction

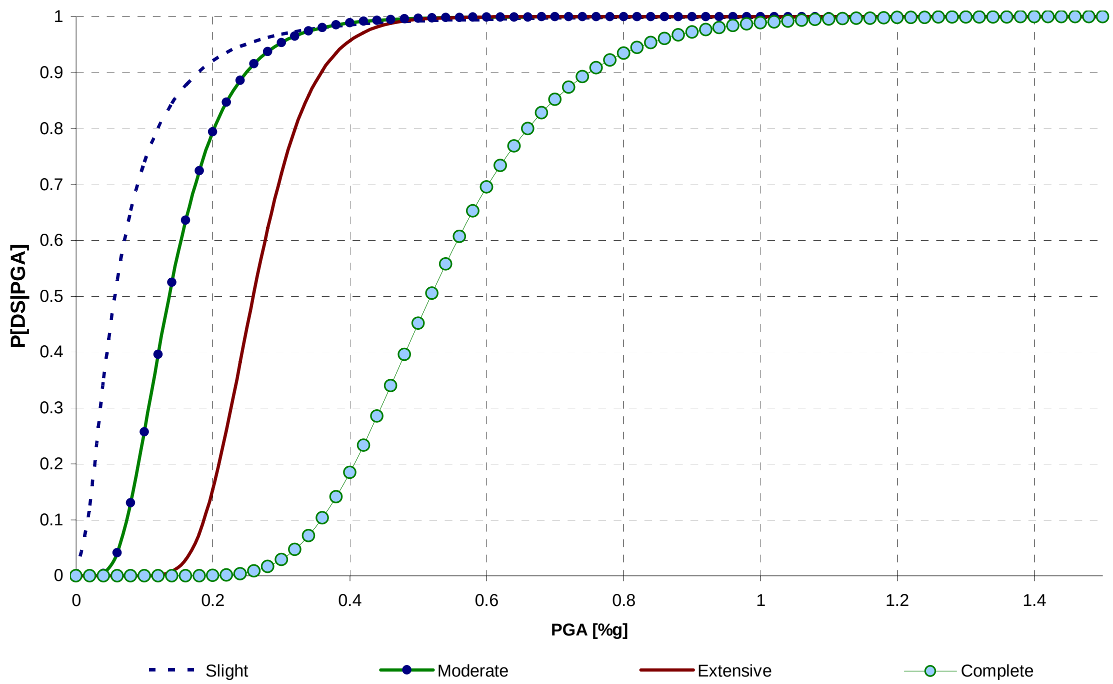


Figure 9-4. Set of Damage Fragility curves using HAZUS limits state for One-Story Reinforced Concrete Frames: Weak Direction

9.3.1.3 ONE-STORY REINFORCED CONCRETE FRAMES. STRONG DIRECTION

The damage state occurrence of these models is presented in Table 9-7. It can be observed from this table that for a PGA of 0.3g 30 structures, half of the sample, reach or exceed the Moderate damage state and 10 from 60 buildings, 17% of the sample, reach or exceed the Extensive damage state. Complete damage state first appears for a PGA of 0.6g.

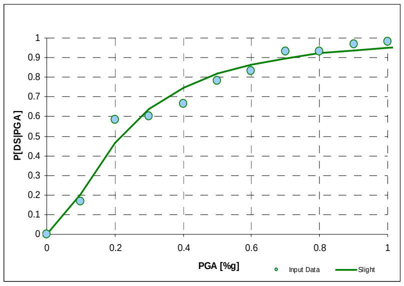
The probability of being in or exceeding each damage state at each PGA is summarized in Table 9-8. At 0.3g there is 60% chance of reaching or exceeding Slight damages, 50% of reaching or exceeding Moderate damage and 17% of probability of suffering damage larger than or equal to the Extensive damage. Complete damage first appears at 0.6g. The fragility curve parameters are summarized in Table 9-1. Figure 9-5 displays the input data points and the fragility curves fitted for each damage state. Finally, the set of fragility curves as a function of PGA developed for this case is plotted in Figure 9-6.

Table 9-7. Cumulative damage-state occurrence using HAZUS limits state: All Earthquakes for One-Story Reinforced Concrete Frames: Strong Direction

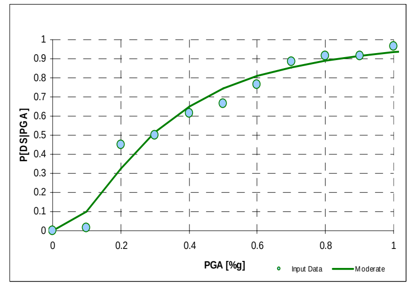
PGA	No Damage	Slight	Moderate	Extensive	Complete
0	60	0	0	0	0
0.1	60	10	1	0	0
0.2	60	35	27	2	0
0.3	60	36	30	10	0
0.4	60	40	37	22	0
0.5	60	47	40	30	0
0.6	60	50	46	33	6
0.7	60	56	53	39	20
0.8	60	56	55	43	24
0.9	60	58	55	47	27
1	60	59	58	51	32
1.1	60	59	58	52	36
1.2	60	59	58	55	37
1.3	60	60	59	56	39
1.4	60	60	60	57	42
1.5	60	60	60	58	43

Table 9-8. Input data damage-state probability using HAZUS limits state: All Earthquakes for One-Story Reinforced Concrete Frames: Strong Direction

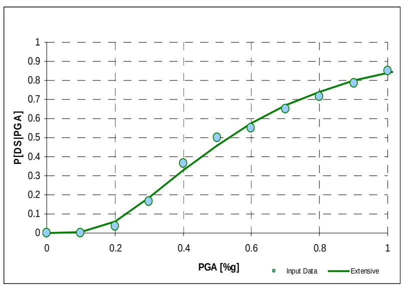
PGA	No Damage	Slight	Moderate	Extensive	Complete
0	1.00	0.00	0.00	0.00	0.00
0.1	1.00	0.17	0.02	0.00	0.00
0.2	1.00	0.58	0.45	0.03	0.00
0.3	1.00	0.60	0.50	0.17	0.00
0.4	1.00	0.67	0.62	0.37	0.00
0.5	1.00	0.78	0.67	0.50	0.00
0.6	1.00	0.83	0.77	0.55	0.10
0.7	1.00	0.93	0.88	0.65	0.33
0.8	1.00	0.93	0.92	0.72	0.40
0.9	1.00	0.97	0.92	0.78	0.45
1	1.00	0.98	0.97	0.85	0.53
1.1	1.00	0.98	0.97	0.87	0.60
1.2	1.00	0.98	0.97	0.92	0.62
1.3	1.00	1.00	0.98	0.93	0.65
1.4	1.00	1.00	1.00	0.95	0.70
1.5	1.00	1.00	1.00	0.97	0.72



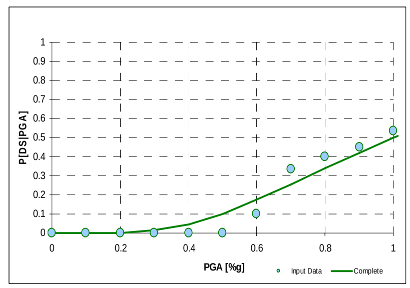
a) Slight Damage



b) Moderate Damage



c) Extensive Damage



d) Complete Damage

Figure 9-5. Damage Fragility curves using HAZUS limits state for One-Story Reinforced Concrete Frames: Strong Direction

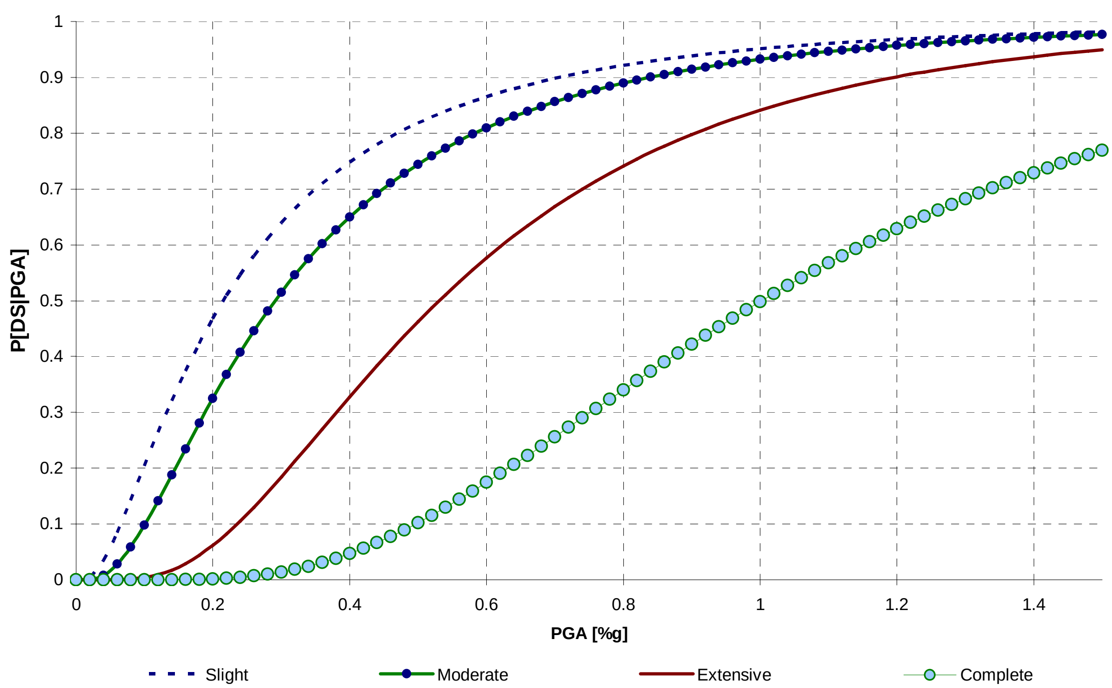


Figure 9-6. Set of Damage Fragility curves using HAZUS limits state for One-Story Reinforced Concrete Frames: Strong Direction

9.3.2 TWO-STORY MODELS

The fragility curves for the Two-Story Reinforced Concrete Frame models, for the same scenarios considered for the One-Story Reinforced concrete moment resistant Frame models, are presented below.

9.3.2.1 TWO-STORY REINFORCED CONCRETE FRAMES: ALL MODELS

The population of Two-Story Frames for each peak ground acceleration value is 90 data points. The damage state occurrence results are presented in Table 9-9. This table shows the number of buildings that reach or exceed each damage state for each PGA. For a peak ground acceleration of 0.3g, a total of 85 building shows at least Slight damages and 70 present damage greater than the Moderate damage state. Damage are observed at a low peak ground acceleration: at 0.1g, 9 structures reach the Moderate damage state.

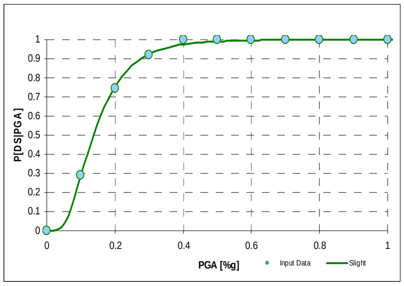
Table 9-9. Cumulative damage-state occurrence using HAZUS limits state: All Earthquakes for Two-Story Reinforced Concrete Frames: All Models

PGA	No Damage	Slight	Moderate	Extensive	Complete
0	90	0	0	0	0
0.1	90	30	9	0	0
0.2	90	70	51	12	0
0.3	90	85	70	23	0
0.4	90	90	82	39	5
0.5	90	90	88	60	7
0.6	90	90	90	70	20
0.7	90	89	89	78	24
0.8	90	90	90	84	37
0.9	90	90	90	87	45
1	90	90	90	87	50
1.1	90	90	90	90	64
1.2	90	90	90	90	72
1.3	90	90	90	90	76
1.4	90	90	90	90	80
1.5	90	90	90	90	81

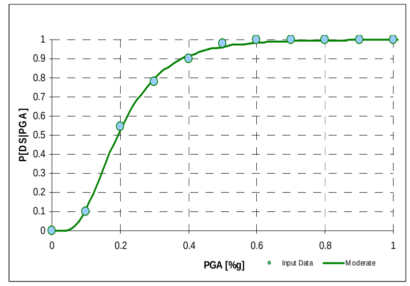
The input damage-state probability is summarized in Table 9-10. This table shows the probability of being in or exceeding each damage state for each PGA. For example at 0.3g there is a 78% probability of reaching or exceeding the Moderate damage state. These data points are plotted in Figure 9-7 with the respective fragility curve fitted for each damage scale. The log-median and log-standard deviation obtained is presented in Table 9-1. The set of fragility curves as a function of PGA proposed for this population is plotted in Figure 9-8.

Table 9-10. Input data damage-state probability using HAZUS limits state: All Earthquakes for Two-Story Reinforced Concrete Frames: All Models

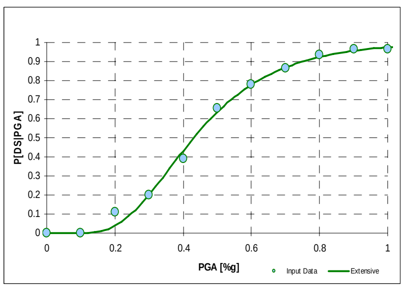
PGA	No Damage	Slight	Moderate	Extensive	Complete
0	1.00	0.00	0.00	0.00	0.00
0.1	1.00	0.33	0.10	0.00	0.00
0.2	1.00	0.78	0.57	0.13	0.00
0.3	1.00	0.94	0.78	0.26	0.00
0.4	1.00	1.00	0.91	0.43	0.06
0.5	1.00	1.00	0.98	0.67	0.08
0.6	1.00	1.00	1.00	0.78	0.22
0.7	1.00	0.99	0.99	0.87	0.27
0.8	1.00	1.00	1.00	0.93	0.41
0.9	1.00	1.00	1.00	0.97	0.50
1	1.00	1.00	1.00	0.97	0.56
1.1	1.00	1.00	1.00	1.00	0.71
1.2	1.00	1.00	1.00	1.00	0.80
1.3	1.00	1.00	1.00	1.00	0.84
1.4	1.00	1.00	1.00	1.00	0.89
1.5	1.00	1.00	1.00	1.00	0.90



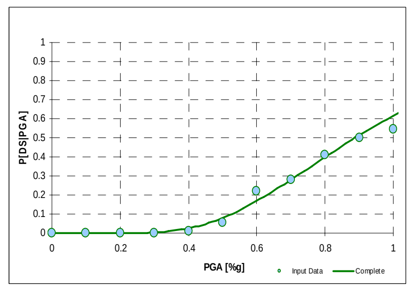
a) Slight Damage



b) Moderate Damage



c) Extensive Damage



d) Complete Damage

Figure 9-7. Damage Fragility curves using HAZUS limits state for Two-Story Reinforced Concrete Frames: All Models

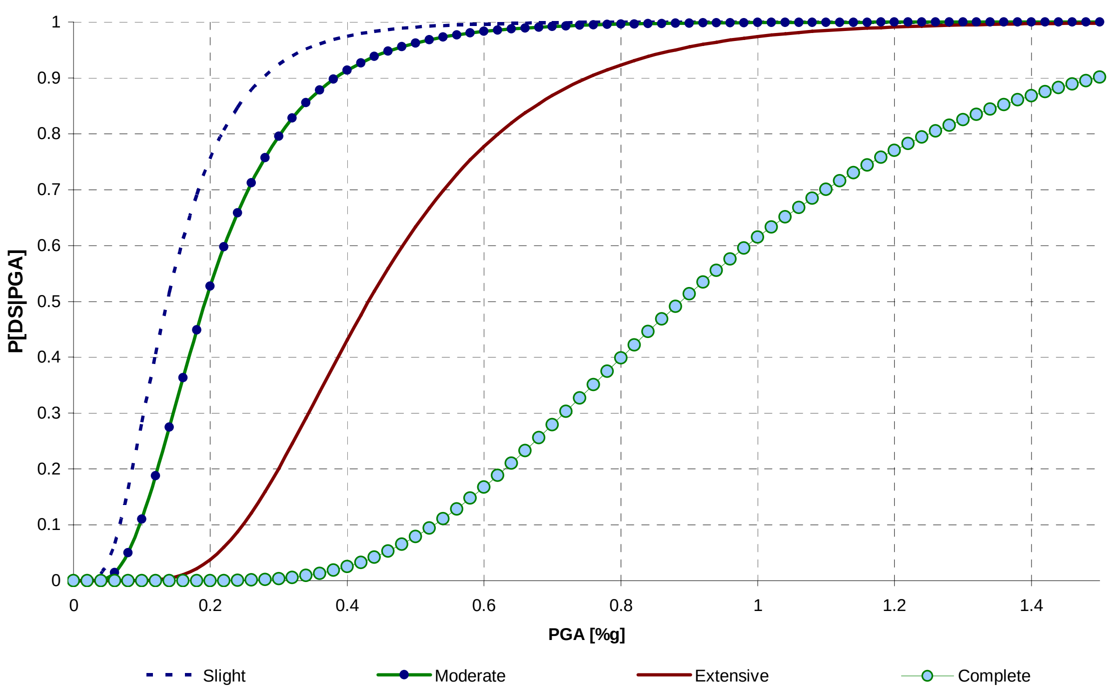


Figure 9-8. Set of Damage Fragility curves using HAZUS limits state for Two-Story Reinforced Concrete Frames: All Models

9.3.2.2 TWO-STORY REINFORCED CONCRETE FRAMES: WEAK DIRECTION

The sample size of these models is 30 for each PGA. Damage state occurrences are presented in Table 9-11 For a PGA value of 0.3g the whole sample reach or exceed the Moderate damage state and 16 out of 30 buildings, half of the sample, present extensive damages. Similar to one-story frames oriented in the weak direction, almost all models reached or exceeded the Moderate damage state at low values of PGA: at 0.2g, 26 models out of 30 reach or exceed the Moderate damage state.

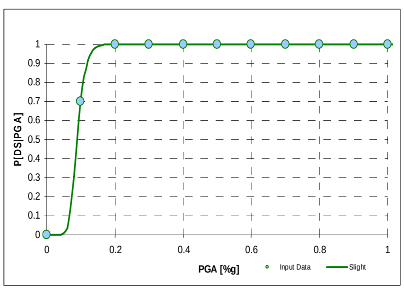
Table 9-11. Cumulative damage-state occurrence using HAZUS limits state: All Earthquakes for Two-Story Reinforced Concrete Frames: Weak Direction

PGA	No Damage	Slight	Moderate	Extensive	Complete
0	30	0	0	0	0
0.1	30	21	5	0	0
0.2	30	30	26	8	0
0.3	30	30	30	16	0
0.4	30	30	30	24	3
0.5	30	29	29	29	5
0.6	30	30	30	30	17
0.7	30	29	29	29	18
0.8	30	30	30	30	23
0.9	30	30	30	30	25
1	30	30	30	30	26
1.1	30	30	30	30	28
1.2	30	30	30	30	30
1.3	30	30	30	30	30
1.4	30	30	30	30	30
1.5	30	30	30	30	30

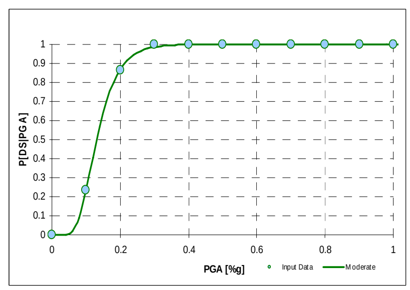
The data point values of the fragility curves are shown in Table 9-12. For this sample, at 0.3g there is a 100% chance of reaching or exceeding Moderate damage state. Figure 9-9 presents graphically the input data points and the fragility curves fitted for each damage state. The parameters of these fragility curves are summarized in Table 9-1. Finally, the set of fragility curves as a function of PGA developed for this case is plotted in Figure 9-10.

Table 9-12. Input data damage-state probability using HAZUS limits state: All Earthquakes for Two-Story Reinforced Concrete Frames: Weak Direction

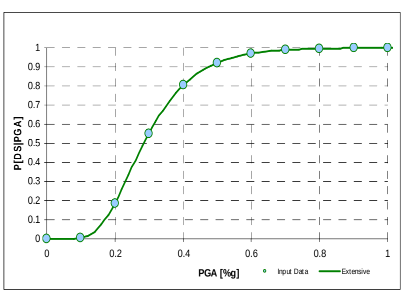
PGA	No Damage	Slight	Moderate	Extensive	Complete
0	1.00	0.00	0.00	0.00	0.00
0.1	1.00	0.70	0.17	0.00	0.00
0.2	1.00	1.00	0.87	0.27	0.00
0.3	1.00	1.00	1.00	0.53	0.00
0.4	1.00	1.00	1.00	0.80	0.10
0.5	1.00	0.97	0.97	0.97	0.17
0.6	1.00	1.00	1.00	1.00	0.57
0.7	1.00	0.97	0.97	0.97	0.60
0.8	1.00	1.00	1.00	1.00	0.77
0.9	1.00	1.00	1.00	1.00	0.83
1	1.00	1.00	1.00	1.00	0.87
1.1	1.00	1.00	1.00	1.00	0.93
1.2	1.00	1.00	1.00	1.00	1.00
1.3	1.00	1.00	1.00	1.00	1.00
1.4	1.00	1.00	1.00	1.00	1.00
1.5	1.00	1.00	1.00	1.00	1.00



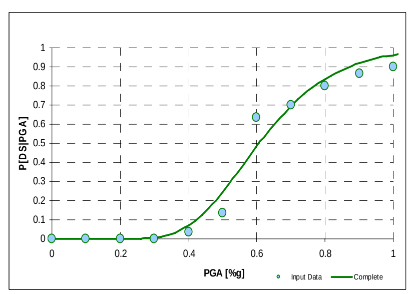
a) Slight Damage



b) Moderate Damage



c) Extensive Damage



d) Complete Damage

Figure 9-9. Damage Fragility curves using HAZUS limits state for Two-Story Reinforced Concrete Frames: Weak Direction

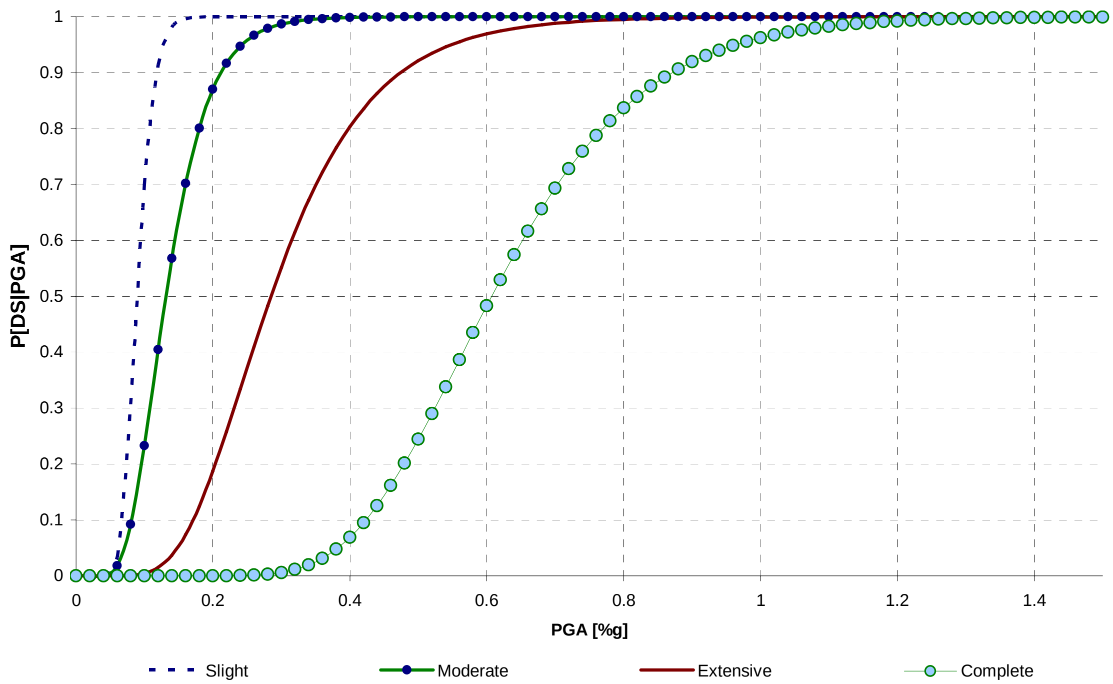


Figure 9-10. Set of Damage Fragility curves using HAZUS limits state for Two-Story Reinforced Concrete Frames: Weak Direction

9.3.2.3 TWO-STORY REINFORCED CONCRETE FRAMES: STRONG DIRECTION

Twelve reinforced concrete two-story frame models fit in this category. A total of 60 data points are obtained for each PGA. Similar to previous model types, the number of buildings that reached or exceeded each damage state are presented in Table 9-13. For 0.3g, 40 models, reached the Moderate damage state and 3 models presented Extensive damages.

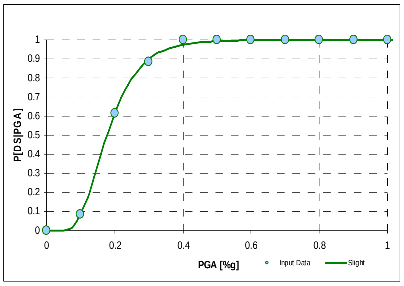
The data point values of the fragility curves are shown in Table 9-14. It is obtained by dividing the cumulative damage-state occurrence by the sample size, in this case 60. At 0.3g there is a 67% chance of reaching or exceeding Moderate damage state. Extensive damages first appears at 0.2g with a probability of occurrence of 3%. Figure 9-11 presents graphically the input data points and the fragility curves fitted for each damage state. The parameters of these fragility curves are summarized in Table 9-1. Finally, the set of fragility curves as a function of PGA developed for this case is plotted in Figure 9-12.

Table 9-13. Cumulative damage-state occurrence using HAZUS limits state: All Earthquakes for Two-Story Reinforced Concrete Frames: Strong Direction

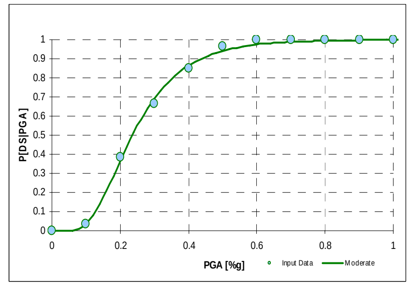
PGA	No Damage	Slight	Moderate	Extensive	Complete
0	60	0	0	0	0
0.1	60	7	0	0	0
0.2	60	40	24	2	0
0.3	60	55	40	3	0
0.4	60	60	52	13	0
0.5	60	60	58	30	0
0.6	60	60	60	40	1
0.7	60	60	60	49	4
0.8	60	60	60	54	13
0.9	60	60	60	57	19
1	60	60	60	57	23
1.1	60	60	60	60	35
1.2	60	60	60	60	42
1.3	60	60	60	60	46
1.4	60	60	60	60	50
1.5	60	60	60	60	51

Table 9-14. Input data damage-state probability using HAZUS limits state: All Earthquakes for Two-Story Reinforced Concrete Frames: Strong Direction

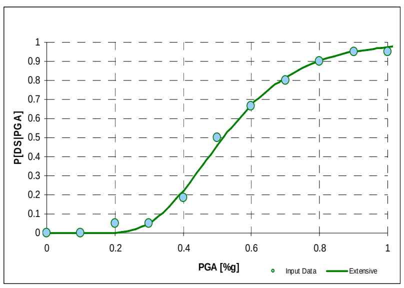
PGA	No Damage	Slight	Moderate	Extensive	Complete
0	1.00	0.00	0.00	0.00	0.00
0.1	1.00	0.12	0.00	0.00	0.00
0.2	1.00	0.67	0.40	0.03	0.00
0.3	1.00	0.92	0.67	0.05	0.00
0.4	1.00	1.00	0.87	0.22	0.00
0.5	1.00	1.00	0.97	0.50	0.00
0.6	1.00	1.00	1.00	0.67	0.02
0.7	1.00	1.00	1.00	0.82	0.07
0.8	1.00	1.00	1.00	0.90	0.22
0.9	1.00	1.00	1.00	0.95	0.32
1	1.00	1.00	1.00	0.95	0.38
1.1	1.00	1.00	1.00	1.00	0.58
1.2	1.00	1.00	1.00	1.00	0.70
1.3	1.00	1.00	1.00	1.00	0.77
1.4	1.00	1.00	1.00	1.00	0.83
1.5	1.00	1.00	1.00	1.00	0.85



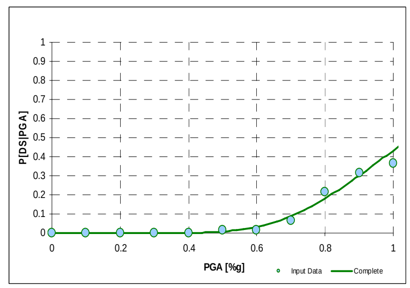
a) Slight Damage



b) Moderate Damage



c) Extensive Damage



d) Complete Damage

Figure 9-11. Damage Fragility curves using HAZUS limits state for Two-Story Reinforced Concrete Frames: Strong Direction

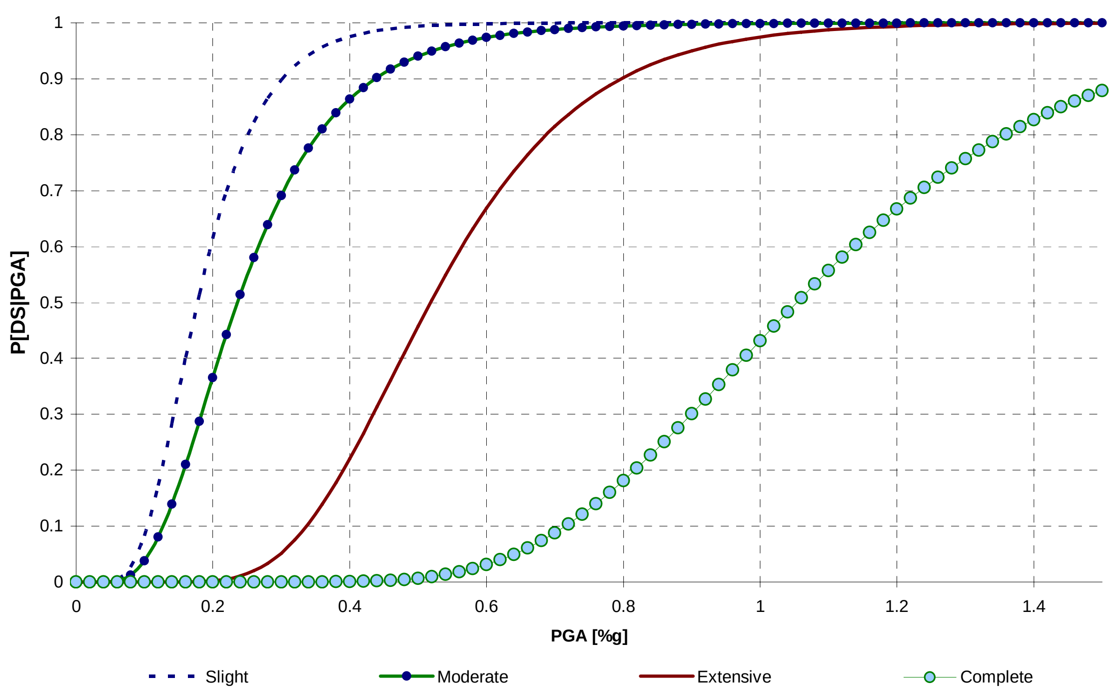


Figure 9-12. Set of Damage Fragility curves using HAZUS limits state for Two-Story Reinforced Concrete Frames: Strong Direction

9.4 CONCRETE SHEAR WALL MODELS

9.4.1 ONE-STORY MODELS

One-story reinforced concrete shear wall models fragility curves are studied by considering three different scenarios. First all models are considered to create general fragility curves for this type of models, then two set of fragility curves are developed by filtering the data and considering only the models with walls oriented in the weak direction of shaking, and last considering models with walls oriented in the direction of shaking.

9.4.1.1 ONE-STORY REINFORCED CONCRETE SHEAR WALLS: ALL MODELS

The 18 one-story shear wall prototypes described in Chapter 6 subjected to the earthquake records normalized to different peak ground acceleration values described in Chapter 5 result in a sample size of 90 data points. For each peak ground acceleration values of damage state occurrence for each earthquake are added and the results summarized in Table 9-15.

Table 9-15 presents the number of buildings that reached or exceeded each damage state at each PGA. For example, if the peak ground acceleration considered is 0.3g, a total of 59 models presented damage greater than the Moderate damage state. Even at low peak ground acceleration, considerable damages are obtained: at 0.1g, 36 structures reached the Moderate damage state, and at 0.2 g, 52 models reached or exceeded the Moderate damage state and 14 models reached the Complete damage state.

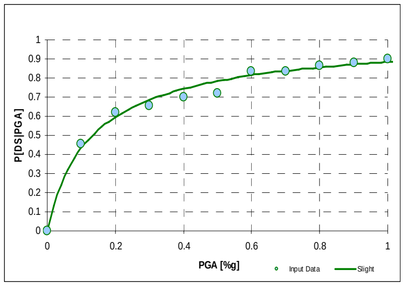
Table 9-15. Cumulative damage-state occurrence using HAZUS limits state: All Earthquakes for One-Story Reinforced Concrete Shear Walls: All Models

PGA	No Damage	Slight	Moderate	Extensive	Complete
0	90	0	0	0	0
0.1	90	41	36	16	2
0.2	90	56	52	27	14
0.3	90	59	59	44	22
0.4	90	63	63	51	25
0.5	90	65	65	60	29
0.6	90	75	74	68	36
0.7	90	75	75	71	45
0.8	90	78	78	75	50
0.9	90	79	79	77	62
1	90	81	81	81	66
1.1	90	82	82	82	73
1.2	90	83	83	83	76
1.3	90	83	83	83	78
1.4	90	83	83	83	79
1.5	90	85	85	85	83

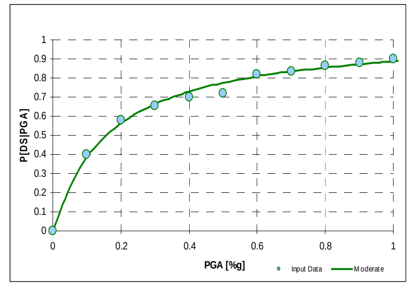
Table 9-16. Input data damage-state probability using HAZUS limits state: All Earthquakes for One-Story Reinforced Concrete Shear Walls: All Models

PGA	No Damage	Slight	Moderate	Extensive	Complete
0	1.00	0.00	0.00	0.00	0.00
0.1	1.00	0.46	0.40	0.18	0.02
0.2	1.00	0.62	0.58	0.30	0.16
0.3	1.00	0.66	0.66	0.49	0.24
0.4	1.00	0.70	0.70	0.57	0.28
0.5	1.00	0.72	0.72	0.67	0.32
0.6	1.00	0.83	0.82	0.76	0.40
0.7	1.00	0.83	0.83	0.79	0.50
0.8	1.00	0.87	0.87	0.83	0.56
0.9	1.00	0.88	0.88	0.86	0.69
1	1.00	0.90	0.90	0.90	0.73
1.1	1.00	0.91	0.91	0.91	0.81
1.2	1.00	0.92	0.92	0.92	0.84
1.3	1.00	0.92	0.92	0.92	0.87
1.4	1.00	0.92	0.92	0.92	0.88
1.5	1.00	0.94	0.94	0.94	0.92

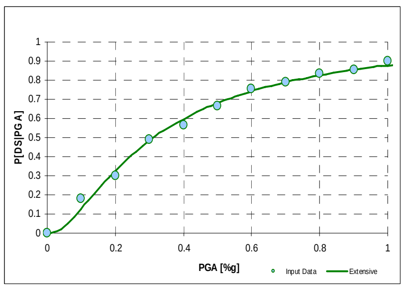
The input cumulative distribution function obtained is shown in Table 9-16. These values represent the probability of being in or exceeding each damage state at each PGA. For example at 0.3g there is a 59% probability of reaching or exceeding the Moderate damage state. These data point of the fragility curves are plotted in Figure 9-13 together with the fragility curves fitted for each damage state. The fragility curve parameters are summarized in Table 9-2. The set of fragility curves as a function of PGA proposed for this population is plotted in Figure 9-14.



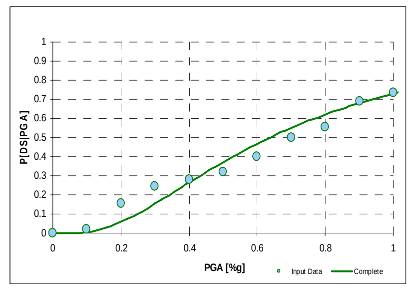
a) Slight Damage



b) Moderate Damage



c) Extensive Damage



d) Complete Damage

Figure 9-13. Damage Fragility curves using HAZUS limits state for One-Story Reinforced Concrete Shear Walls: All Models

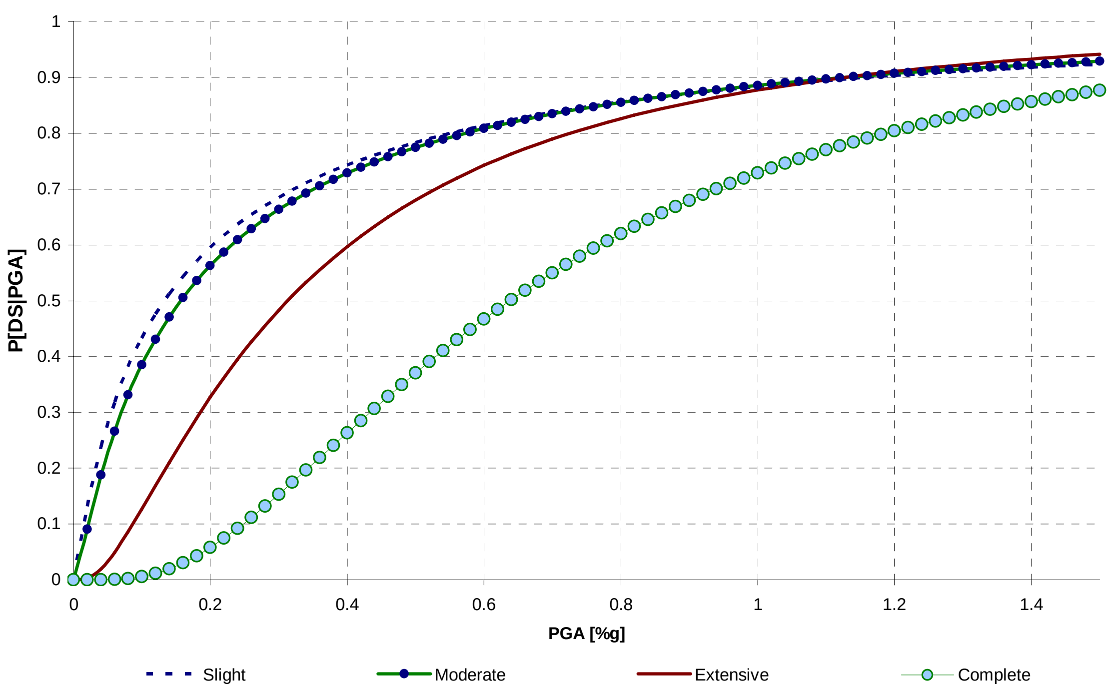


Figure 9-14. Set of Damage Fragility curves using HAZUS limits state for One-Story Reinforced Concrete Shear Walls: All Models

9.4.1.2 ONE-STORY REINFORCED CONCRETE SHEAR WALLS: WEAK DIRECTION

In this section, the weak direction of models with walls oriented in one direction is studied. Table 9-17 presents the cumulative damage state occurrence for each peak ground acceleration value. For a PGA value of 0.3g the whole sample reached or exceeded the Moderate damage state, 29 models reached or exceeded Extensive damages, and 22 out of 30 buildings reach the Complete damage state. Similar to frames with columns oriented in the weak direction, all models reached or exceeded the Moderate damage state at low values of PGA.

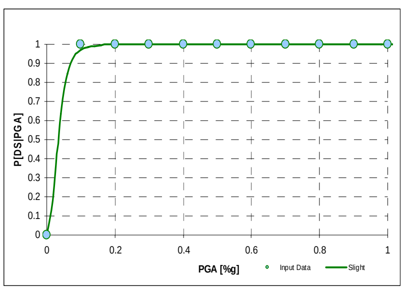
Table 9-17. Cumulative damage-state occurrence using HAZUS limits state: All Earthquakes for One-Story Reinforced Concrete Shear Walls: Weak Direction

PGA	No Damage	Slight	Moderate	Extensive	Complete
0	30	0	0	0	0
0.1	30	30	28	16	2
0.2	30	30	30	26	14
0.3	30	30	30	29	22
0.4	30	30	30	29	25
0.5	30	30	30	30	28
0.6	30	30	30	30	28
0.7	30	30	30	30	28
0.8	30	30	30	30	29
0.9	30	30	30	30	29
1	30	30	30	30	29
1.1	30	30	30	30	29
1.2	30	30	30	30	30
1.3	30	30	30	30	30
1.4	30	30	30	30	30
1.5	30	30	30	30	30

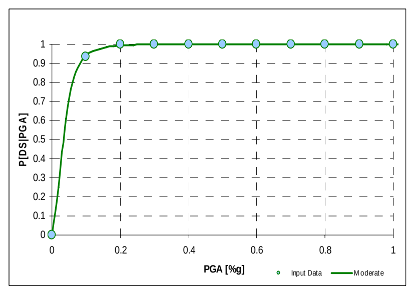
The data point values of the fragility curves are shown in Table 9-18. At 0.3g there is a 100% chance of reaching or exceeding the Moderate damage state and 73% probability of reaching the Complete damage. Figure 8-15 presents graphically the input data points and fragility curves fitted for each damage state. The parameters of these fragility curves are summarized in Table 9-2. Finally, the set of fragility curves as a function of PGA developed for this case is plotted in Figure 9-16.

Table 9-18. Input data damage-state probability using HAZUS limits state: All Earthquakes for One-Story Reinforced Concrete Shear Walls: Weak Direction

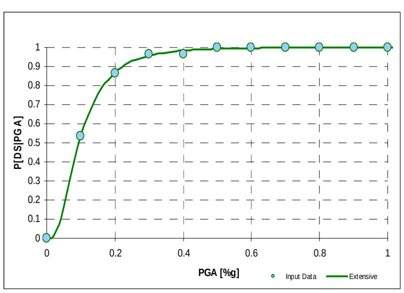
PGA	No Damage	Slight	Moderate	Extensive	Complete
0	1.00	0.00	0.00	0.00	0.00
0.1	1.00	1.00	0.93	0.53	0.07
0.2	1.00	1.00	1.00	0.87	0.47
0.3	1.00	1.00	1.00	0.97	0.73
0.4	1.00	1.00	1.00	0.97	0.83
0.5	1.00	1.00	1.00	1.00	0.93
0.6	1.00	1.00	1.00	1.00	0.93
0.7	1.00	1.00	1.00	1.00	0.93
0.8	1.00	1.00	1.00	1.00	0.97
0.9	1.00	1.00	1.00	1.00	0.97
1	1.00	1.00	1.00	1.00	0.97
1.1	1.00	1.00	1.00	1.00	0.97
1.2	1.00	1.00	1.00	1.00	1.00
1.3	1.00	1.00	1.00	1.00	1.00
1.4	1.00	1.00	1.00	1.00	1.00
1.5	1.00	1.00	1.00	1.00	1.00



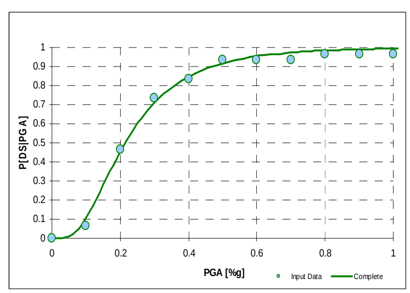
a) Slight Damage



b) Moderate Damage



c) Extensive Damage



d) Complete Damage

Figure 9-15. Damage Fragility curves using HAZUS limits state for One-Story Reinforced Concrete Shear Walls: Weak Direction

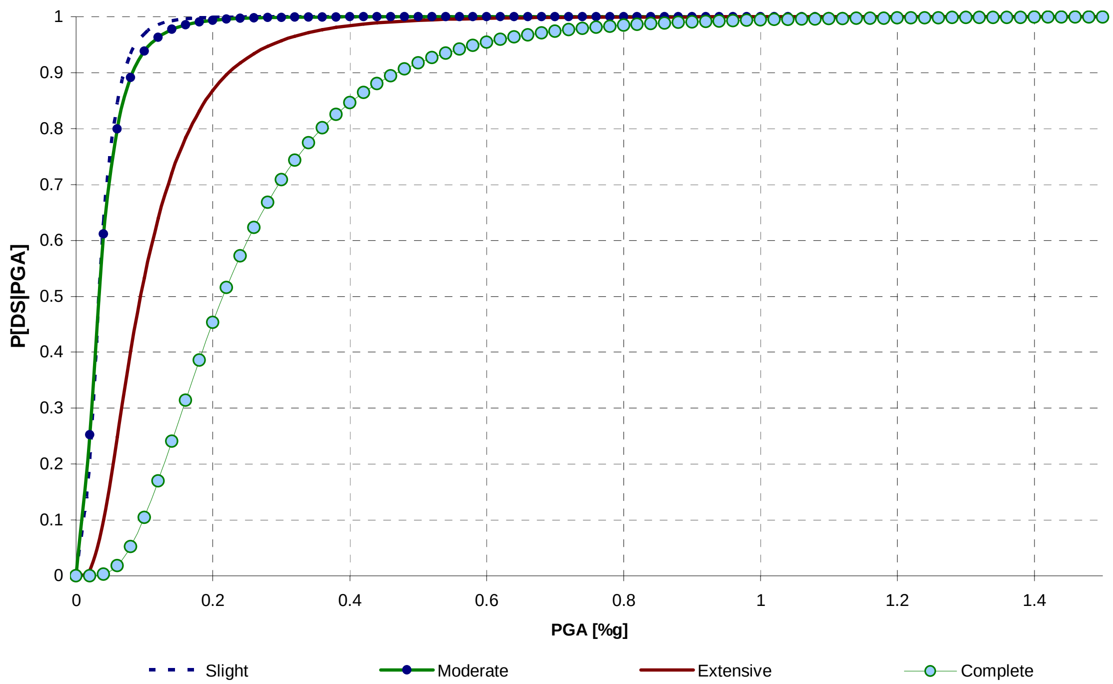


Figure 9-16. Set of Damage Fragility curves using HAZUS limits state for One-Story Reinforced Concrete Shear Walls: Weak Direction

9.4.1.3 ONE-STORY REINFORCED CONCRETE SHEAR WALLS: STRONG DIRECTION

From the 18 one-story reinforced concrete shear wall models, 12 have walls oriented in the strong direction. A total of 60 data points are obtained for each PGA. Similar to previous model types, the number of buildings that reached or exceeded each damage state are presented in Table 9-19. For 0.3g, 29 models, approximately half of the population, reached the Moderate damage state and 15 models present Extensive damages.

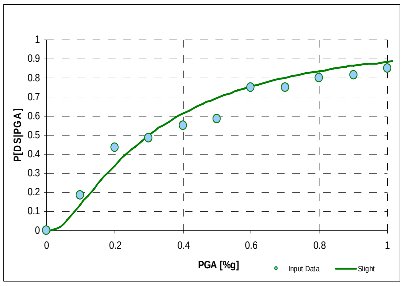
The input damage state probability, data point values of the fragility curves are summarized in Table 9-20. For this sample, at 0.3g, there is a 48% chance of reaching or exceeding the Moderate damage state and 25% of reaching Extensive damages. Figure 9-17 presents graphically the input data points and the fragility curves fitted for each damage state. The parameters of these fragility curves are summarized in Table 9-2. The set of fragility curves as a function of PGA developed for this case is plotted in Figure 9-18.

Table 9-19. Cumulative damage-state occurrence using HAZUS limits state: All Earthquakes for One-Story Reinforced Concrete Shear Walls: Strong Direction

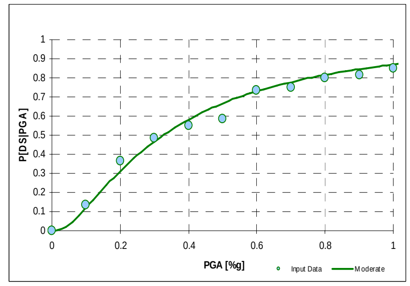
PGA	No Damage	Slight	Moderate	Extensive	Complete
0	60	0	0	0	0
0.1	60	11	8	0	0
0.2	60	26	22	1	0
0.3	60	29	29	15	0
0.4	60	33	33	22	0
0.5	60	35	35	30	1
0.6	60	45	44	38	8
0.7	60	45	45	41	17
0.8	60	48	48	45	21
0.9	60	49	49	47	33
1	60	51	51	51	37
1.1	60	52	52	52	44
1.2	60	53	53	53	46
1.3	60	53	53	53	48
1.4	60	53	53	53	49
1.5	60	55	55	55	53

Table 9-20. Input data damage-state probability using HAZUS limits state: All Earthquakes for One-Story Reinforced Concrete Shear Walls: Strong Direction

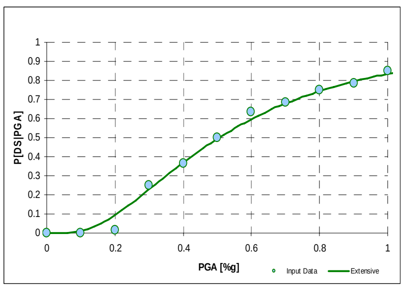
PGA	No Damage	Slight	Moderate	Extensive	Complete
0	1.00	0.00	0.00	0.00	0.00
0.1	1.00	0.18	0.13	0.00	0.00
0.2	1.00	0.43	0.37	0.02	0.00
0.3	1.00	0.48	0.48	0.25	0.00
0.4	1.00	0.55	0.55	0.37	0.00
0.5	1.00	0.58	0.58	0.50	0.02
0.6	1.00	0.75	0.73	0.63	0.13
0.7	1.00	0.75	0.75	0.68	0.28
0.8	1.00	0.80	0.80	0.75	0.35
0.9	1.00	0.82	0.82	0.78	0.55
1	1.00	0.85	0.85	0.85	0.62
1.1	1.00	0.87	0.87	0.87	0.73
1.2	1.00	0.88	0.88	0.88	0.77
1.3	1.00	0.88	0.88	0.88	0.80
1.4	1.00	0.88	0.88	0.88	0.82
1.5	1.00	0.92	0.92	0.92	0.88



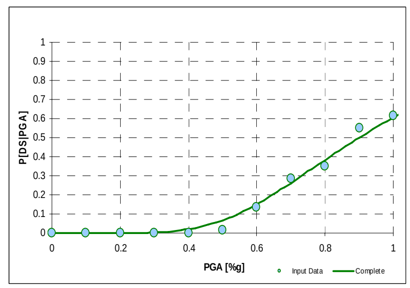
a) Slight Damage



b) Moderate Damage



c) Extensive Damage



d) Complete Damage

Figure 9-17. Damage Fragility curves using HAZUS limits state for One-Story Reinforced Concrete Shear Walls: Strong Direction

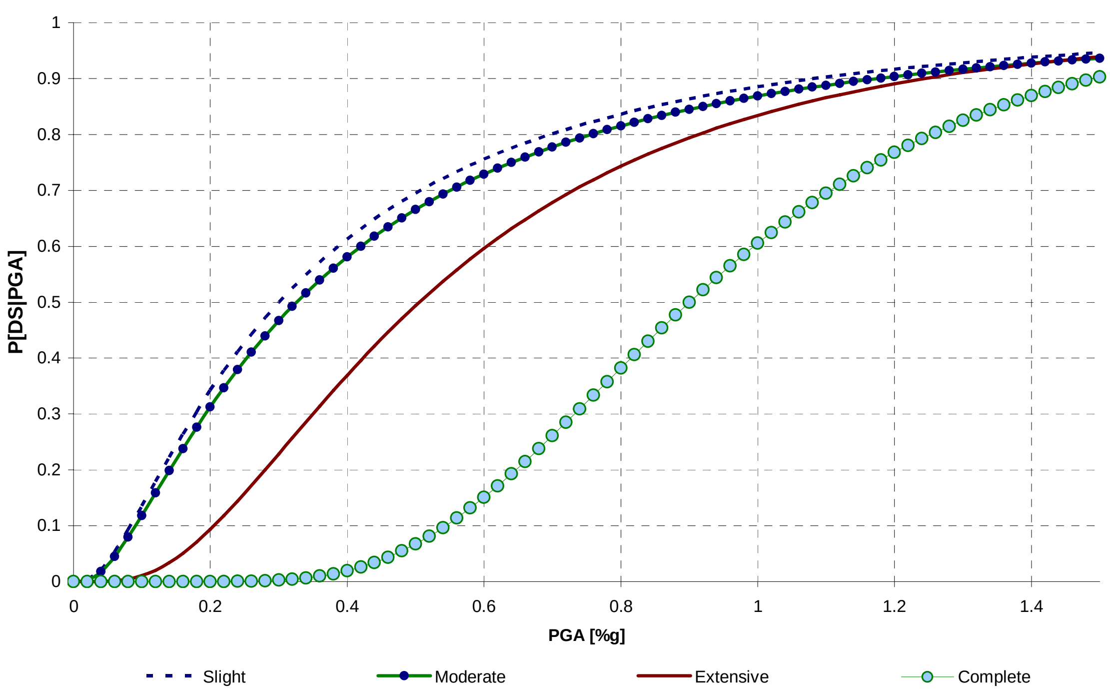


Figure 9-18. Set of Damage Fragility curves using HAZUS limits state for One-Story Reinforced Concrete Shear Walls: Strong Direction

9.4.2 TWO-STORY MODELS

9.4.2.1 TWO-STORY REINFORCED CONCRETE SHEAR WALLS: ALL MODELS

The 18 two-story shear wall prototypes described in Chapter 6, subjected to earthquake records normalized to different peak ground acceleration values described in Chapter 5, result in a sample size of 90 data points. For each peak ground acceleration values of damage state occurrence for each earthquake are added and the results summarized in Table 9-21.

Table 9-21 shows the number of buildings that reached or exceeded each damage state for each PGA. For example, if the peak ground acceleration considered is 0.3g, a total of 85 building shows at least Slight damages and 55, more than half of the sample, present damage greater than the Extensive damage state. Even at low peak ground acceleration, considerable damages are obtained, at 0.1g, 43 structures reach the Moderate damage state.

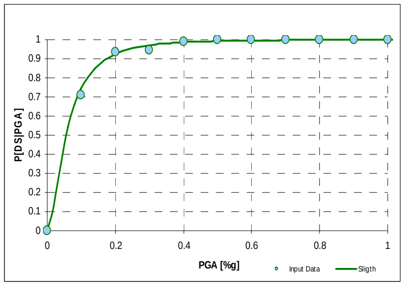
The input cumulative distribution function obtained is shown in Table 9-22. These values represent the probability of being in or exceeding each damage state at each PGA. For example at 0.3g there is a 92% probability of reaching or exceeding the Moderate damage state. These input data point of the fragility curves are plotted in Figure 9-19 with the corresponding fragility curves fitted for each damage state. The fragility curve parameters are summarized in Table 9-2. The set of fragility curves as a function of PGA proposed for this population is plotted in Figure 9-20.

Table 9-21. Cumulative damage-state occurrence using HAZUS limits state: All Earthquakes for Two-Story Reinforced Concrete Shear Walls: All Models

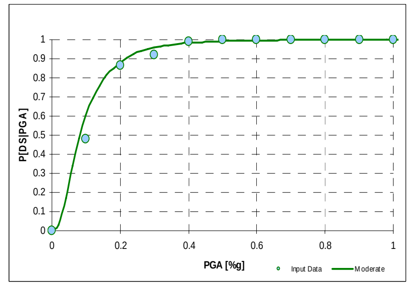
PGA	No Damage	Slight	Moderate	Extensive	Complete
0	90	0	0	0	0
0.1	90	64	43	14	0
0.2	90	84	78	36	11
0.3	90	85	83	55	23
0.4	90	89	89	69	29
0.5	90	90	90	81	44
0.6	90	90	90	86	52
0.7	90	90	90	88	57
0.8	90	90	90	88	67
0.9	90	90	90	89	67
1	90	90	90	90	79
1.1	90	90	90	90	88
1.2	90	90	90	90	88
1.3	90	90	90	90	88
1.4	90	90	90	90	89
1.5	90	90	90	90	89

Table 9-22. Input data damage-state probability using HAZUS limits state: All Earthquakes for Two-Story Reinforced Concrete Shear Walls: All Models

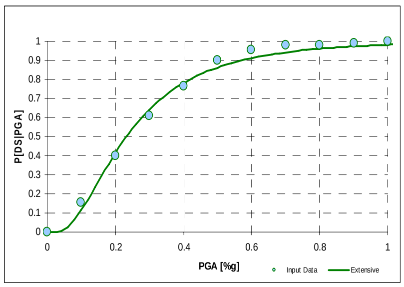
PGA	No Damage	Slight	Moderate	Extensive	Complete
0	1.00	0.00	0.00	0.00	0.00
0.1	1.00	0.71	0.48	0.16	0.00
0.2	1.00	0.93	0.87	0.40	0.12
0.3	1.00	0.94	0.92	0.61	0.26
0.4	1.00	0.99	0.99	0.77	0.32
0.5	1.00	1.00	1.00	0.90	0.49
0.6	1.00	1.00	1.00	0.96	0.58
0.7	1.00	1.00	1.00	0.98	0.63
0.8	1.00	1.00	1.00	0.98	0.74
0.9	1.00	1.00	1.00	0.99	0.74
1	1.00	1.00	1.00	1.00	0.88
1.1	1.00	1.00	1.00	1.00	0.98
1.2	1.00	1.00	1.00	1.00	0.98
1.3	1.00	1.00	1.00	1.00	0.98
1.4	1.00	1.00	1.00	1.00	0.99
1.5	1.00	1.00	1.00	1.00	0.99



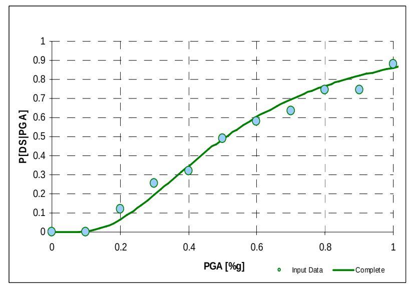
a) Slight Damage



b) Moderate Damage



c) Extensive Damage



d) Complete Damage

Figure 9-19. Damage Fragility curves using HAZUS limits state for Two-Story Reinforced Concrete Shear Walls: All Models

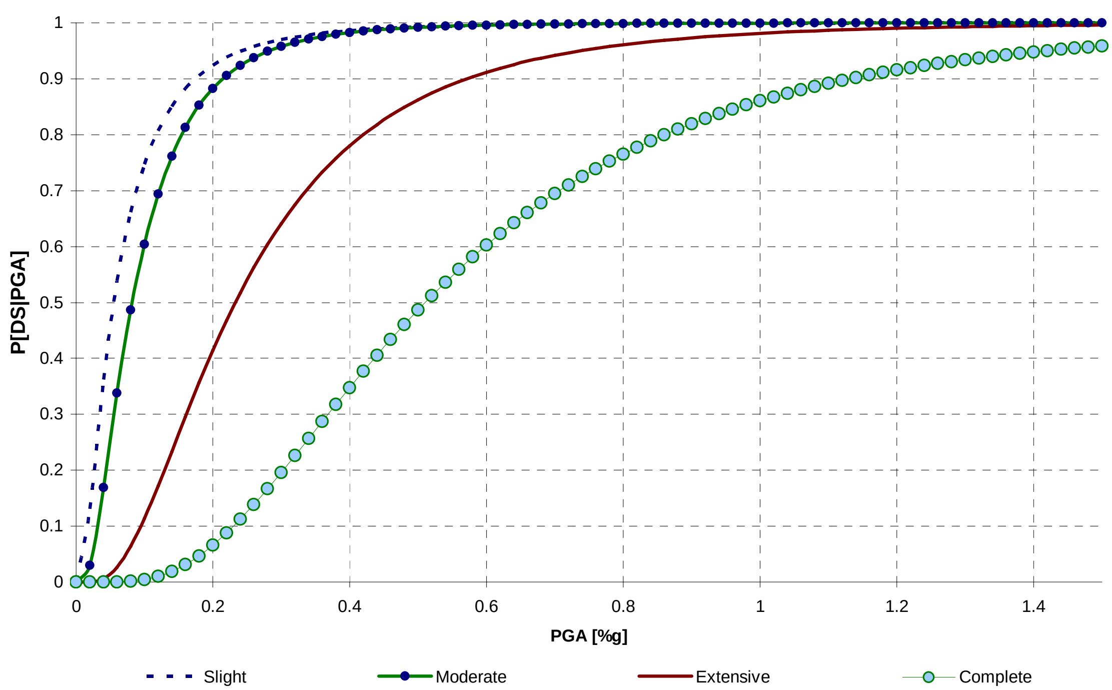


Figure 9-20. Set of Damage Fragility curves using HAZUS limits state for Two-Story Reinforced Concrete Shear Walls: All Models

9.4.2.2 TWO-STORY REINFORCED CONCRETE SHEAR WALLS: WEAK DIRECTION

The sample size for this type of models is 30 for each PGA. For each peak ground acceleration values of damage state occurrence for each earthquake are added and the results summarized in Table 9-23. This table shows the number of buildings that reached or exceeded each damage state at each PGA. For example, if the peak ground acceleration considered is 0.3g, the whole population shows at least Moderate damages and 28 out of 30 models present Extensive damages. Even at low peak ground acceleration, considerable damages are obtained: at 0.1g, 26 structures reached the Moderate damage state, 11 fall in Extensive damages.

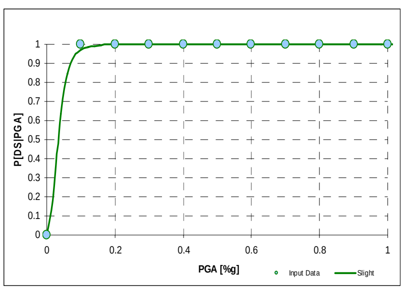
The input cumulative distribution function obtained is shown in Table 8-24. These input data point of the fragility curves are plotted in Figure 9-21 with the corresponding fragility curves fitted for each damage state. The fragility curve parameters are summarized in Table 9-2. The set of fragility curves as a function of PGA proposed for this population is plotted in Figure 9-22.

Table 9-23. Cumulative damage-state occurrence using HAZUS limits state: All Earthquakes for One-Story Reinforced Concrete Shear Walls: Weak Direction

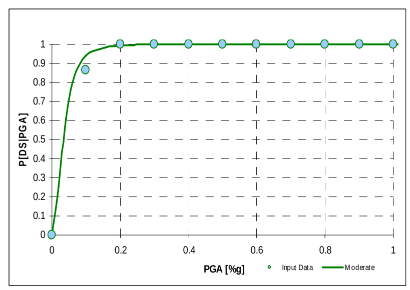
PGA	No Damage	Slight	Moderate	Extensive	Complete
0	30	0	0	0	0
0.1	30	30	26	14	0
0.2	30	30	30	26	11
0.3	30	30	30	28	23
0.4	30	30	30	29	23
0.5	30	30	30	30	27
0.6	30	30	30	30	27
0.7	30	30	30	30	28
0.8	30	30	30	30	28
0.9	30	30	30	30	28
1	30	30	30	30	29
1.1	30	30	30	30	30
1.2	30	30	30	30	30
1.3	30	30	30	30	30
1.4	30	30	30	30	30
1.5	30	30	30	30	30

Table 9-24. Input data damage-state probability using HAZUS limits state: All Earthquakes for Two-Story Reinforced Concrete Shear Walls: Weak Direction

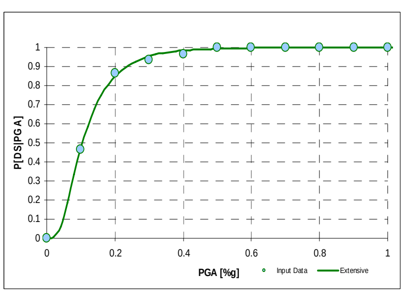
PGA	No Damage	Slight	Moderate	Extensive	Complete
0	1.00	0.00	0.00	0.00	0.00
0.1	1.00	1.00	0.87	0.47	0.00
0.2	1.00	1.00	1.00	0.87	0.37
0.3	1.00	1.00	1.00	0.93	0.77
0.4	1.00	1.00	1.00	0.97	0.77
0.5	1.00	1.00	1.00	1.00	0.90
0.6	1.00	1.00	1.00	1.00	0.90
0.7	1.00	1.00	1.00	1.00	0.93
0.8	1.00	1.00	1.00	1.00	0.93
0.9	1.00	1.00	1.00	1.00	0.93
1	1.00	1.00	1.00	1.00	0.97
1.1	1.00	1.00	1.00	1.00	1.00
1.2	1.00	1.00	1.00	1.00	1.00
1.3	1.00	1.00	1.00	1.00	1.00
1.4	1.00	1.00	1.00	1.00	1.00
1.5	1.00	1.00	1.00	1.00	1.00



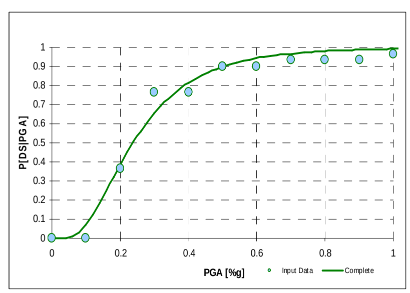
a) Slight Damage



b) Moderate Damage



c) Extensive Damage



d) Complete Damage

Figure 9-21. Damage Fragility curves using HAZUS limits state for Two-Story Reinforced Concrete Shear Walls: Weak Direction

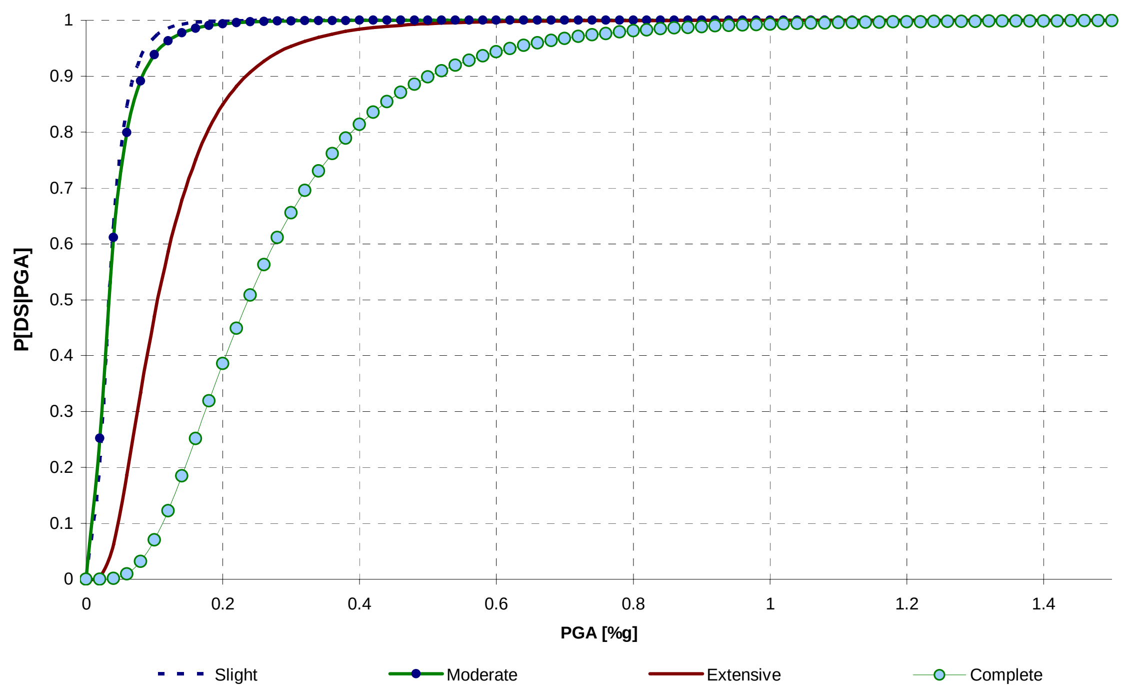


Figure 9-22. Set of Damage Fragility curves using HAZUS limits state for Two-Story Reinforced Concrete Shear Walls: Weak Direction

9.4.2.3 TWO-STORY REINFORCED CONCRETE SHEAR WALLS: STRONG DIRECTION

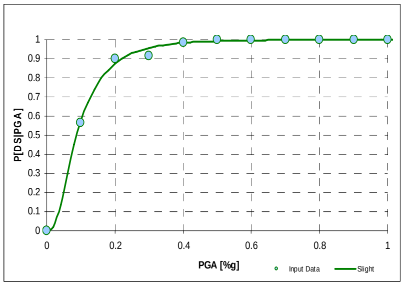
The sample size for this type of models is 60 for each PGA. For each peak ground acceleration values of damage state occurrence for each earthquake are added and the results summarized in Table 9-25 This table shows the number of buildings that reached or exceeded each damage state at each PGA. For example, if the peak ground acceleration considered is 0.3g, 53 models shows at least moderate damages and 27 out of 60 models present Extensive damages. Even at low peak ground acceleration, considerable damages are obtained: at 0.1g, 17 structures reached the Moderate damage state The input cumulative distribution function obtained is shown in Table 9-26. These input data point of the fragility curves are plotted in Figure 9-23 with the corresponding fragility curves fitted for each damage state. The fragility curve parameters are summarized in Table 9-2 The set of fragility curves as a function of PGA proposed for this population is plotted in Figure 9-24.

Table 9-25. Cumulative damage-state occurrence using HAZUS limits state: All Earthquakes for Two-Story Reinforced Concrete Shear Walls: Strong Direction

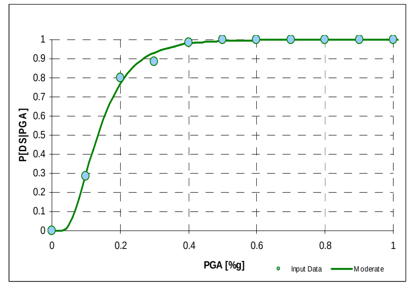
PGA	No Damage	Slight	Moderate	Extensive	Complete
0	60	0	0	0	0
0.1	60	34	17	0	0
0.2	60	54	48	10	0
0.3	60	55	53	27	0
0.4	60	59	59	40	6
0.5	60	60	60	51	17
0.6	60	60	60	56	25
0.7	60	60	60	58	29
0.8	60	60	60	58	39
0.9	60	60	60	59	39
1	60	60	60	60	50
1.1	60	60	60	60	58
1.2	60	60	60	60	58
1.3	60	60	60	60	58
1.4	60	60	60	60	59
1.5	60	60	60	60	59

Table 9-26. Input data damage-state probability using HAZUS limits state: All Earthquakes for Two-Story Reinforced Concrete Shear Walls: Strong Direction

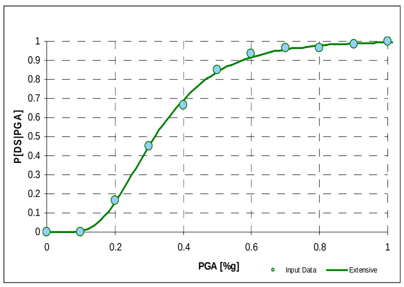
PGA	No Damage	Slight	Moderate	Extensive	Complete
0	1.00	0.00	0.00	0.00	0.00
0.1	1.00	0.57	0.28	0.00	0.00
0.2	1.00	0.90	0.80	0.17	0.00
0.3	1.00	0.92	0.88	0.45	0.00
0.4	1.00	0.98	0.98	0.67	0.10
0.5	1.00	1.00	1.00	0.85	0.28
0.6	1.00	1.00	1.00	0.93	0.42
0.7	1.00	1.00	1.00	0.97	0.48
0.8	1.00	1.00	1.00	0.97	0.65
0.9	1.00	1.00	1.00	0.98	0.65
1	1.00	1.00	1.00	1.00	0.83
1.1	1.00	1.00	1.00	1.00	0.97
1.2	1.00	1.00	1.00	1.00	0.97
1.3	1.00	1.00	1.00	1.00	0.97
1.4	1.00	1.00	1.00	1.00	0.98
1.5	1.00	1.00	1.00	1.00	0.98



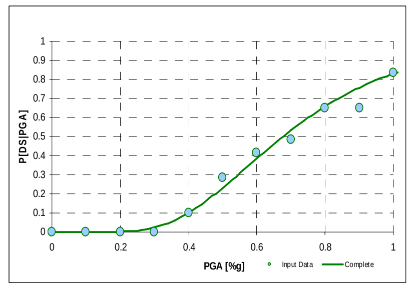
a) Slight Damage



b) Moderate Damage



c) Extensive Damage



d) Complete Damage

Figure 9-23. Damage Fragility curves using HAZUS limits state for Two-Story Reinforced Concrete Shear Walls: Strong Direction

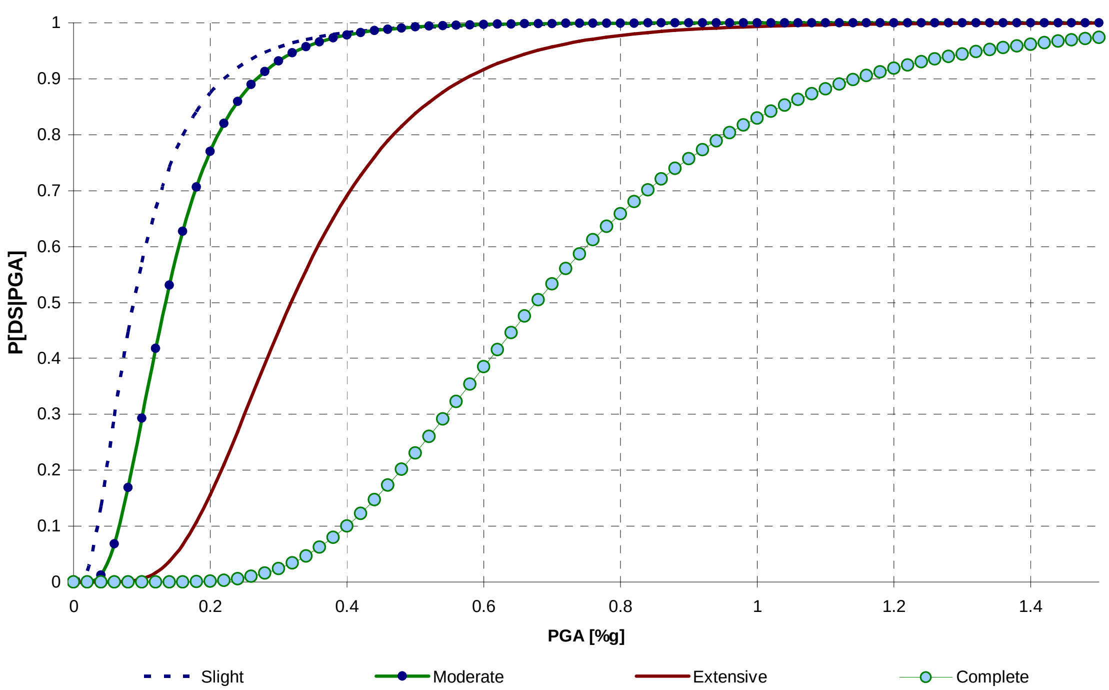


Figure 9-24. Set of Damage Fragility curves using HAZUS limits state for Two-Story Reinforced Concrete Shear Walls: Strong Direction

9.4.3 MULTISTORY MODELS

Values of damage state occurrence for multistory shear wall models are presented in Table 9-27. For the whole sample of 130 models the table shows that for a peak ground acceleration of 0.3g, a total of 39 building shows at least Slight damages and only 17 models present damage greater than the Moderate damage state.

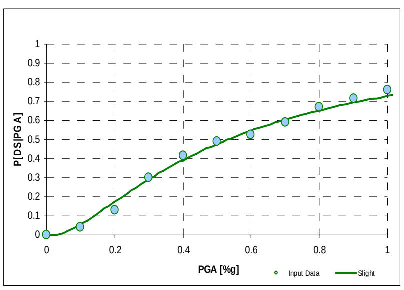
The cumulative distribution function obtained is summarized in Table 9-28. For example at 0.3g, there is a 17% probability of reaching or exceeding the Moderate damage state. These values are data point of the fragility curves. Figure 9-25 plots the input data points and the lognormal function fitted for Slight, moderate, Extensive and Complete damage. The log-median and log-standard deviation obtained is presented in Table 9-2. The set of fragility curves as a function of PGA proposed for this population is plotted in Figure 9-26.

Table 9-27. Cumulative damage-state occurrence using HAZUS limits state: All Earthquakes for Multistory Reinforced Concrete Shear Walls: All Models

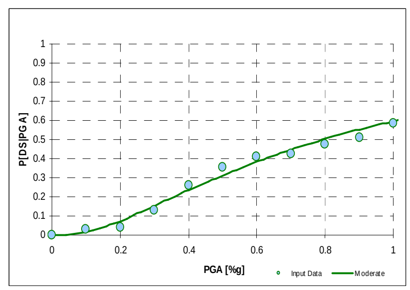
PGA	No Damage	Slight	Moderate	Extensive	Complete
0	130	0	0	0	0
0.1	130	5	4	1	0
0.2	130	17	5	4	1
0.3	130	39	17	5	2
0.4	130	54	34	9	2
0.5	130	64	46	12	4
0.6	130	68	53	15	4
0.7	130	77	55	24	6
0.8	130	87	62	28	7
0.9	130	93	66	37	9
1	130	99	76	46	10
1.1	130	101	84	51	13
1.2	130	102	88	55	15
1.3	130	102	94	60	18
1.4	130	102	95	61	17
1.5	130	104	97	64	21

Table 9-28. Input data damage-state probability using HAZUS limits state: All Earthquakes for Multistory Reinforced Concrete Shear Walls: All Models

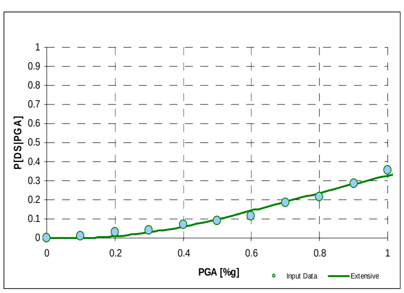
PGA	No Damage	Slight	Moderate	Extensive	Complete
0	1.00	0.00	0.00	0.00	0.00
0.1	1.00	0.04	0.03	0.01	0.00
0.2	1.00	0.13	0.04	0.03	0.01
0.3	1.00	0.30	0.13	0.04	0.02
0.4	1.00	0.42	0.26	0.07	0.02
0.5	1.00	0.49	0.35	0.09	0.03
0.6	1.00	0.52	0.41	0.12	0.03
0.7	1.00	0.59	0.42	0.18	0.05
0.8	1.00	0.67	0.48	0.22	0.05
0.9	1.00	0.72	0.51	0.28	0.07
1	1.00	0.76	0.58	0.35	0.08
1.1	1.00	0.78	0.65	0.39	0.10
1.2	1.00	0.78	0.68	0.42	0.12
1.3	1.00	0.78	0.72	0.46	0.14
1.4	1.00	0.78	0.73	0.47	0.13
1.5	1.00	0.80	0.75	0.49	0.16



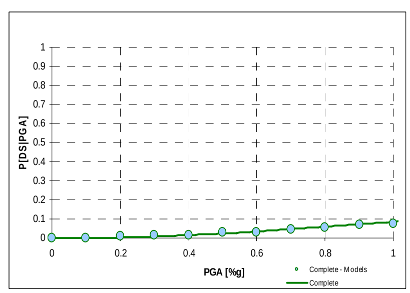
a) Slight Damage



b) Moderate Damage



c) Extensive Damage



d) Complete Damage

Figure 9-25. Damage Fragility curves using HAZUS limits state for Multistory Reinforced Concrete Shear Walls: All Models

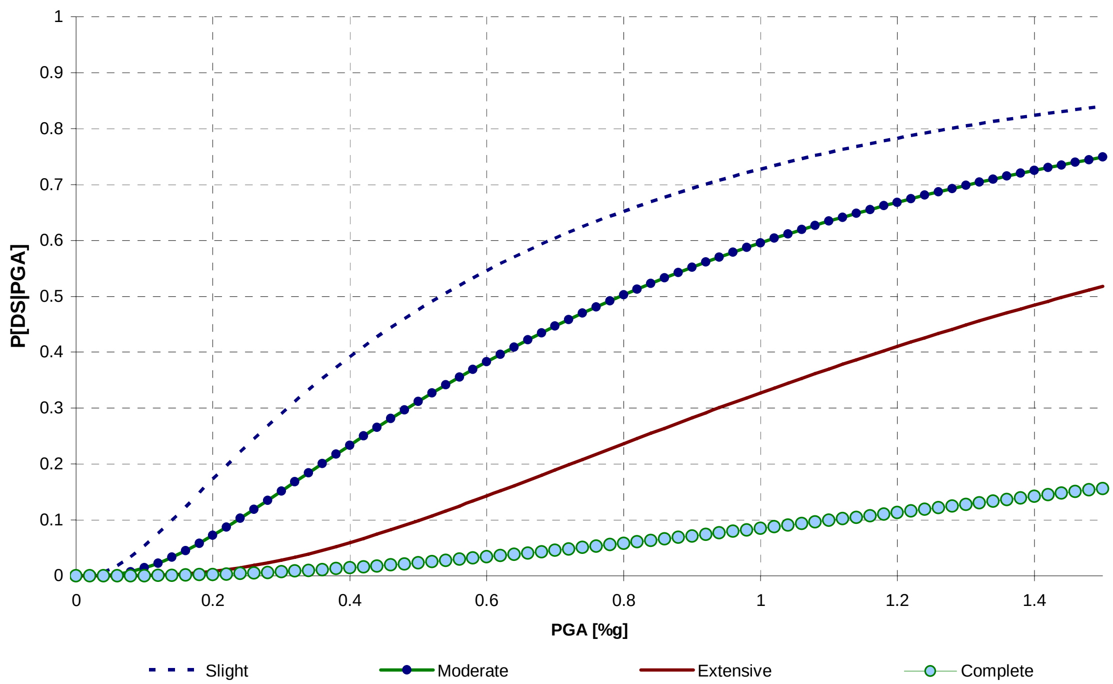


Figure 9-26. Set of Damage Fragility curves using HAZUS limits state for Multistory Reinforced Concrete Shear Walls: All Models

9.5 COMPARISONS OF FRAGILITY CURVES

Figure 9-27 to Figure 9-30 compares the one and two story and multistory models taking into account all models. From these curves it can be inferred that multistory reinforced concrete wall models behave better than other types of models analyzed. Multistory models have only around 5% of probability of reach Extensive damage and 20% of reaching or exceeding Moderate damage at 0.4g. These low probability of damage, even at high PGA values, makes multistory residential models the least vulnerable structure studied and shows that they behave well when submitted to earthquake forces.

When Frame models are compared, one-story frame models are more susceptible to complete damages than two-story frame models, this result is because two-story models usually have a greater percentage of columns to floor area than one-story models.

Comparing one and two story shear wall models, for all damage-states, two-story shear walls models are more susceptible to damages than one-story shear wall models. Comparing lateral resisting systems, shear wall models are more susceptible to Extensive and Complete damage state than frame models.

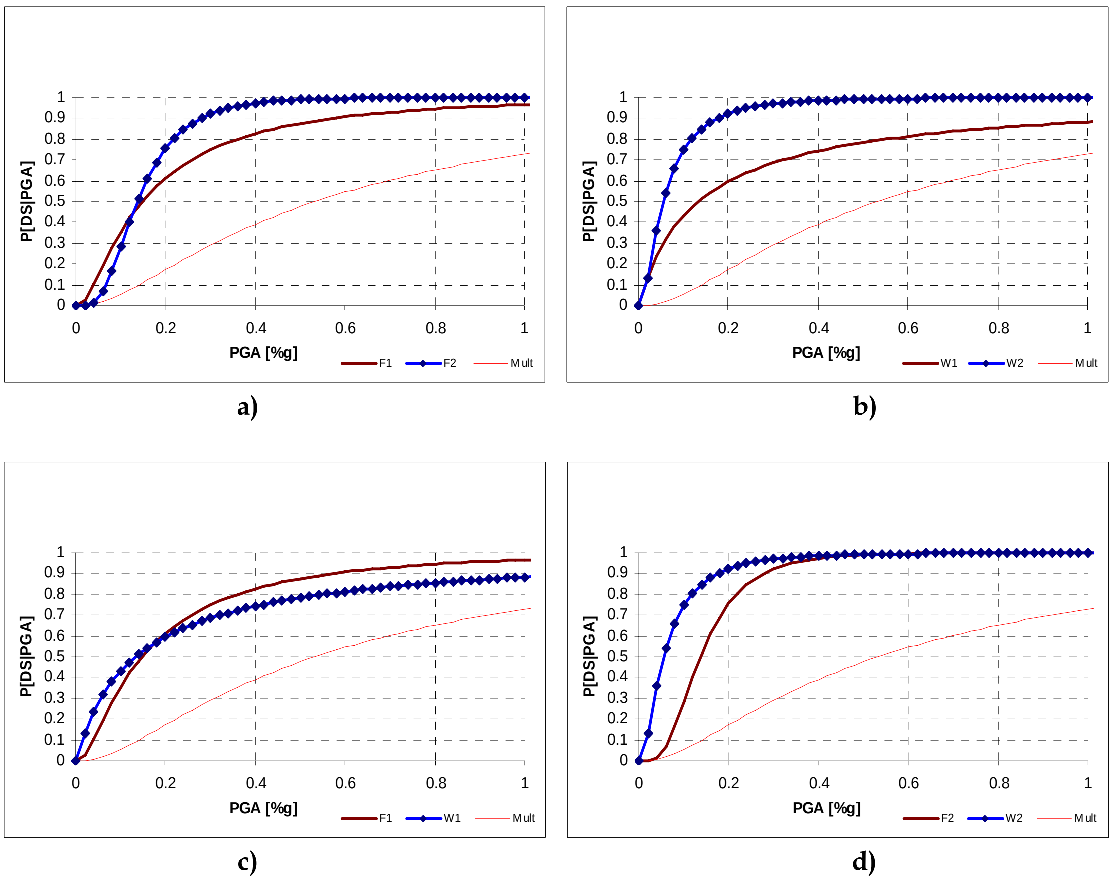
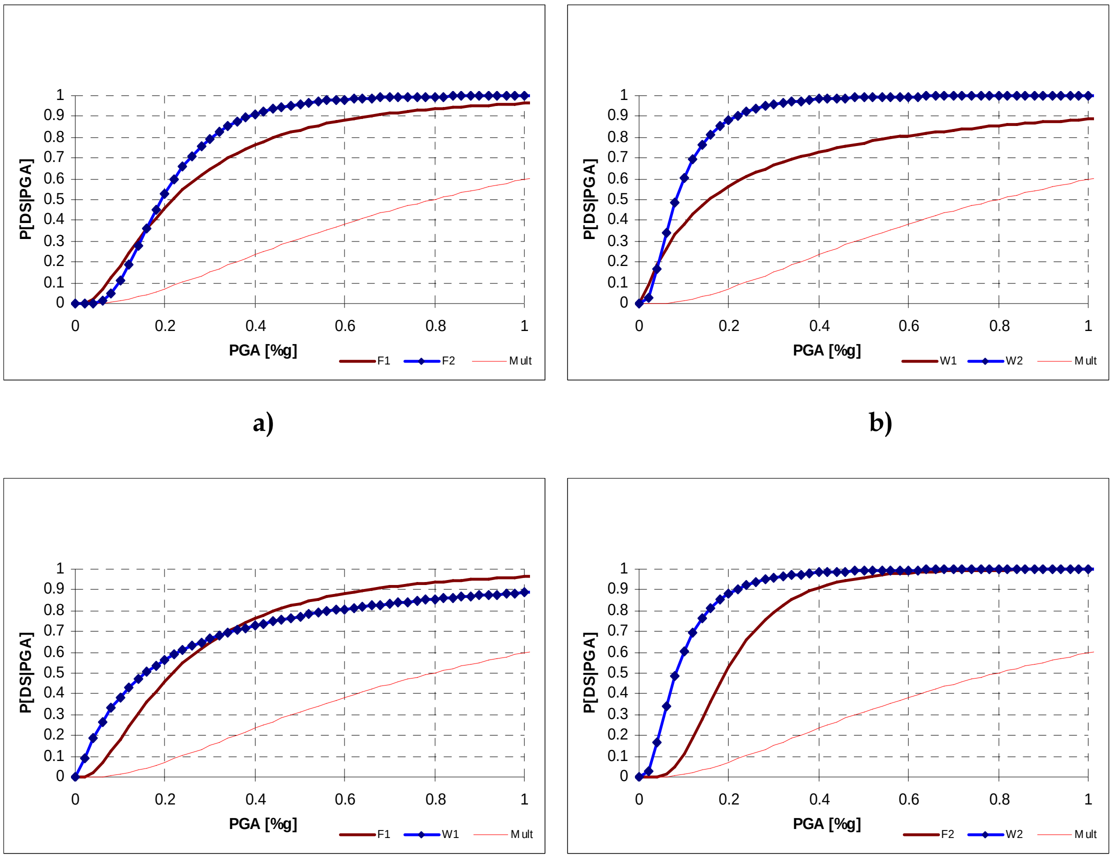
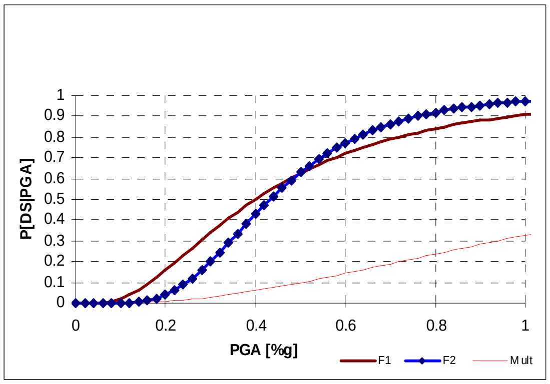


Figure 9-27. Slight damage fragility curves using HAZUS limits comparisons. a) One and Two-Story Frame, and Multistory Models: All Directions, b) One and Two-Story Shear Wall, and Multistory: All Directions, c) One-Story Models: All Directions, and Multistory; and d) Two-Story Models, and Multistory: All Directions

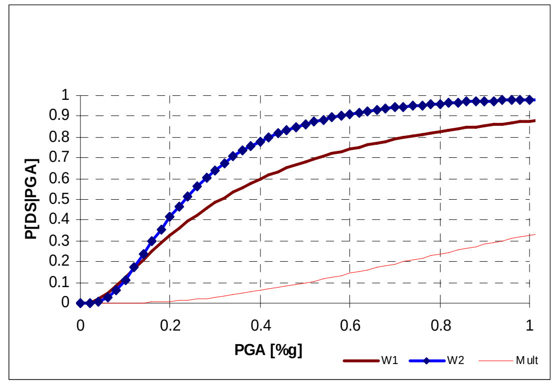


c) d)

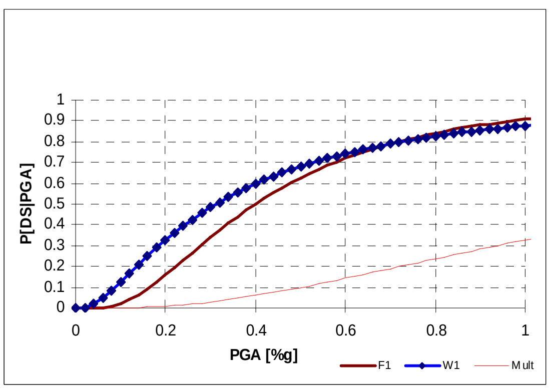
Figure 9-28.. Moderate damage fragility curves using HAZUS limits comparisons. a) One and Two-Story Frame, and Multistory Models: All Directions, b) One and Two-Story Shear Wall, and Multistory: All Directions, c) One-Story Models: All Directions, and Multistory; and d) Two-Story Models, and Multistory: All Directions



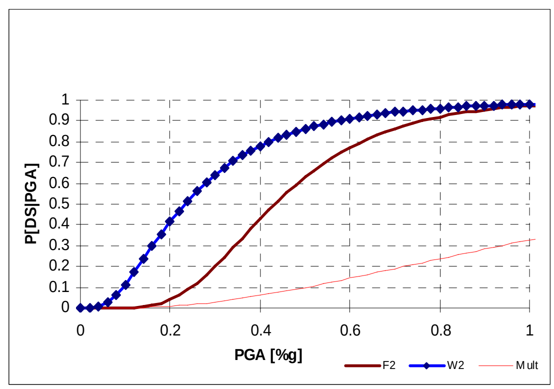
a)



b)

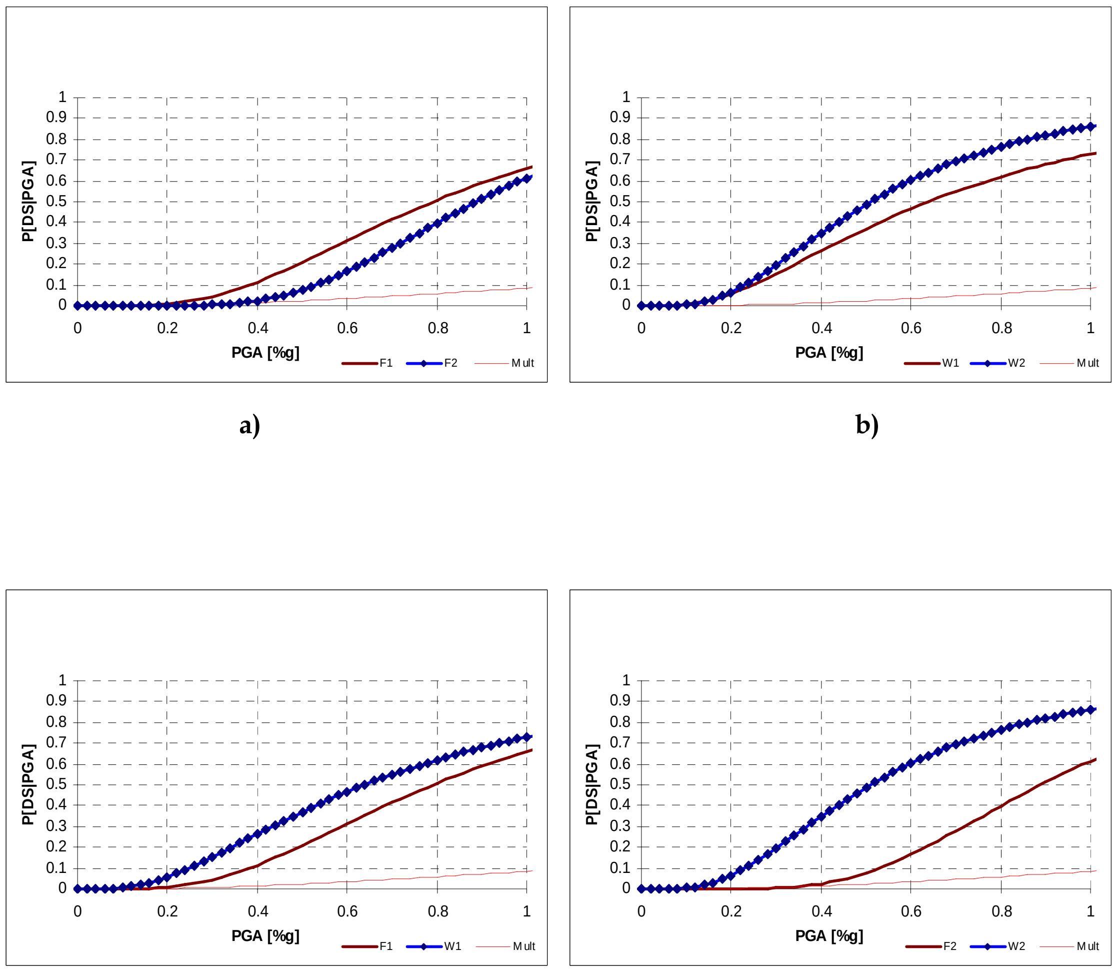


c)



d)

Figure 9-29. Extensive damage fragility curves using HAZUS limits comparisons. a) One and Two-Story Frame, and Multistory Models: All Directions, b) One and Two-Story Shear Wall, and Multistory: All Directions, c) One-Story Models: All Directions, and Multistory; and d) Two-Story Models, and Multistory: All Directions



a) b)

c) d)

Figure 9-30. Complete damage fragility curves using HAZUS limits comparisons. a) One and Two-Story Frame, and Multistory Models: All Directions b) One and Two-Story Shear Wall, and Multistory: All Directions, c) One-Story Models: All Directions, and Multistory; and d) Two-Story Models, and Multistory: All Directions

Figure 9-31 to Figure 9-34 present comparisons between one and two-story models with lateral resisting system oriented in the weak direction for each damage state. It can be shown that this direction of the models is very susceptible to damage. For shear wall models at 0.3g almost 100% of the models reached or exceeded the Extensive damage state and 65% reach the Complete damage state; and for reinforced concrete frames, there is a 100% probability of reaching or exceeding Extensive damage.

Fragility curves of one and two-story frame models are similar, and also fragility curves of one and two-story shear wall models. For all cases, comparing lateral resisting system in the weak direction, moment frame models are less susceptible to Slight, Moderate and Extensive damage than shear wall models, but frame models are more susceptible to Complete damage than shear wall models.

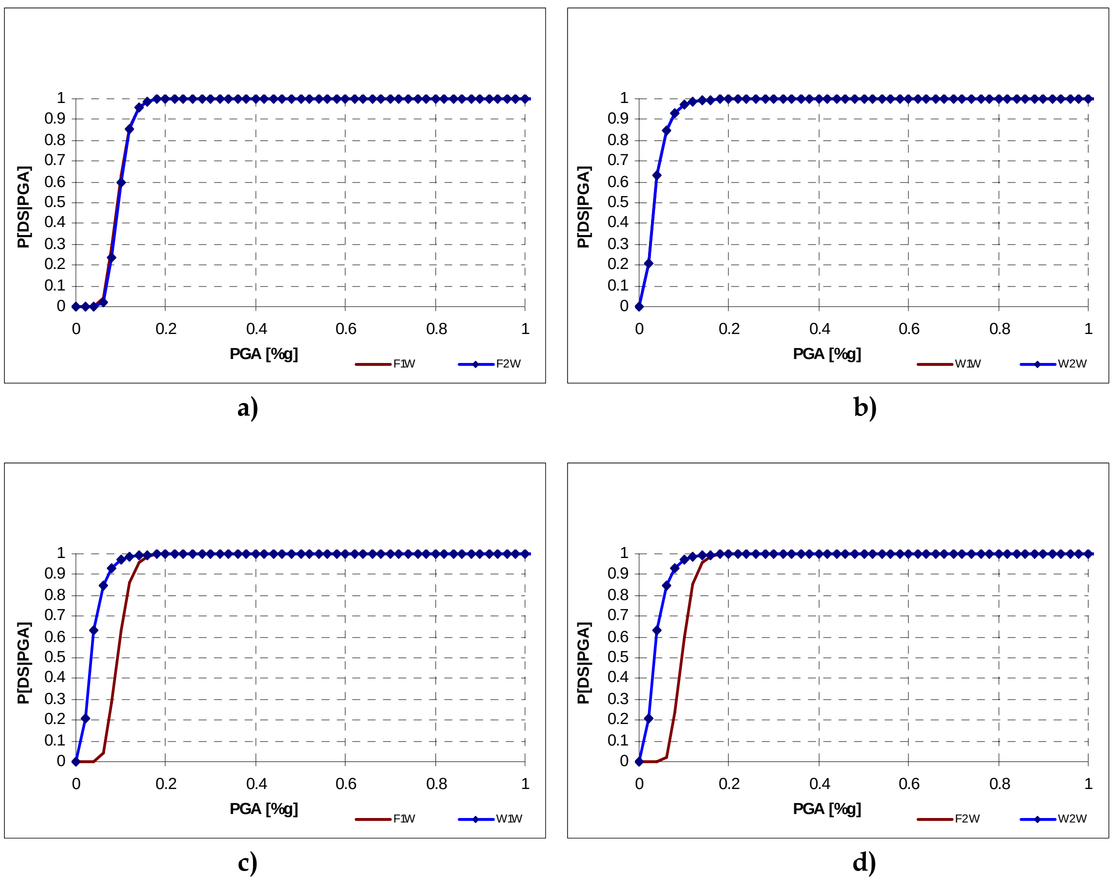
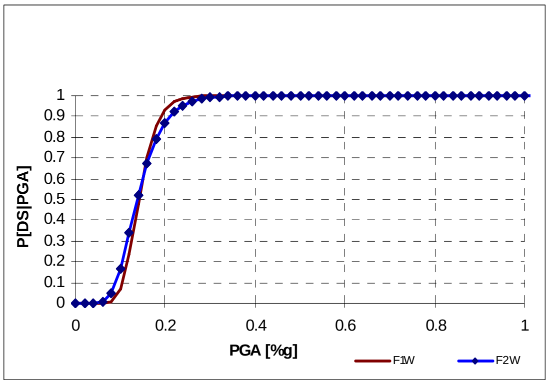
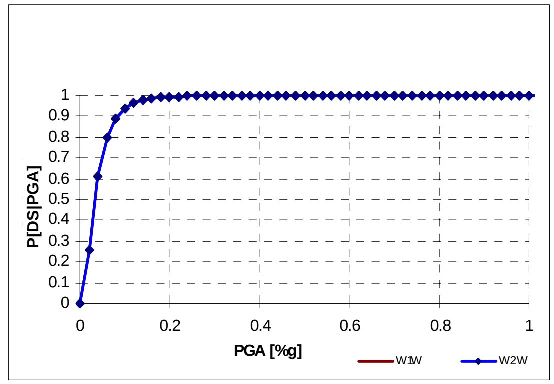


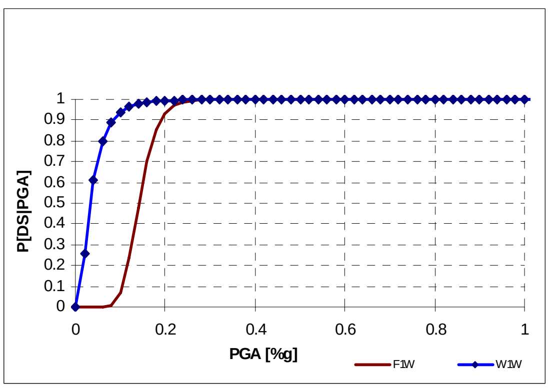
Figure 9-31.. Minor damage fragility curves using HAZUS limits comparisons. a) One and Two-Story Frames: Weak Direction, b) One and Two-Story Shear Walls: Weak Direction, c) One-Story Model: Weak Direction; and d) Two-Story Models: Weak Direction



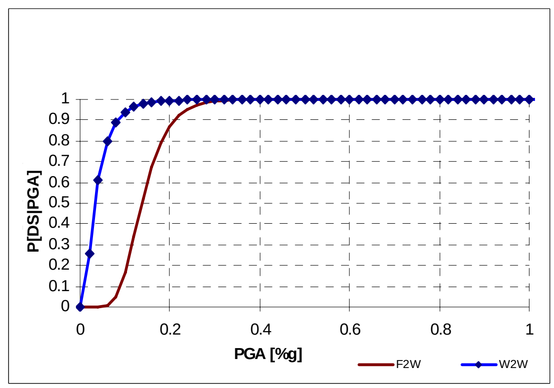
a)



b)



c)



d)

Figure 9-32. Moderate damage fragility curves using HAZUS limits comparisons. a) One and Two-Story Frames: Weak Direction, b) One and Two-Story Shear Walls: Weak Direction, c) One-Story Model: Weak Direction; and d) Two-Story Models: Weak Direction

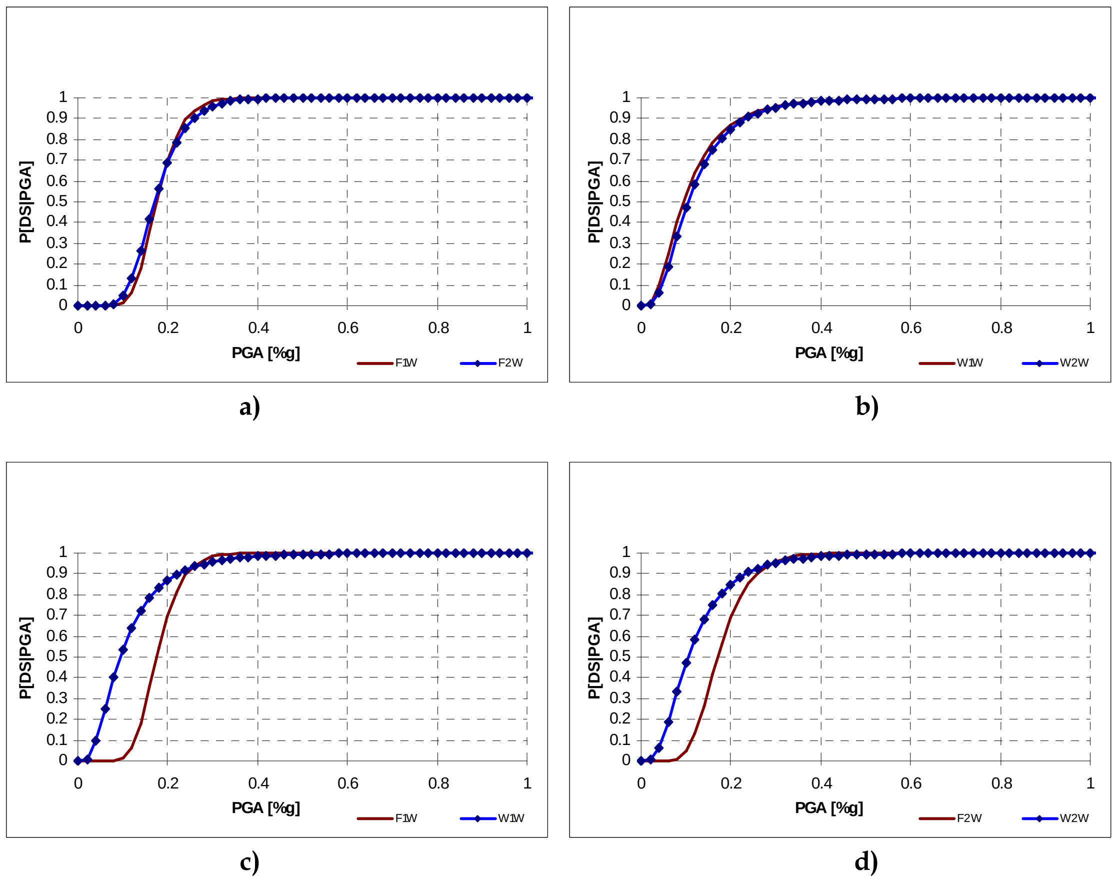
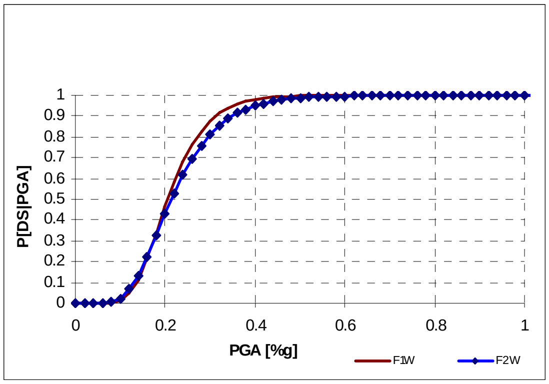
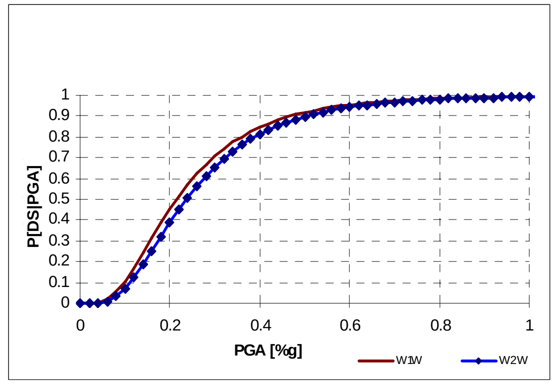


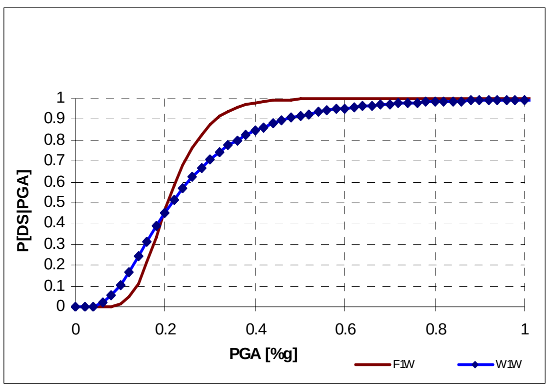
Figure 9-33. Extensive damage fragility curves using HAZUS limits comparisons. a) One and Two-Story Frames: Weak Direction, b) One and Two-Story Shear Walls: Weak Direction, c) One-Story Model: Weak Direction; and d) Two-Story Models: Weak Direction



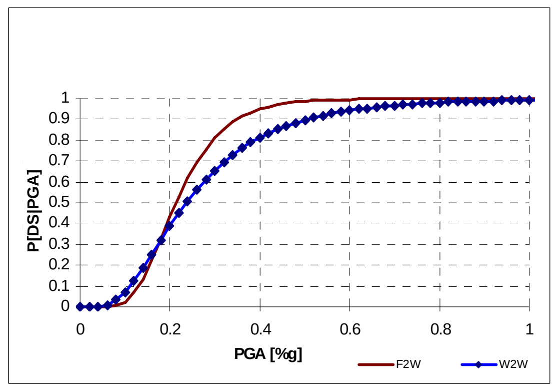
a)



b)

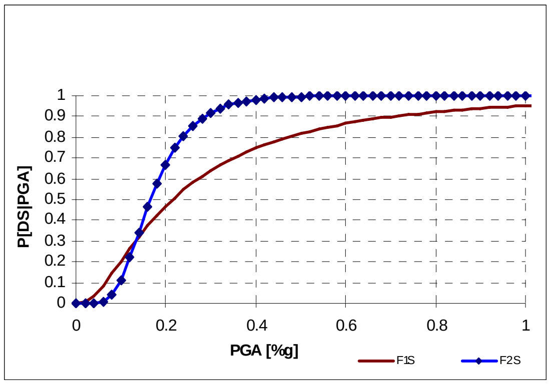


c)

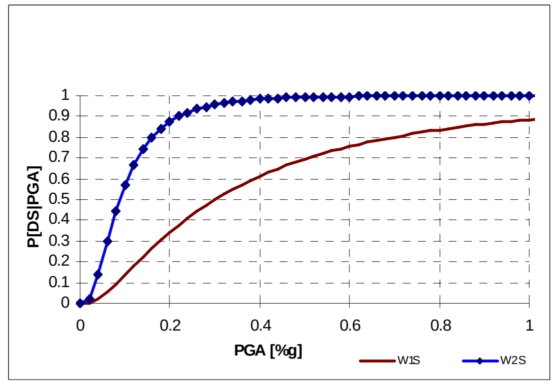


d)

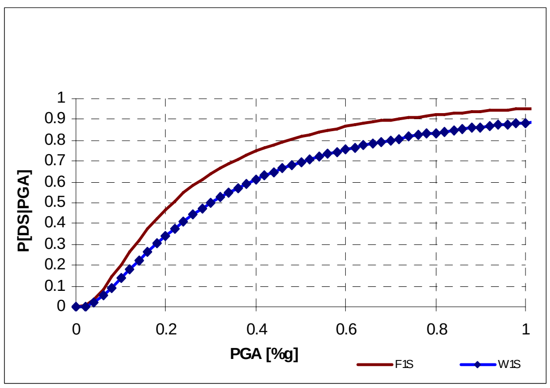
Figure 9-34. Major damage fragility curves using HAZUS limits comparisons. a) One and Two-Story Frames: Weak Direction, b) One and Two-Story Shear Walls: Weak Direction, c) One-Story Model: Weak Direction; and d) Two-Story Models: Weak Direction



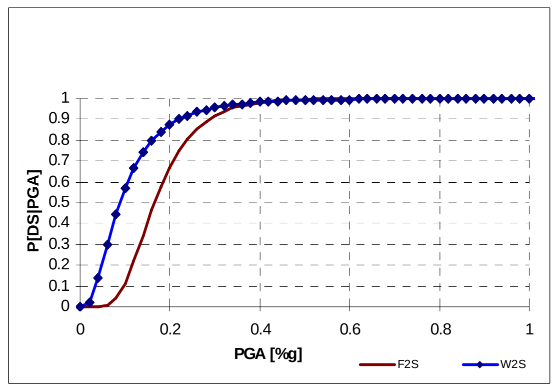
a)



b)

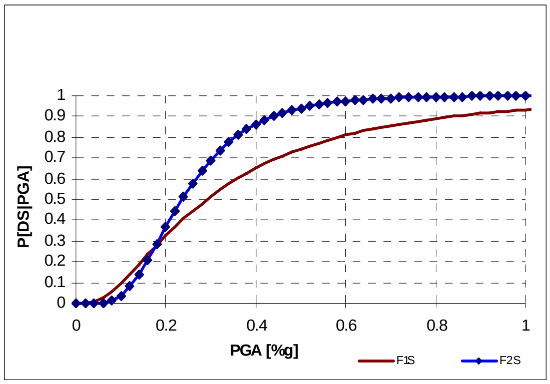


c)

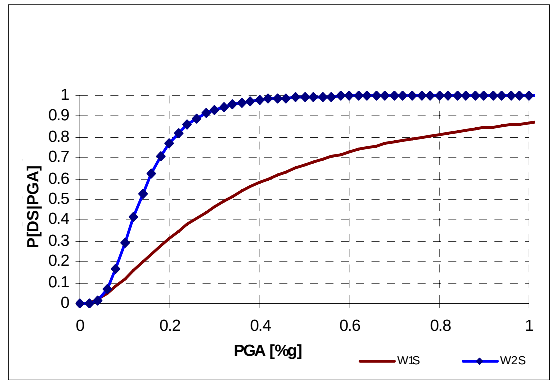


d)

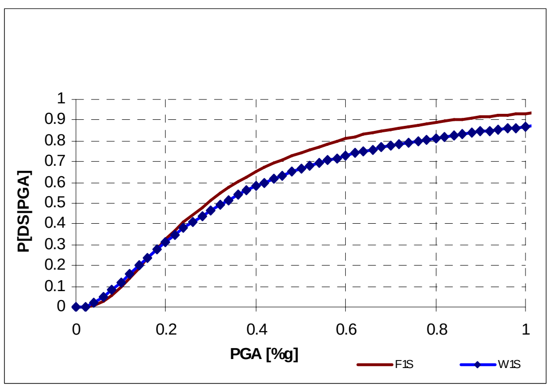
Figure 9-35. Minor damage fragility curves using HAZUS limits comparisons. a) One and Two-Story Frames: Strong Direction, b) One and Two-Story Shear Walls: Strong Direction, c) One-Story Model: Strong Direction; and d) Two-Story Models: Strong Direction



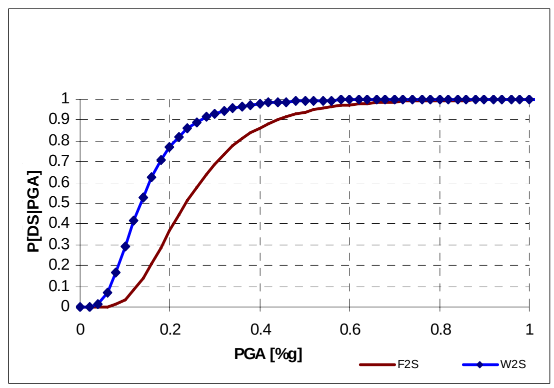
a)



b)

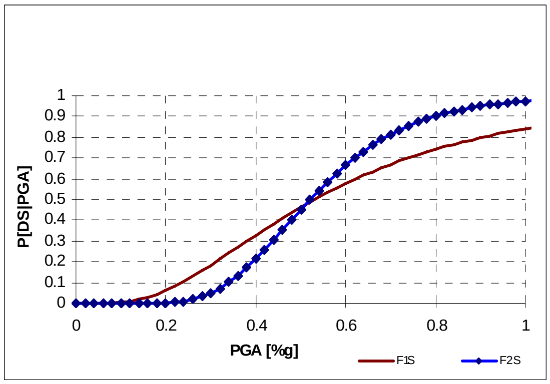


c)

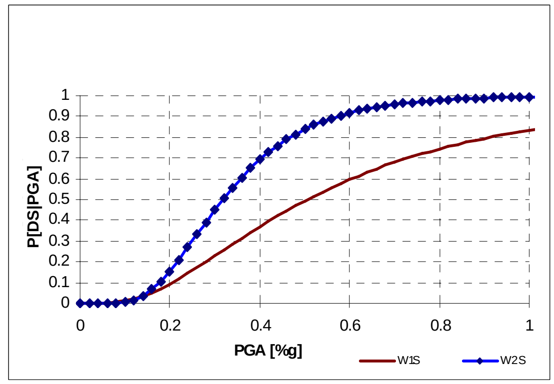


d)

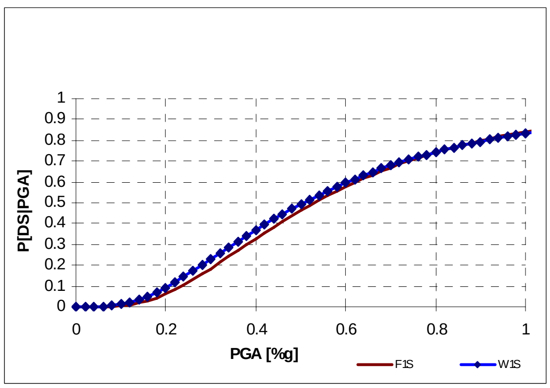
Figure 9-36. Moderate damage fragility curves using HAZUS limits comparisons. a) One and Two-Story Frames: Strong Direction, b) One and Two-Story Shear Walls: Strong Direction, c) One-Story Model: Strong Direction; and d) Two-Story Models: Strong Direction



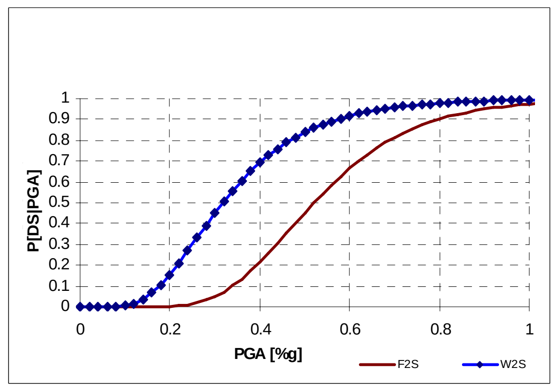
a)



b)



c)



d)

Figure 9-37. Extensive damage fragility curves using HAZUS limits comparisons. a) One and Two-Story Frames: Strong Direction, b) One and Two-Story Shear Walls: Strong Direction, c) One-Story Model: Strong Direction; and d) Two-Story Models: Strong Direction

Figure 9-35 to Figure 9-38 compares the one and two story models with lateral resisting system oriented in the strong direction. From these curves it can be inferred that for a large PGA, two-story models are more susceptible to Extensive damages than one-story models.

Fragility curves for one-story models are very similar, thus the probability of being in or exceeding each damage state is almost the same for one-story shear wall models and one-story frames.

Comparing two-story models, for all cases two-story shear wall models results more susceptible to damage than two-story frame models.

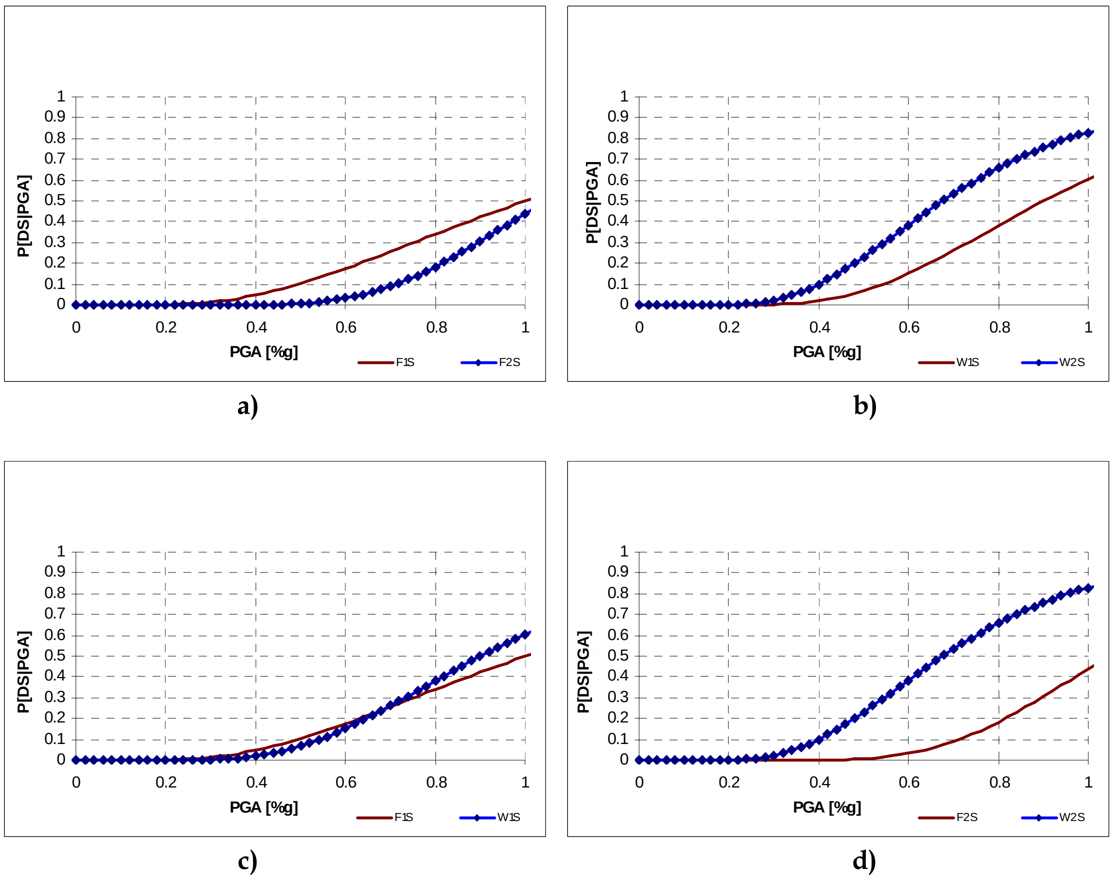
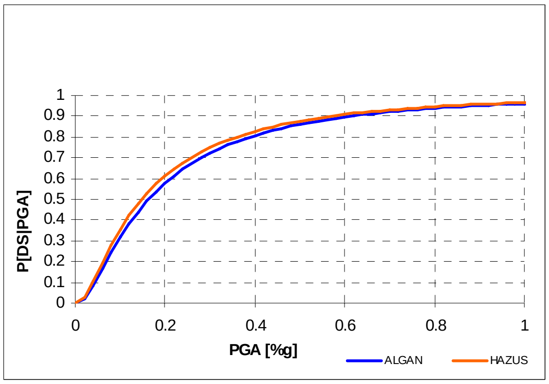


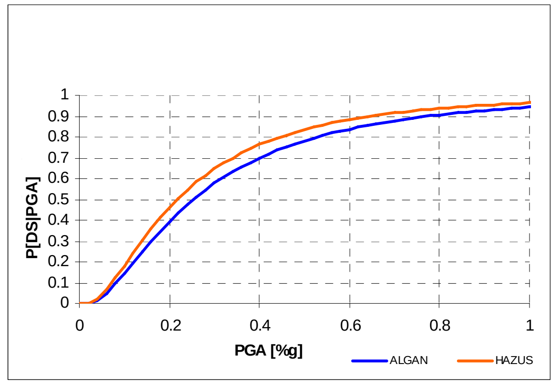
Figure 9-38. Complete damage fragility curves using HAZUS limits comparisons. a) One and Two-Story Frames: Strong Direction, b) One and Two-Story Shear Walls: Strong Direction, c) One-Story Model: Strong Direction; and d) Two-Story Models: Strong Direction

9.6 COMPARISON OF ALGAN AND HAZUS FRAGILITY CURVES

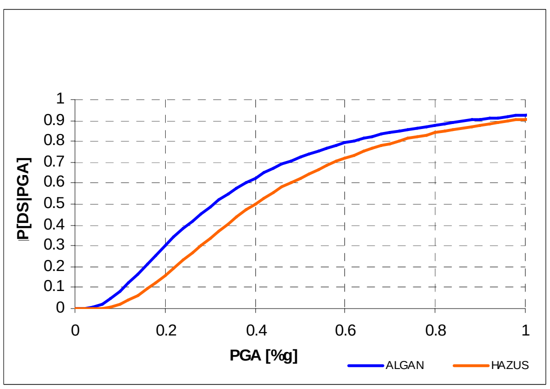
Figure 9-39 to Figure 9-43 present comparisons of Algan and HAZUS limits. For all models it can be seen that the biggest difference appears in the Complete damage state. This difference is due to the definitions of damage limits. Algan defines major damage as damage where the structure exhibits such deterioration that may need to be demolished and rebuilt and is based on a maximum drift of 2%. HAZUS defines extensive damage with a drift limits close to 2% also, and considers complete damage or collapse when the structure loses it stability. For low code HAZUS assigns a maximum drift of 5% for low rise concrete models.



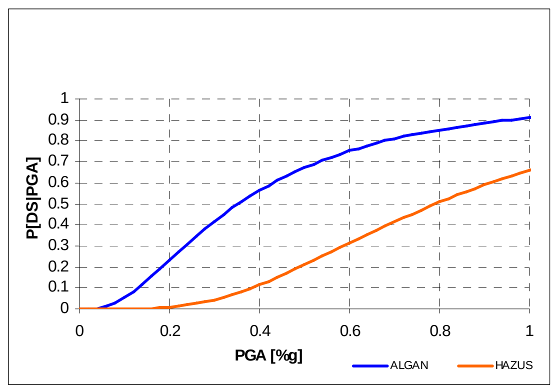
a) Minor Vs Slight Damage



b) Moderate Damage

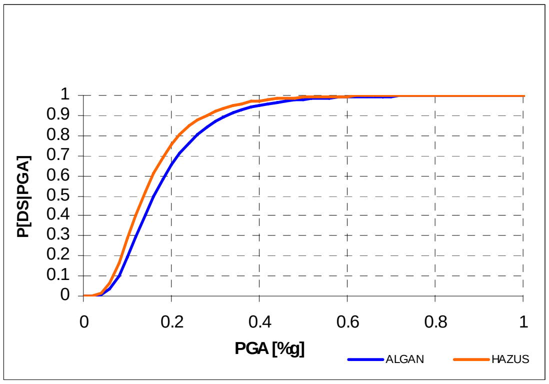


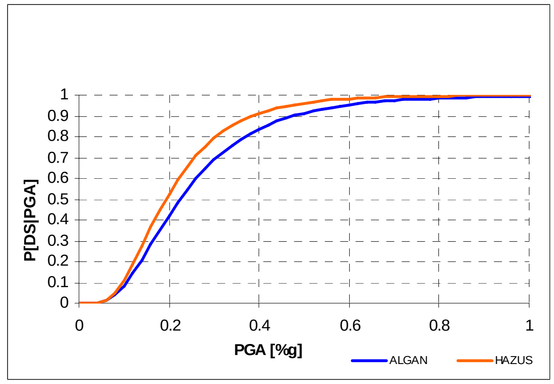
c) Substantial Vs Extensive Damage



d) Major Vs Complete Damage

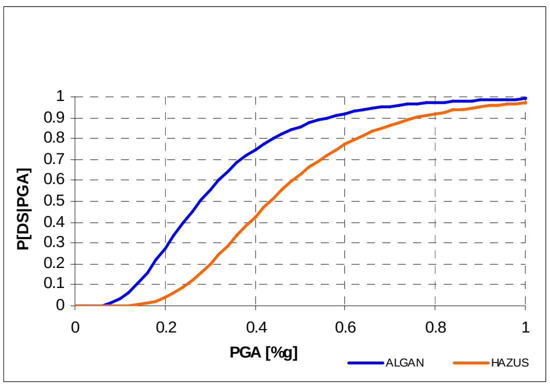
Figure 9-39. Algan Vs HAZUS fragility curves comparisons. One-Story Reinforced Concrete Frames: All Models

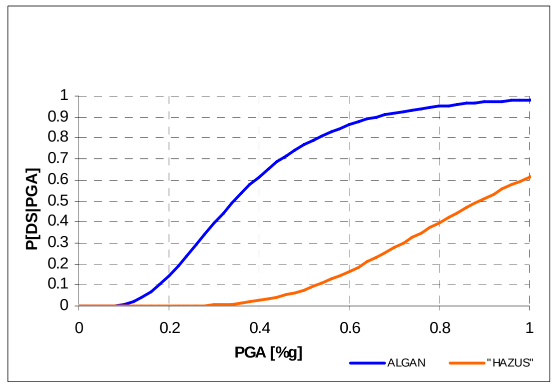




a) Minor Vs Slight Damage

b) Moderate Damage

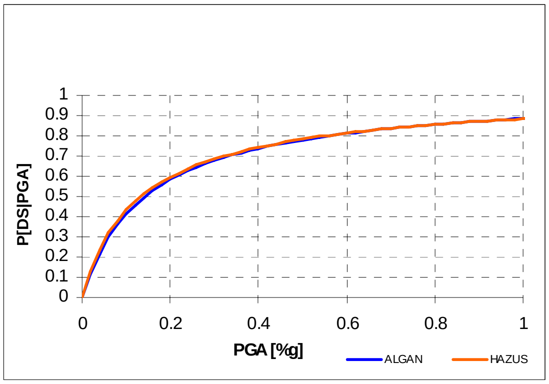




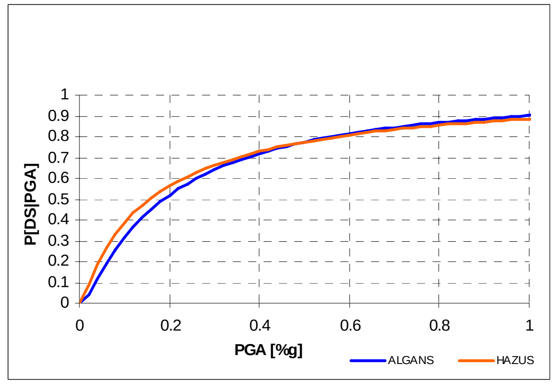
c) Substantial Vs Extensive Damage

d) Major Vs Complete Damage

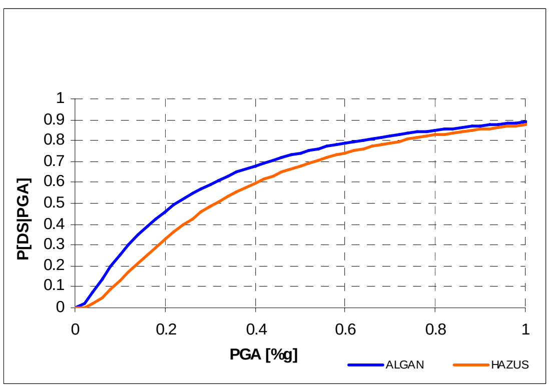
Figure 9-40. Algan Vs HAZUS fragility curves comparisons. Two-Story Reinforced Concrete Frames: All Models



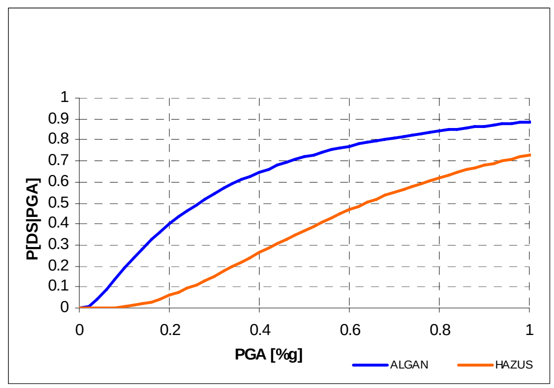
a) Minor Vs Slight Damage



b) Moderate Damage

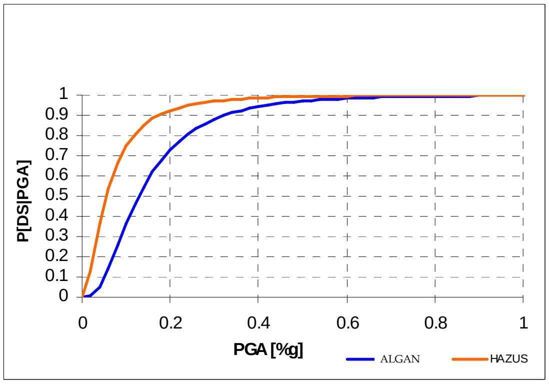


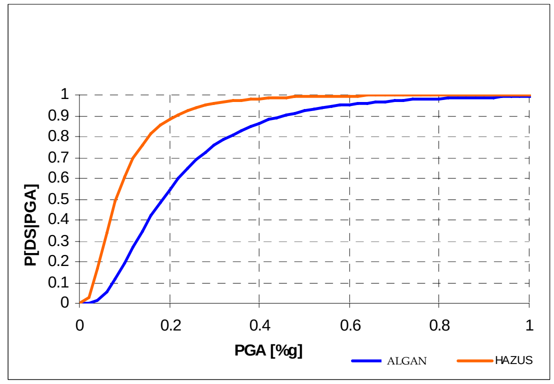
c) Substantial Vs Extensive Damage



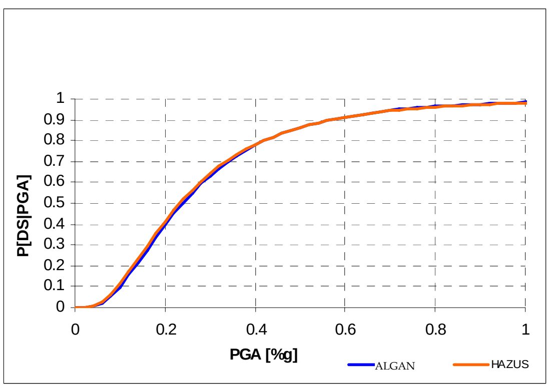
d) Major Vs Complete Damage

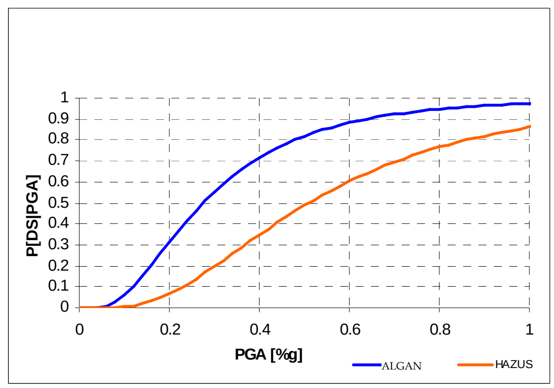
Figure 9-41. Algan Vs HAZUS fragility curves comparisons. One-Story Reinforced Concrete Shear Walls: All Models





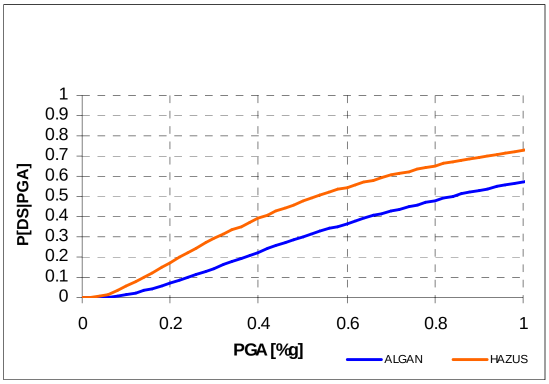
a) Minor Vs Slight Damage **b) Moderate Damage**



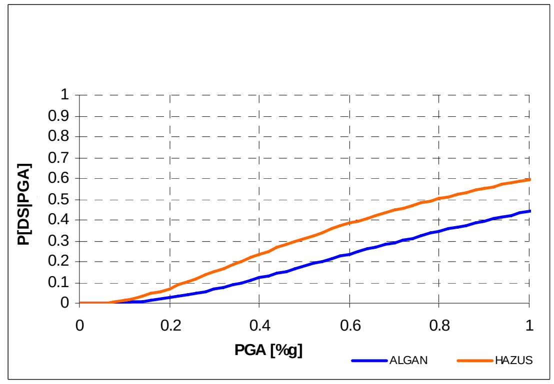


c) Substantial Vs Extensive Damage **d) Major Vs Complete Damage**

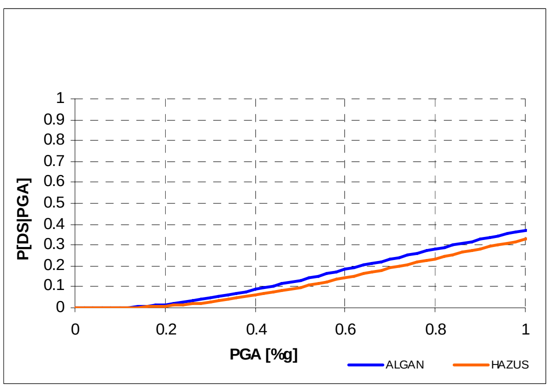
Figure 9-42. Algan Vs HAZUS fragility curves comparisons. Two-Story Reinforced Concrete Shear Walls: All Models



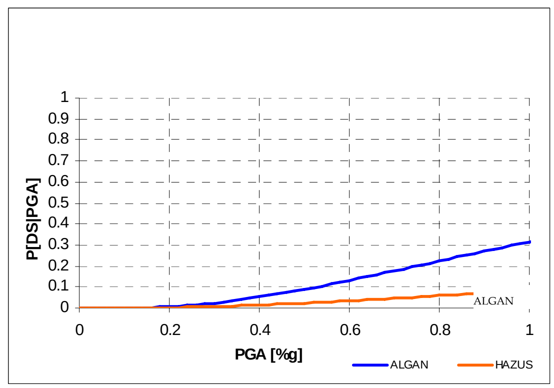
a) Minor Vs Slight Damage



b) Moderate Damage



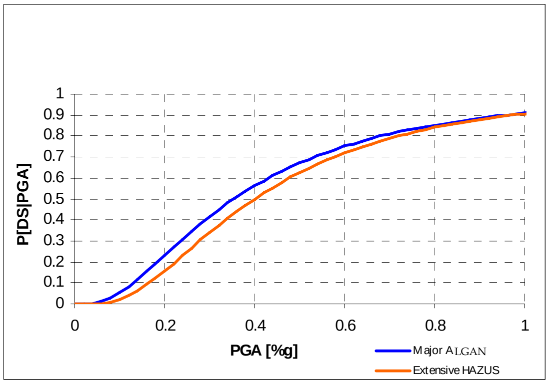
c) Substantial Vs Extensive Damage



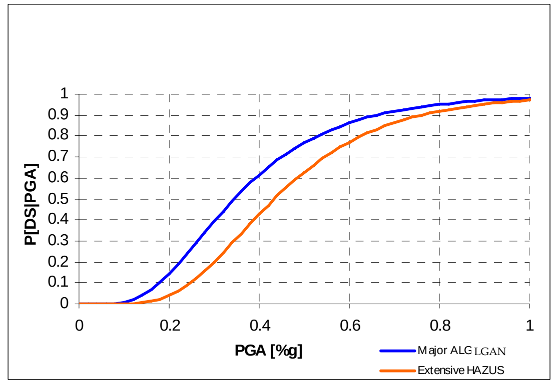
d) Major Vs Complete Damage

Figure 9-43. Algan Vs HAZUS fragility curves comparisons. Multistory Reinforced Concrete Shear Walls: All Models

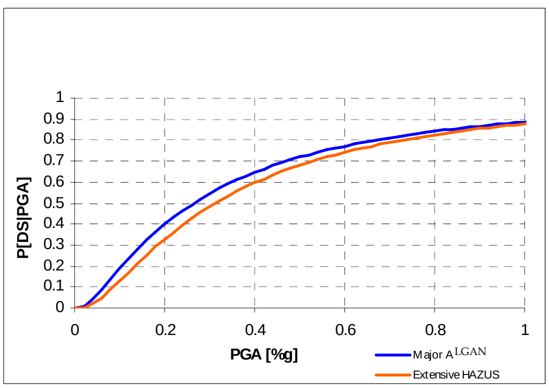
Figure 9-44 shows the excellent agreement of Algan fragility curves for Major damage state and HAZUS curve for Extensive damage state fragility. There is not a one to one relationship between Algan and HAZUS limit states. Algan Substantial damage limit is an intermediate limit between HAZUS Moderate and Extensive damage limits.



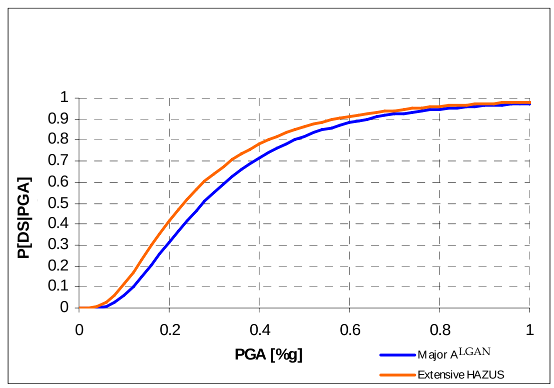
a) P1N



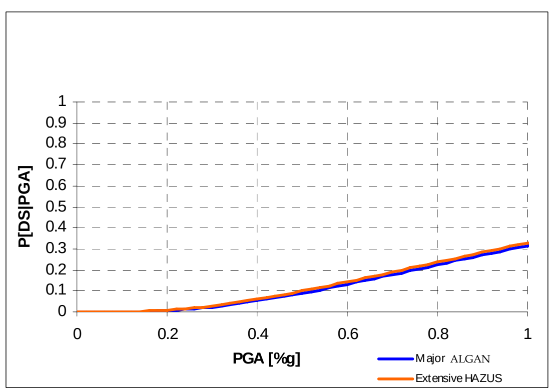
b) P2N



c) Pa1N



d) Pa2N



e)Mult

Figure 9-44. Comparisons between Algan's Major damage fragility curves and HAZUS'S Extensive damage fragility curves

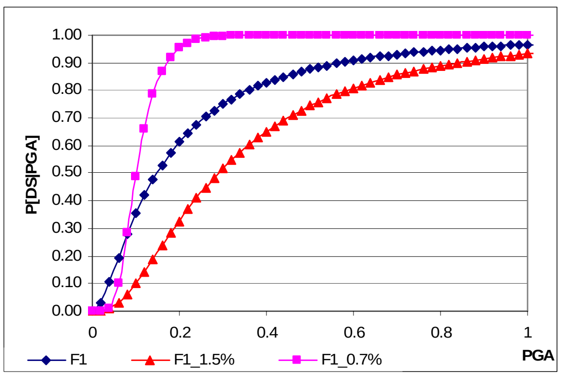
Fragility curve parameters of the more extreme damage states are particularly difficult to estimate since these levels of damage are rarely observed even in the strongest ground shaking. This fact explains the big gap between Algan Major fragility curves and HAZUS Complete fragility curves. The definition of these damages states are different, HAZUS considers complete damage as collapse and the drift limits is based on the fact that in the 1995 Kobe earthquake, the worst earthquake disaster to occur in a modern urban region, only about 10 in every 100 mid-rise commercial buildings located close to fault rupture had severe damage or collapse. Typically, the fraction of modern buildings with such damage (e.g., complete structural damage state) is much less than 10 in 100.

9.7 INFLUENCE OF COLUMN AREA TO FLOOR AREA RATIO, WALL AREA TO FLOOR AREA RATIO, AND REINFORCEMENT ON SEISMIC PERFORMANCE OF LOW RISE RESIDENTIAL BUILDINGS

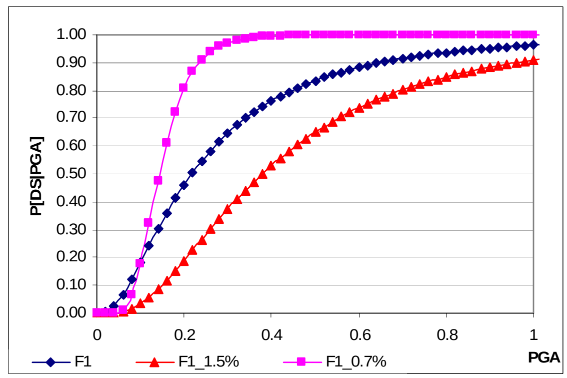
This section analyzes the influence of column or wall area to floor area of low rise residential building in the seismic performance of the models. The database of each model type was filtered to develop fragility curves for each colum or wall area to floor area ratio.

The plots legend used to name each models type are presented next: the code name is composed of four parts: The first one refers to the lateral resisting system, "F" for Frames, "W" for shear walls, the second part, a numerical one shows the number of story of the models and last a number that describe de direction of the walls or column, "S" for columns or walls oriented in the strong direction, when all population is considered only, this part is not used, the last number refers to the percentage of wall or column studied. For example: "F1S_1.5%" refers to one-story shear wall models with walls oriented in the strong direction and a percentage of columns of 1.5%, "F1" refers to the whole population of one-story frames.

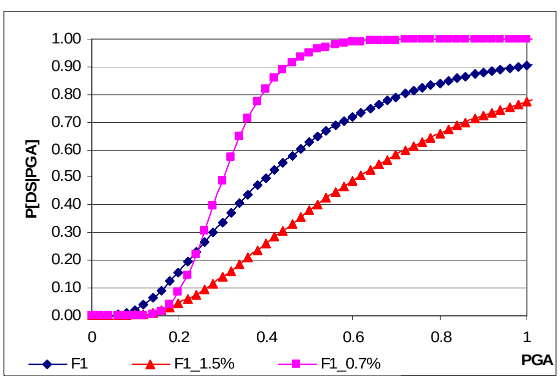
Figure 9-45 to Figure 9-52 present comparisons between each percentage of wall or columns to floor area for each case studied. For all models it can be seen that the higher the percentage of lateral resisting, the better the seismic performance, as expected. The biggest difference appears when models are studied in their strong direction. For example from Figure 9-45 it can be read that One-Story Concrete Frame Models with a percentage of column to floor area of 1.5% present a probably of 21% of reaching or exceeding Extensive Damage State when subjected to a PGA of 0.4g, while One-Story Concrete Frame Models with a percentage of column to floor area of 0.7% present a probability of reaching or exceeding Extensive Damage State when subjected to a PGA of 0.4g.



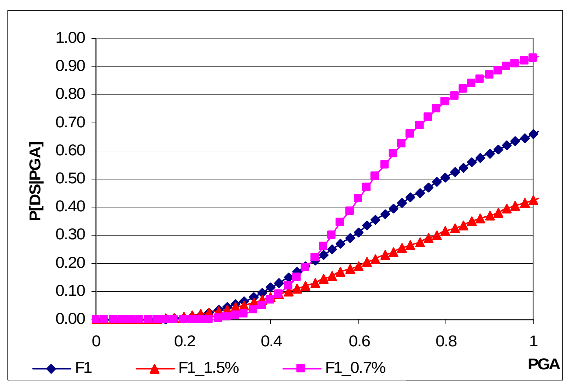
a) Slight Damage



b) Moderate Damage

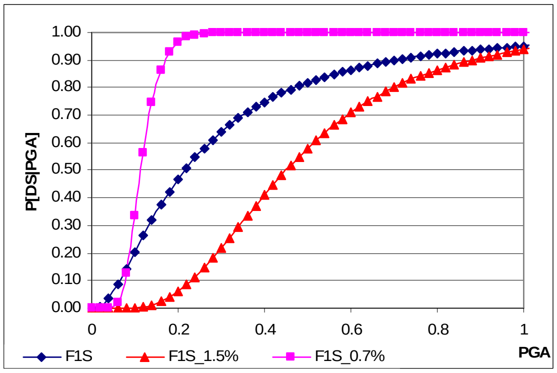


c) Extensive Damage

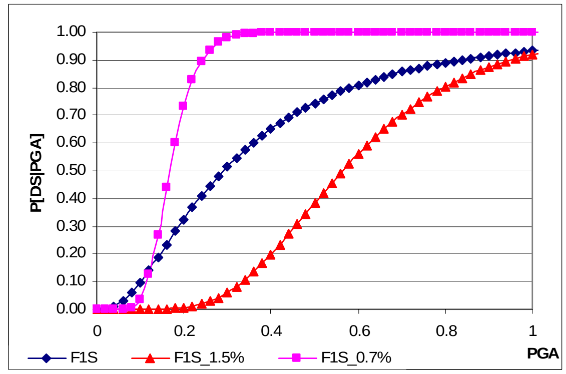


d) Complete Damage

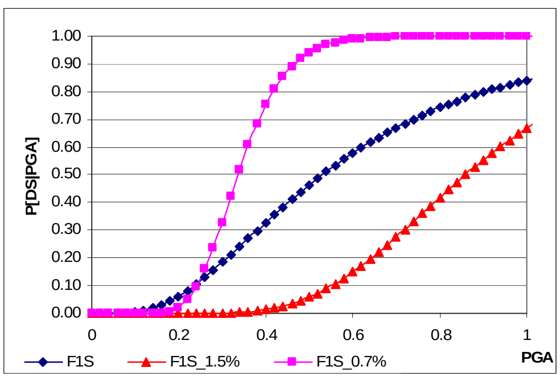
Figure 9-45. Fragility curves comparisons for different column to floor area percentage. One-Story Reinforced Concrete Frame Models: All Directions



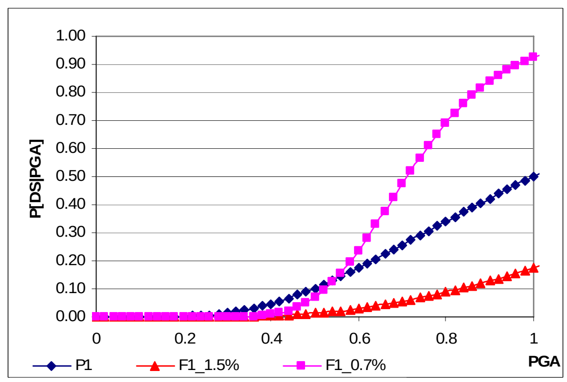
a) Slight Damage



b) Moderate Damage

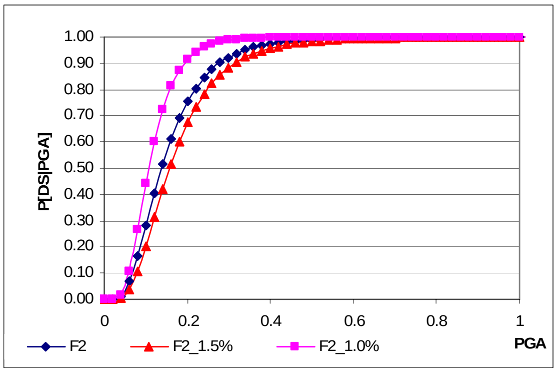


c) Extensive Damage

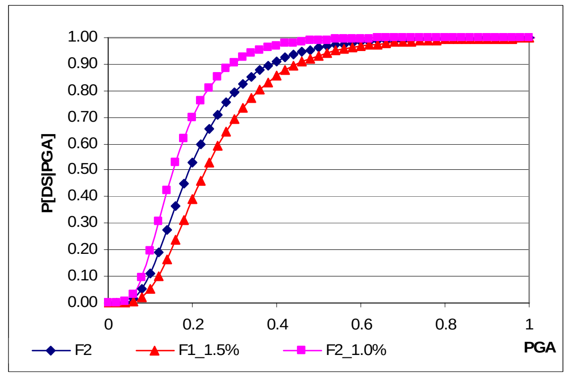


d) Complete Damage

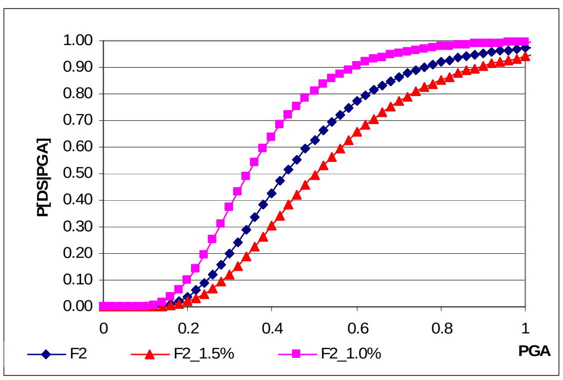
Figure 9-46. Fragility curves comparisons for different column to floor area percentage. One-Story Reinforced Concrete Frame Models: Strong Direction



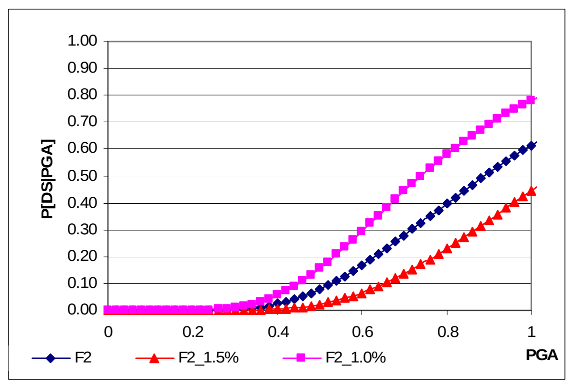
a) Slight Damage



b) Moderate Damage

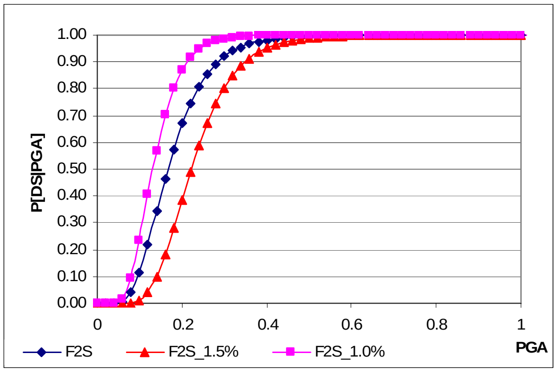


c) Extensive Damage

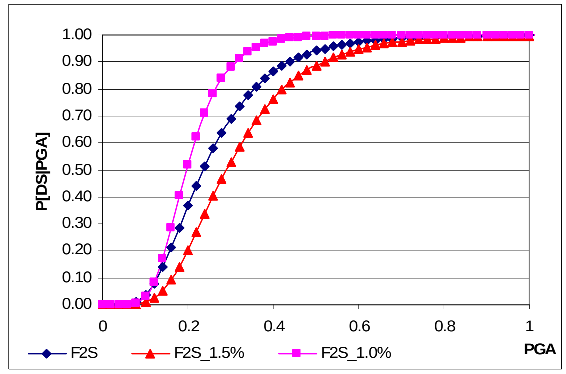


d) Complete Damage

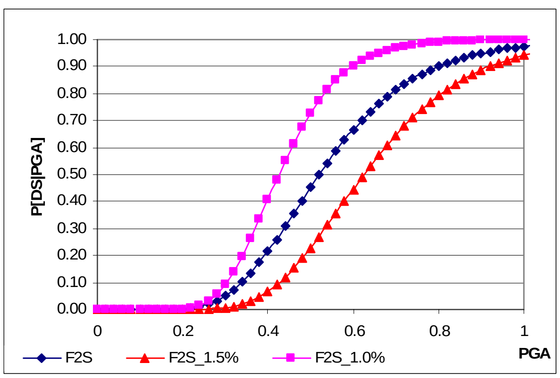
Figure 9-47. Fragility curves comparisons for different column to floor area percentage. Two-Story Reinforced Concrete Frame Models: All Directions



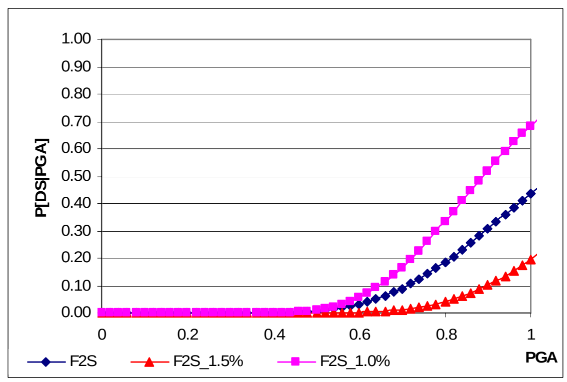
a) Slight Damage



b) Moderate Damage

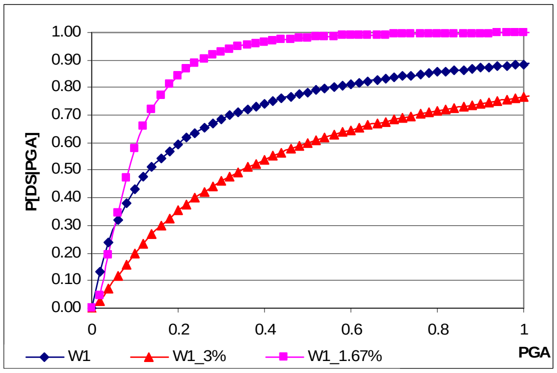


c) Extensive Damage

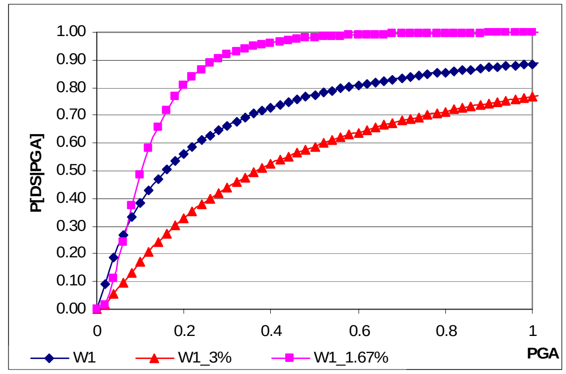


d) Complete Damage

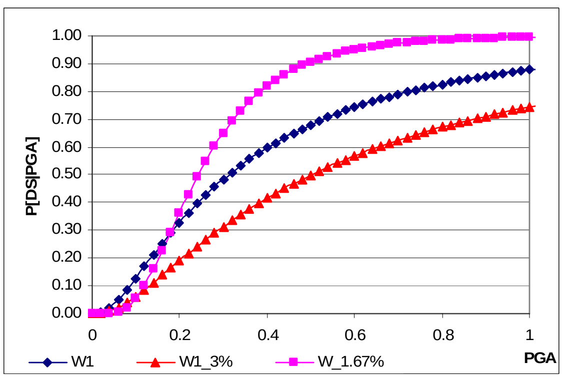
Figure 9-48. Fragility curves comparisons for different column to floor area percentage. Two-Story Reinforced Concrete Frame Models: Strong Direction



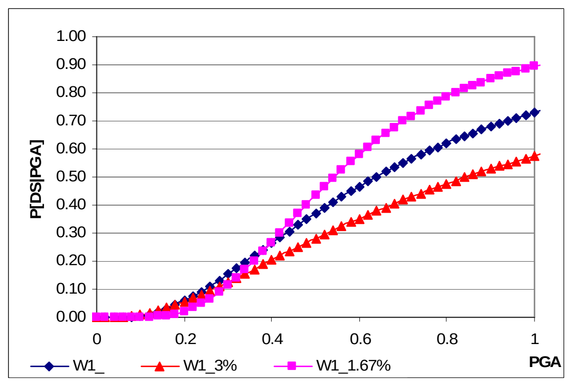
a) Slight Damage



b) Moderate Damage

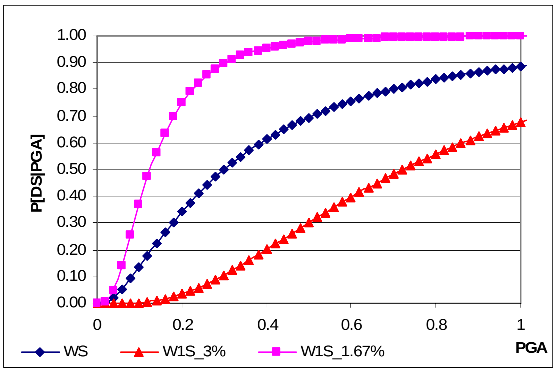


c) Extensive Damage

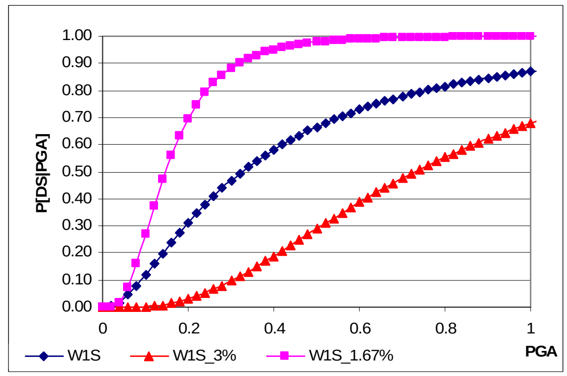


d) Complete Damage

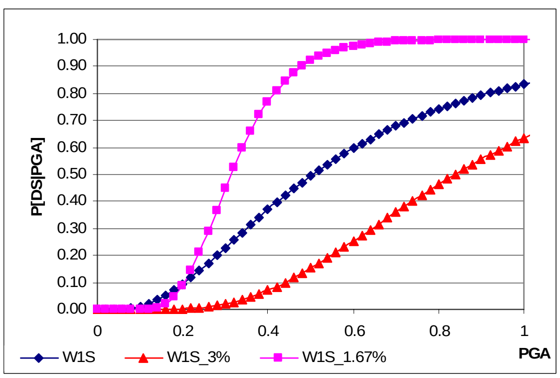
Figure 9-49. Fragility curves comparisons for different column to floor area percentage. One-Story Reinforced Concrete Shear Wall Models: All Directions



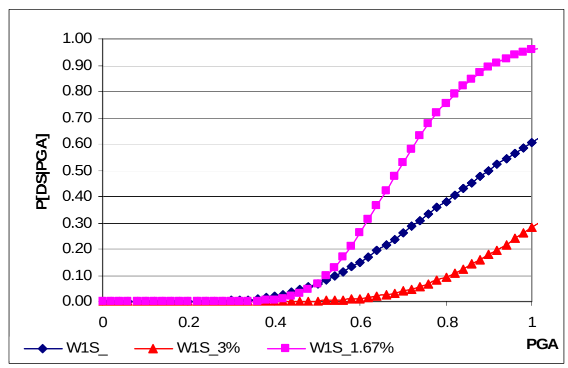
a) Slight Damage



b) Moderate Damage

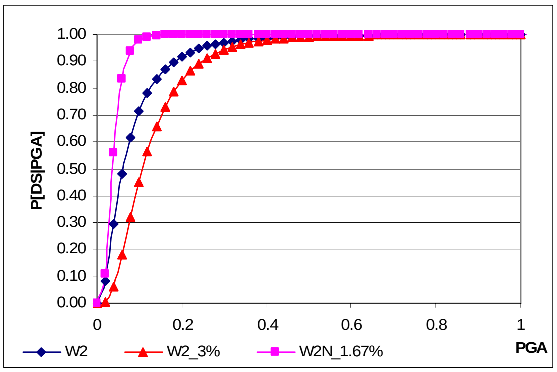


c) Extensive Damage

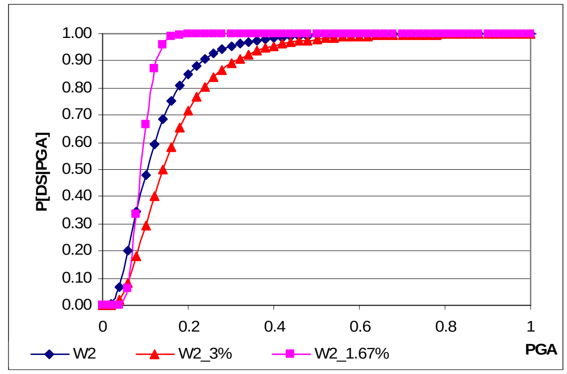


d) Complete Damage

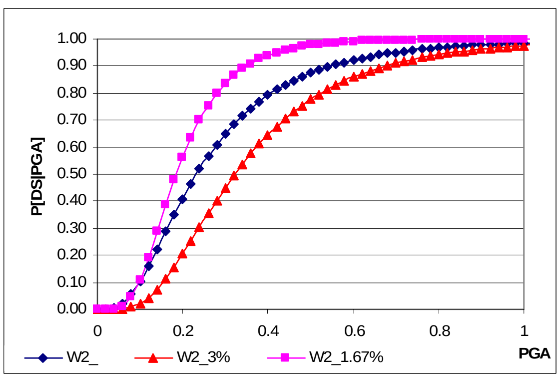
Figure 9-50. Fragility curves comparisons for different column to floor area percentage. One-Story Reinforced Concrete Shear Wall Models: Strong Direction



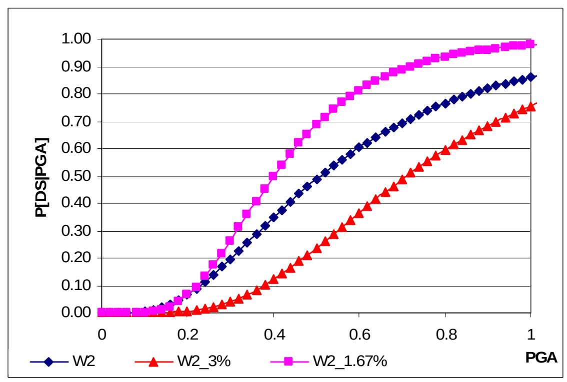
a) Slight Damage



b) Moderate Damage

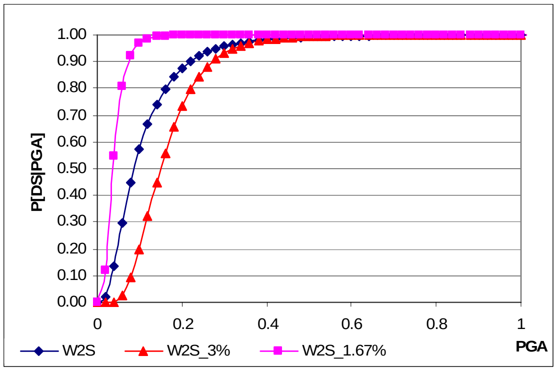


c) Extensive Damage

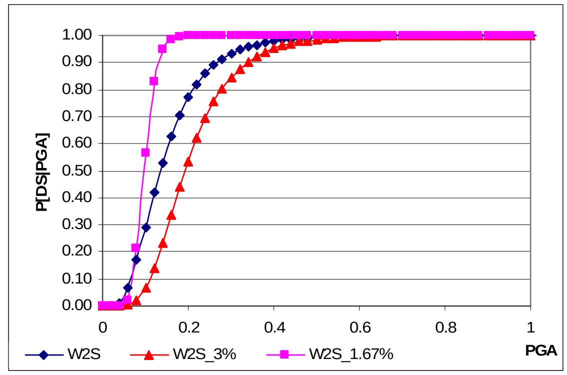


d) Complete Damage

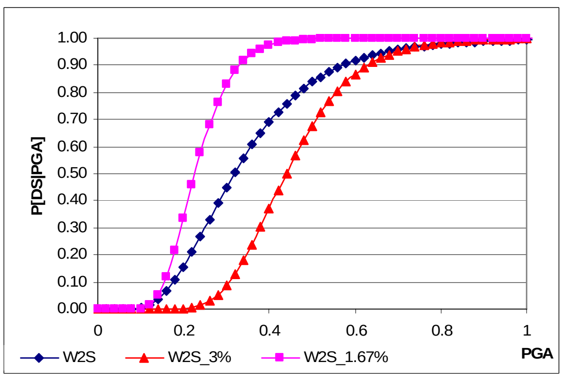
Figure 9-51. Fragility curves comparisons for different column to floor area percentage. Two-Story Reinforced Concrete Shear Wall Models: All Directions



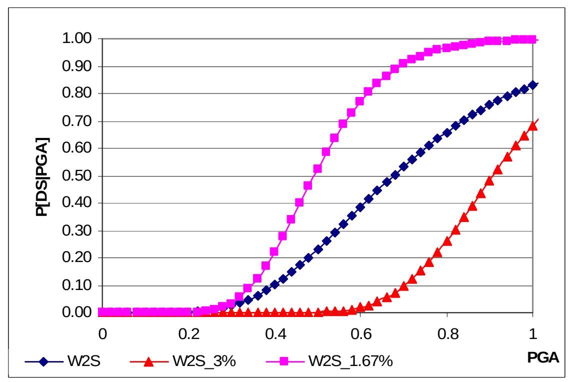
a) Slight Damage



b) Moderate Damage



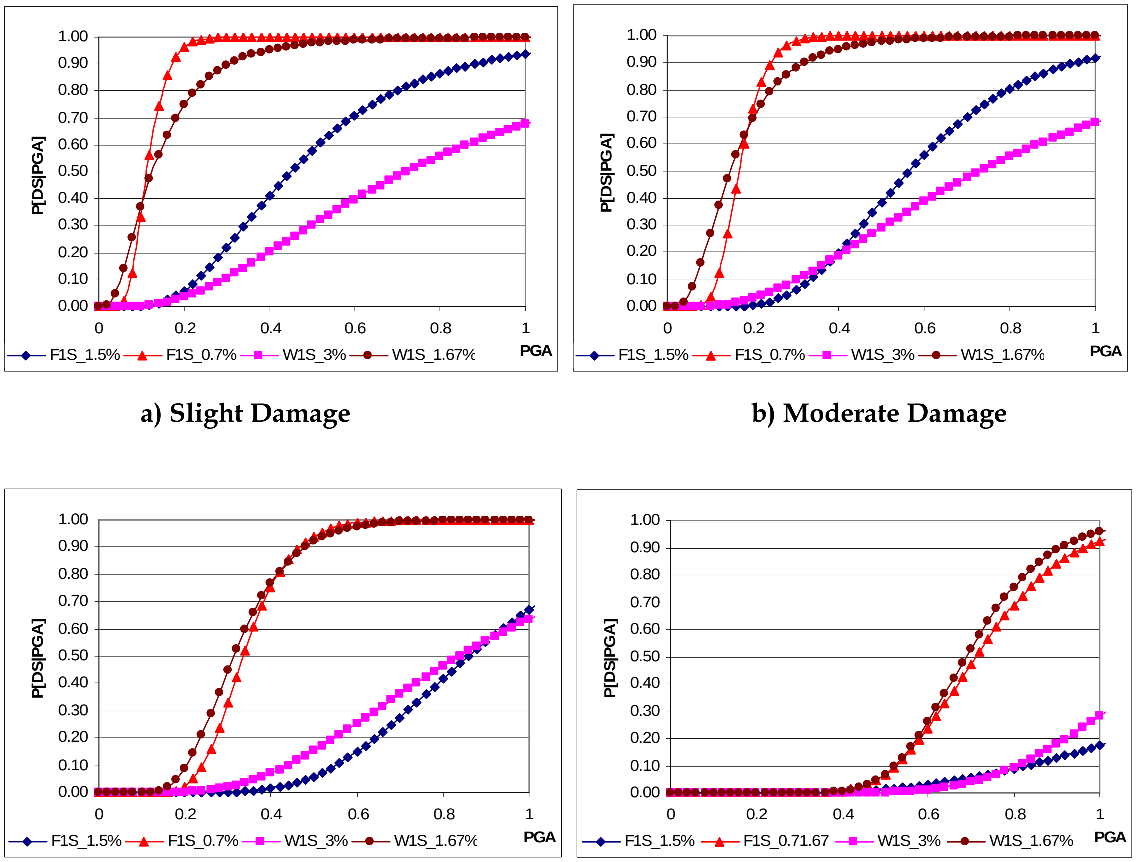
c) Extensive Damage



d) Complete Damage

Figure 9-52. Fragility curves comparisons for different column to floor area percentage. One-Story Reinforced Concrete Shear Wall Models: Strong Direction

Figure 9-53 to Figure 9-54 present comparisons between models studied in their strong direction with same number of story. Figure 9-53 show that within one-story models, shear wall models with wall to floor area percentage of 1.67% are the most susceptible to extensive damages, followed by frames with column to floor area of 0.7%, shear wall models with wall to floor area percentage of 3%, and the least susceptible to extensive damage are frames with column to floor area of 1.5%. Fragility curves for extensive and complete damage state fragility curves for wall models with wall to floor area percentage of 1.67% and frames with column to floor area of 0.7% are very similar, also, fragility curves for extensive and complete damage state fragility curves for wall models with wall to floor area percentage of 3% and frames with column to floor area of 0.7% are very similar.

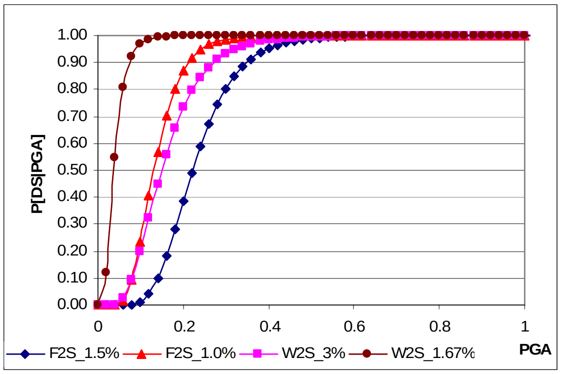


a) Slight Damage **b) Moderate Damage**

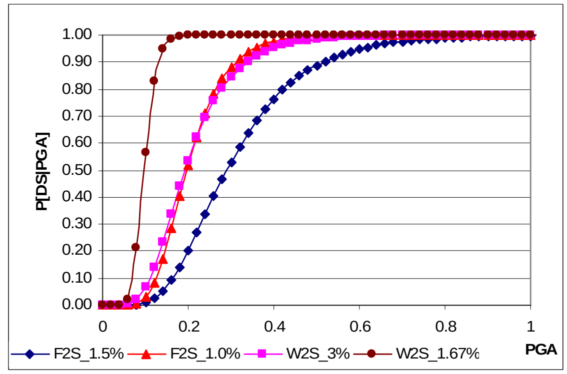
c) Extensive Damage **d) Complete Damage**

Figure 9-53. Fragility curves comparisons for different column to floor area percentage. One-Story Models: Strong Direction.

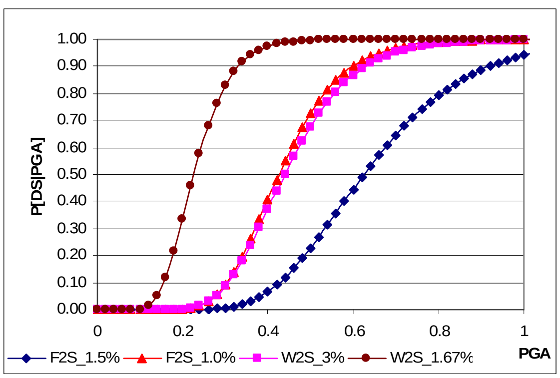
Figure 9-54 show that from two-story models, shear wall models with wall to floor area percentage of 1.67% are the most susceptible to extensive damages, followed by frames with column to floor area of 1.0%, shear wall models with wall to floor area percentage of 3%, and the least susceptible to extensive damage are frames with column to floor area of 1.5%. Fragility curves for extensive and complete damage state fragility curves for wall models with wall to floor area percentage of 3% and frames with column to floor area of 1% are very similar.



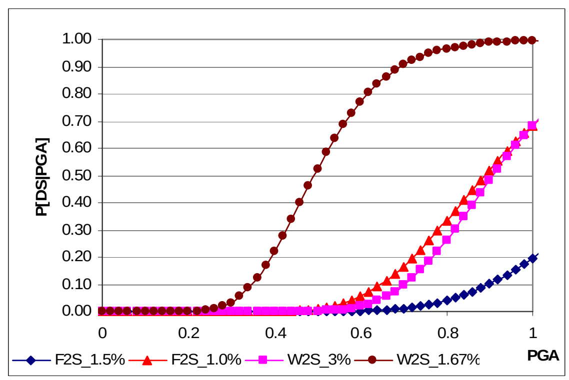
a) Slight Damage



b) Moderate Damage



c) Extensive Damage



d) Complete Damage

Figure 9-54. Fragility curves comparisons for different column to floor area percentage. Two-Story Models: Strong Direction.

Based on the damage behavior presented above, and taking in account that the geometry of frame and shear wall models are the same, and only lateral resisting system percentage and reinforcement differs, it can be inferred that the vulnerability to damage depens not only on the percentage of the area ot the lateral resisting system to the floor, but also on the reinforcement.

10 CONCLUSIONS AND FUTURE WORK

10.1 INTRODUCTION

This chapter briefly summarizes the work done throughout the investigation. It also presents the main conclusions of the research and makes some recommendation of possible works that arises from this research.

10.2 SUMMARY

Structural drawings of Puerto Rico residences were collected from the Regulations and Permits Administration in Puerto Rico, Mayagüez and San Juan offices, and also from engineering offices. The structural drawings collected were analyzed and the typical structural parameters such as concrete strength, yield strength of reinforcing bars, floor area, columns and beams dimensions, percentage of walls, slab thickness, story height, span length and reinforcement ratio were identified. With this data typical models were defined and described in Chapters 6 and 7.

After residential structural drawings were gathered, structural drawings of residential and typical models were defined. These analytical models were analyzed using the nonlinear dynamic time history method considering flexural nonlinear behavior for frames and both flexural and shear nonlinear behavior for shear walls. Both Algan's formulation (1982) and the HAZUS (2003) drift limits were used to calculate the expected damage of the models. Damage of the structures is quantified by a damage index (DI) based on the inter-story drift ratio of the structure. The damage states considered were: Minor, Moderate, Substantial and Major for Algan limits, and Slight, Moderate, Extensive and Complete, for HAZUS limit states. With this information lognormal functions expressed in the form of two parameters (log-median and log-standard deviation) were fitted and fragility curves developed as a function of PGA. A total of 13 sets of fragility curves were developed for each method and proposed in Chapter 8 and Chapter 9

10.3 CONCLUSIONS

The main objective of this work, namely the development of vulnerability curve functions for existing reinforced concrete residential buildings in Puerto Rico was accomplished. A total of 13 sets of fragility curves using both Algan and HAZUS limit states were developed. The scenarios studied were one and two-story concrete frame and wall buildings evaluated for forces in both directions independently and also taking in account both directions simultaneously, and also multistory shear wall residential buildings taking into account both directions simultaneously.

After obtaining a variety of structural drawings of reinforced concrete buildings in Puerto Rico from the Regulations and Permits Administration of Puerto Rico and also from engineering offices, typical structural characteristics of concrete residential buildings in Puerto Rico were established. The assumed properties for all the structures are:

- Material properties are the same for all cases: concrete strength of 3 ksi, and reinforcing bars with yield strength of 60 ksi.

- One and two story buildings have a typical slab thickness of 5”, minor dimension of the beams of 6”, an average of floor area of 1800 sq.ft., three spans in each direction and story heights between 8 and 12 ft. Both structural drawings with columns oriented in one direction only and also columns oriented in both directions were found for this type of residential building.

- One-story concrete frames houses have a column area to floor area ratio that varies from 0.7 to 1.5%

- Two-story reinforced frames present a percentages of columns area to floor area between 1.0% and 1.5%,

- One and two-story shear wall models have a wall area to floor area ratio between 1.67% and 3.0%.

- All multistory residential structural drawings present reinforced concrete shear walls oriented in both directions as the main system to resist earthquakes load. These buildings have a range of wall area to floor area percentages from 0.3% to 6.7% and story height that ranges from 8 to 9.5 ft.

After typical structural characteristics were identified, 72 typical one and two-story models: 18 per story per lateral resisting system, were created for analysis. In the case of multistory buildings, due to the variability of structural parameters, real structures were modeled in both directions instead of creating prototype models. A total of 26 models from 3 stories to 10 stories were obtained from the structural drawings.

The objective of analyzing the expected damage of these structures subjected to past earthquake records and local synthetics records scaled to different peak ground accelerations was also accomplished:

A nonlinear time history analysis of all models subjected to each of the earthquake ground motions described in Chapter 5 was carried out. From the analyses, the damage parameters defined by Algan (1982): maximum drift ratio for frames, and both drift ratio and tangential deviation for walls are obtained and the damage states of the models werecalculated based on Algan limit states. The damage states were also calculated using the drift limits used in HAZUS. The damage states considered in Algan method were: “Minor”, “Moderate”, “Substantial” and “Major”; and for the HAZUS method, “Slight”, “Moderate”, “Extensive”, and “Complete”.

From the fragility curves generated, the following conclusions can be drawn:

- The models with lateral resistant systems oriented in one direction are very vulnerable when loaded in their weak direction. There is more than 65% probability that all types of models reach Extensive damage state at a peak ground acceleration of 0.3g. Thus retrofitting is necessary to improve their seismic behavior.

- For PGA greater than 0.3g, the fragility curves for all one-story models are very similar, i.e. the probability of being in or exceeding each damage state is almost the same for one-tory shear wall models and one-story frames.

- For all damage-states, two-story shear walls residences were found to be more susceptible to damages than one-story shear wall residences. Comparing lateral resisting systems, shear wall models are more susceptible to Extensive and Complete damage state than frame models.

- Multistory reinforced concrete wall models behave better than other types of models analyzed. Multistory models have only around 5% of probability of reaching major damage and 10% probability of reaching or exceeding moderate damage at PGA of 0.4g using Algan limits and around 5% probability of reaching extensive damage and 20% probability of reaching or exceeding moderate damage at PGA of 0.4g using the HAZUS limits. These low probabilities of damage, even at high PGA values make multistory residential models the least vulnerable structures studied and shows that they behave well when submitted to earthquake forces.

- For all models, it was observed that the biggest difference between Algan and HAZUS fragility curves appears in the Complete damage state. Algan fragility curves for Major damage and HAZUS curves for Extensive damage match very well for all the type of structures studied. There is not a one to one relationship between Algan and HAZUS limit states. Algan Substantial limit is an intermediate limit between HAZUS Moderate and Extensive limits.

- For models with the same lateral resisting system, was confirmed that the higher the percentage of column or wall area to floor area, the better the seismic performance, as expected.

- The vulnerability to damage depends not only on percentage of column or wall area to floor area, but also on the reinforcement.

10.4 RECOMMENDATIONS FOR FUTURE WORK

It is very important to calibrate and define new limits for the damage-states, taking into account local construction practice for typical structures in Puerto Rico. Also, the overall building damage was assumed to be controlled by the maximum interstory drift ratio. It is important to study the damage distribution using experimental tests.

This investigation was focused on symmetric structures where torsional effects are neglected, and assumption in agreement with most of the structural drawings gathered. Nevertheless, some irregular structures were also found, thus it will be very valuable to study the effect of torsion and 3D effects in the fragility curves proposed.

The more data points for fragility curve generation, the more reliable the fragility curves are, thus it is important to continuously update and to enrich the damage database with more example cases, earthquake records and damage data not only analytical but also experimental results. Also in case that an actual earthquake occurs, it is recommended to carry out damage survey and calibrate the fragility curves, and to combine analytical and real damage estimates to improve the fragility curves developed in this investigation.

This investigation considered a soil type B according to the UBC (1997) classification, and the records used are based on rock. It would be interesting to study the influence of soil type, especially soft soils, in the fragility curves development: specific fragility curves for different soil types can be developed and compared. Also this investigation did not consider the contribution of the soil structure interaction. It also important to study the effect of considering this interaction in the seismic behavior of multistory models. Soil structure iteration can cause additional large increases in the natural period leading to much larger relative displacement of tall, rigid structures on softer soil as stated by Grondin (2004).

Common construction material and construction practices differ from those specified in structural drawings. It will be important to take in account variability of materials properties, such as concrete strength, yield stress of reinforcing bars, the rigid joint behavior assumed in the analyses, and the development and anchoring of reinforcing bars.

Another point that might be considered is the effect of accounting for masonry infill walls in the behavior of one and two-story concrete frames and shear wall models. As some concrete houses present infill walls in the first story and others do not, it will be useful to have both cases studied. It is predicted that the concrete blocks will help to improve the seismic behavior of frames and wall models with resisting system oriented in one direction.

11 REFERENCES

1. Algan, B. (1982). “Drift and Damage Considerations in Earthquake-Resistant Design of Reinforced Concrete Buildings”, PhD thesis, Department of Civil Engineering, University of Illinois at Urbana Champaign.

2. Ang, A.H-S., Kim, W.J., Kim, S.B. (1993). “Damage estimation of existing bridge structures”, *Structural Engineering in Hazards Mitigation: Prc. ASCE Structures Congress*, Irvine CA, Vol. 2, pp. 1137-1142.

3. ATC-13, (1985). “Earthquake Damage Evaluation Data for California”, *Report No. ATC-13*, Applied Technology Council, Redwood City, California.

4. Banon, H., Bigss, J.M., Irvine, H.M., (1981). “Seismic Damage in Reinforced Concrete Frames, *Journal of Structural Engineering,* ASCE, Vol. 107 (9), pp. 1713-1729.

5. Barbat, A., Yépez , F., Canas, J., (1996). “Damage Scenarios Simulation for Seismic Risk Assessment in Urban Zone”, *Earthquake Spectra*, Vol. 12 (3), pp. 371-393

6. Bonett, R. (2003). “Vulnerabilidad y Riesgo Sísmico de Edificios. Aplicación a Entornos Urbanos en Zonas de Amenaza Alta y Moderada.”, PhD thesis, Universidad Politécnica de Cataluña, Barcelona, Spain.

7. Bookshire, D. Chang, S., Cochrane, H., Olson, R., Rose, A., Steenson, J. (1997). “Direct and Indirect Economic Losses from Earthquake Damage”, *Earthquake Spectra*, Vol. 13 (4), pp. 683-701.

8. Chung, YS., Meyer, C., Shinozuka, M. (1987). “Seismic Damage Assessment of RC Members”, *Technical Report NCEER-87-0022*, National Center for Earthquake Engineering Research, State University of New York, Buffalo, NY.

9. Chung, YS., Meyer, C., Shinozuka, M. (1987a). "Modeling of Concrete Damage", *Structural Journal*, American Concrete Institute, Vol. 86 (3), pp. 259-271.

10. Clough, S., Penzien, J. (1975). *Dynamic of Structures*, McGraw-Hill, New York.

11. Czarnecki, R. (1973). "Earthquake Damage to Tall Buildings". *Structures Publication No. 359,* Department of Civil Engineering, Massachusetts Institute of Technology, Cambridge, MA.

12. Ellingwood, B., Rosowsky, D., Li, Y., Kim, J.H. (2004). "Fragility Assessment of Light-Frame Wood Construction subjected to Wind and Earthquake Hazards", *Journal of Structural Engineering,* ASCE, Vol. 130 (12), pp. 1021-1930.

13. Erduran, E., Yakut, A. (2004). "Drift Based Damage Functions for Reinforced Concrete Columns", *Computers and Structures*, Vol. 82, pp. 121-130.

14. FEMA 154 (2002). "Rapid Visual Screening of Buildings for Potential Seismic Hazards: A Handbook", *Earthquake Hazards Reductions Series 41*, Second Edition. Applied Technology Council, Redwood City, CA.

15. FEMA 310 (1998). "Seismic Evaluation Handbook", American Society for Civil Engineers, Washington, D.C.

16. Ferritto, J. M. (1982). "An Economic Analysis of Earthquake Design Levels", *Technical Report N-1640*, Naval Facility Engineering Service Center, Port Hueneme, California.

17. Ferritto, J. M. (1983). "An Economic Analysis of Earthquake Design Levels for New Concrete Construction", *Technical Report N-1671*, Naval Facility Engineering Service Center, Port Hueneme, California.

18. Ferritto, J. M. (1997). "Economic Analysis Procedure for Earthquake Hazard Mitigation", *Technical Report TR-2055-SHR*, Naval Facility Engineering Service Center, Port Hueneme, California.

19. Ghobarah, A. (2004). "On Drift Limits Associated with Different Damage Levels", *International Workshop on Performance-Based Seismic Design*, Department of Civil Engineering, McMaster University, Ontario, Canada, June 28 - July 1.

20. Giberson, M. F (1967). “The Response of Nonlinear Multistory Structures Subjected to Earthquake Excitation”, PhD thesis, California Institute of Technology, Pasadena, California.

21. Godoy, L.A., Sosa, E.M. (2005). “Relevantamiento de Edificios de Seis o Más Pisos en el Area Metropolitana de San Juan”, *Technical Report*, Programa de Movimiento Fuerte de Puerto Rico, Department of Civil Engineering, University of Puerto Rico, Mayagüez Campus.

22. Grondin, M. (2004). “Advance Simulation Tools. Soil Structure interaction”, *Technical Report Damage Synthesis Project DS-3*, Mid-America Earthquake Center, University of Illinois at Urbana-Champaign.

23. Guzmán, A. (1998). “Cost-Performance Criteria for Seismic Retrofitting.”, PhD. thesis, Civil Engineering Department, University of Puerto Rico, Mayagüez Campus.

24. Hassan, A. F., Sozen, M. (1997). “Seismic Vulnerability Assessment of Low-Rise Buildings in Regions with Infrequent Earthquakes”, *ACI Structural Journal*, Vol. 94 (1), pp. 31-39.

25. Hasselman, T. K., Eguchi, R., Wiggins, J., (1980). *Assessment of Damageability for Existing Buildings in a Natural Hazards Environmen*, Vol. I, Redondo Beach, California.

26. HAZUS-MH MR1 (2003). *Multi-Hazard Loss Estimation Methodology: Earthquake Model*, Department of Homeland Security, FEMA, Washington, D.C.

27. Hoedajanto, D. (1971). “ A Model to Simulate Lateral Force Response of Reinforced Concrete Structures with Cylindrical and Box Sections”, PhD thesis, Department of Civil Engineering, University of Illinois at Urbana Champaign.

28. Hueste, M. B, Wight, J. (1997). “Evaluation of a Four-Story Reinforced Concrete Building Damaged During the Northridge Earthquake”, *Earthquake Spectra*, Vol. 13 (3), pp. 387-414.

29. Hueste, M. B., Foltz, R. (2004). “Estimating Seismic Damage and Repair Cost”, *Mid-America Earthquake Center Report, Group CM-4,* Texas A&M University, College Station, TX.

30. Irizarry, J. (1999). “Design Earthquakes and Design Spectra for Puerto Rico’s Main Cities Based on Worldwide Strong Motion Records”, M.Sc. thesis, Department of Civil Engineering, University of Puerto Rico, Mayagüez Campus.

31. Karim, K., Yamazaki, F. (2003). “A Simplified Method of Constructing Fragility Curves for Highway Bridges”, *Earthquake Engineering and Structrual Dynamic,* Vol. 32 (10), pp. 1603-1623.

32. Kent, D., Park, R. A. (1971). “Flexural Member With Confined Concrete”, *Journal of the Structural Division,* ASCE, Vol. 97 (ST7), pp. 1969-1990.

33. Kim, S., Shinozuka, M. (2003). “Development of Fragility Curves of Bridges Retrofitted by Column Jacketing”, *Probabilistic Engineering Mechanics,* Vol. 19 (12), pp. 105-112.

34. Kircher, C., Nassar, A., Dustu, O., Holmes, W. (1997). “Development of Building Damage Functions for Earthquake Loss Estimation”, *Earthquake Spectra*, Vol. 13 (4), pp. 663-642.

35. Kishi, N., Yakut, A., Byeon, S. (2001). “Advanced Component Method-An Objective Methodology for the Assessment of Building Vulnerability”, *Proc. of Second Asian Symposium on Risk Assessment and Management*, pp. 88-97, Kobe University, Japan.

36. Kunreuther, H. (1999). “Insurance as an Integrating Policy Tool for Disaster Management: The Role of Public-Private Partnerships”, *Earthquake Spectra*, Vol. 15 (4), pp. 725-745.

37. Kustu, O., Miller, D. D., Brokken, S. T. (1982). ”Development of Damage Functions for High-Rise Building Components”, *JAB-10145-2*, URS/ John Blume & Associates, Report prepared for the U.S. Department of Energy, San Francisco, CA.

38. López, R. (1988). “A Numerical Model for Nonlinear Response of R/C Frame-Wall Structure”, PhD thesis, Department of Civil Engineering, University of Illinois at Urbana Champaign.

39. López, R., Suárez, L., Santiago, A, Herrera, J. C,(2001). “Verification of HAZUS Fragility Curves of Concrete and Steel Buildings for Puerto Rico”, *Technical Report*, Natural Hazards Mitigation Institute, Department of Civil Engineering, University of Puerto Rico, Mayagüez Campus.

40. Lui, Y.R., (1996). “Nonlinear Time History and Push-Over Analyses for Seismic Design and Evaluation”, PhD thesis, Department of Civil Engineering, University of Texas at Austin.

41. Matamoros, A., García, L. Browning, J. Lepage, A. (2004). “Flat-Rate Design Method for Low-and Medium-Rise Reinforced Concrete Structues”, *ACI Structural Journal*, Vol. 101 (4), pp. 435-446.

42. McCormack, T., Rad, F. (1997). “An Earthquake Loss Estimation Methodology for Buildings Based on ATC-13 and ATC-231”, *Earthquake Spectra*, Vol. 13 (4), pp. 605-621.

43. McGuire, R. (2004). *Seismic Hazard and Risk Analysis*, Earthquake Engineering Research Institute, Oakland, CA.

44. Montejo, L. (2004). “Generation and Analysis of Spectrum-Compatible Earthquake Time Histories using Wavelets”, M.Sc. thesis, Department of Civil Engineering, University of Puerto Rico, Mayagüez Campus.

45. Mork, K. J. (1992). “Stochastic Analysis of Reinforced Concrete Frames Under Seismic Excitation”, *Soil Dynamics and Earthquake Engineering*, Vol. 1 (3), pp. 145-161.

46. Newmark, N.M. (1959). “A Method of Computation for Structural Dynamics”, *Journal of Engineering Mechanics Division,* ASCE, Vol. 85 (EM3), pp. 67-94.

47. Otani, S., Sozen, MA. (1972),"Behavior of Multistory Reinforced Concrete Frames During Earthquakes”, *Structural Research Series*, No. 392, University of Illinois at Urbana-Champaign.

48. Park, Y. J., Ang, A.H-S. (1985). “Mechanistic Seismic Damage Model for Reinforced Concrete”, *Journal of Structural Engineering,* ASCE, Vol. 111 (4), pp. 722-739.

49. Park, Y. J., Ang, M., Wen Y. K. (1985). “Seismic Damage Analysis of Reinforced Concrete Buildings”, *Journal of Structural Engineering,* ASCE, Vol. 111 (4), pp. 740-757.

50. Park, Y. J., Ang, M., Wen Y. K. (1987). “Damage-Limiting Aseismic Design of Buildings”, *Earthquake Spectra*, Vol. 3 (1), pp. 1-25.

51. Rossetto, A., Elnashai, A. (2003). "Derivation of Vulnerability Functions for European-type RC Structures Based on Observational Data", *Engineering Structures,* Vol. 25 (10), pp. 1241-1263.

52. Roufaiel, M. S., Meyer, C. (1987). "Reliability of Concrete Frames Damaged by Earthquakes", *Journal of Structural Engineering,* ASCE, Vol. 113 (3), pp. 445-457.

53. Saiidi, M., Sozen, M. (1979). "Simple and Complex Models for Nonlinear Seismic Resonse of Reinforced Concrete Structures", *Structural Research Series*, No. 465, University of Illinois at Urbana-Champaign.

54. Sandi, H. (1986). "Vulnerability and Risk Analysis for Individual Structures and Systems", *Proceedings of the 8th European Conference on Earthquake Engineering*, Lisbon, Portugal, pp. 11-60.

55. Shinozuka, M., Feng, M., Kim, S. (2000). "Nonlinear Static Procedure for Fragility Curve Development", *Journal of Engineering Mechanics,* ASCE, Vol. 126 (12), pp. 1287-1295.

56. Shinozuka, M, Kim, F. Uzaua, T. Ueda, T. (2003). "Statical Analysis of Fragility Curves", *Technical Report MCEER-03-0002* , Department of Civil and Enviromental Engineering, University of Southern California.

57. Singal, A., Kiremidjian, A. (1998). "Bayesian Updating of Fragilities with Application to RC Frames", *Journal of Structural Engineering,* ASCE, Vol. 124 (8), pp. 922-929.

58. Singhal, A., Kiremidjian, A. (1996). "Method for Probabilistic Evaluation of Seismic Structural Damage", *Journal of Structural Engineering,* ASCE, Vol. 122 (12), pp. 1459-1467.

59. Stephens, J. E., Yao, J. T. P. (1987). "Damage Assessment Using Response Measurement", *Journal of Structural Engineering,* ASCE, Vol. 113 (4), pp. 787-801.

60. Uniform Building Code. (1997). International Conference of Building Officials, Whittier, Calif.

61. Valles, R. E., Reinhorn, A. M., Kunnath, S.K., Li, C., Madan, A. (1996). *IDARC-2D Version 4.0: A Computer Program for the Inelastic Damage Analysis of Building*, State University of New York at Buffalo, New York.

62. Vázquez, D., (2002). "Seismic Behavior and Retrofitting of Hillside and Hilly Terrain R/C Houses Raised on Gravity Columns", PhD thesis, Department of Civil Engineering, University of Puerto Rico, Mayagüez Campus.

63. Wang, M.L, Shah, S.P (1987). "Reinforced Concrete Hysteresis Model Based in the Damage Concept", *Earthquake Engineering and Structural Dynamics*, Vol. 15 (8), pp. 993-1033.

64. Wang, M.L, Wang, J. (1992). "Nonlinear Dynamic Analysis of Reinforced Concrete Shear Wall Structures", *Soil Dynamics and Earthquake Engineering*, Vol. 11 (5), pp. 255-268.

65. Whitman, R., Anagnos, T., Kircher, C., Lagorio, H., Lawson, R., Schneider, P. (1997). "Development of a National Earthquake Loss Estimation Methodology", *Earthquake Spectra*, Vol. 13 (4), pp. 643-661.

66. Whitman, R., Tarek, S. A., Wong, E. (1977). "Preliminary Correlations Between Earthquake Damage and Strong Ground Motion", *Structures Publication*, No. 564., MIT-CE R77-5. Department of Civil Engineering, Massachusetts Institute of Technology, Boston, Massachusetts

67. Williams, M., Sexsmith, R. (1995). "Seismic Damage Indices for Concrete Structures: A State-of-the-Art Review", *Earthquake Spectra*, Vol. 11 (2), pp. 319-349.

68. Wong, E. H. (1975). "Correlations Between Earthquake Damage and Strong Ground Motion", M.S. thesis, Department of Civil Engineering, Massachussets Institute of Technology.

69. Yépez, F., Barbat, A. H., Canas, J. A., (1994). "Riesgo, Peligrosidad y Vulnerabilidad Sísmica de Edificios de Mampostería", *Monograph IS-12*, Internacional Center for Numerical Methods in Engineering, Barcelona, Spain.

70. Yépez, F., Barbat, A. H., Canas, J.A., (1995). "Simulación de Escenarios de Daño Para Estudios de Riesgo Sísmico", *Monograph IS-14*, Internacional Center for Numerical Methods in Engineering, Barcelona, Spain.

APPENDICES

A. NONLINEAR ANALYSIS OF REINFORCED CONCRETE FRAME MODELS: DRIFT VALUES.

Table A- 1. Analysis Result: Drift Values of One-Story Concrete Frame models

	Model 1					Model 2				
	DRIFT VALUES									
PGA	Mayaguez	SanJuan	Northridge	Centro	San Salvador	Mayaguez	SanJuan	Northridge	Centro	San Salvador
0.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.1	0.0042	0.0038	0.0068	0.0030	0.0074	0.0023	0.0023	0.0023	0.0012	0.0011
0.2	0.0128	0.0074	0.0105	0.0108	0.0121	0.0079	0.0053	0.0071	0.0157	0.0151
0.3	0.0229	0.0097	0.0159	0.0222	0.0213	0.0137	0.0113	0.0112	0.0099	0.0187
0.4	0.0409	0.0134	0.0253	0.0350	0.0329	0.0233	0.0124	0.0197	0.0163	0.0196
0.5	0.0473	0.0207	0.0326	0.0425	0.0430	0.0354	0.0171	0.0243	0.0217	0.0297
0.6	0.0579	0.0345	0.0438	0.0563	0.3313	0.0563	0.0213	0.0310	0.0402	0.0419
0.7	0.0675	0.0433	0.0550	0.0679	0.0588	0.0672	0.0272	0.0405	0.0548	0.0523
0.8	0.0803	0.0507	0.0669	0.1034	0.0654	0.0726	0.0341	0.0494	0.0785	0.0638
0.9	0.0928	0.0602	0.0766	0.1255	0.0719	0.0851	0.0435	0.0589	0.0899	0.0728
1.0	0.1041	0.0657	0.0906	0.1500	0.0770	0.0957	0.0530	0.0712	0.0959	0.0818
1.1	0.1181	0.0706	0.1024	0.1735	0.0808	0.1073	0.0656	0.0807	0.1054	0.0929
1.2	0.1311	0.0749	0.1175	0.2034	0.0905	0.1225	0.0739	0.0950	0.1168	0.1018
1.3	0.1434	0.0808	0.1344	0.2356	0.1036	0.1328	0.0790	0.1065	0.1247	0.1097
1.4	0.1539	0.0858	0.1476	0.2706	0.1163	0.1435	0.0891	0.1194	0.1341	0.1176
1.5	0.1638	0.0906	0.1597	0.3043	0.1318	0.1510	0.0965	0.1309	0.1428	0.1245

	Model 3					Model 4				
	DRIFT VALUES									
PGA	Mayaguez	SanJuan	Northridge	Centro	San Salvador	Mayaguez	SanJuan	Northridge	Centro	San Salvador
0.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.1	0.0105	0.0052	0.0088	0.0114	0.0100	0.0066	0.0029	0.0041	0.0052	0.0059
0.2	0.0231	0.0082	0.0234	0.0160	0.0130	0.0176	0.0066	0.0114	0.0042	0.0083
0.3	0.0368	0.0190	0.0327	0.0374	0.0252	0.0262	0.0124	0.0020	0.0256	0.0223
0.4	0.0536	0.0312	0.0447	0.0522	0.0304	0.0359	0.0207	0.0267	0.0348	0.0268
0.5	0.0648	0.0329	0.0555	0.0699	0.0399	0.0458	0.0276	0.0367	0.0429	0.0291
0.6	0.0755	0.0521	0.0751	0.0902	0.0494	0.0498	0.0334	0.0515	0.0508	0.0404
0.7	0.0989	0.0725	0.0862	0.0548	0.0582	0.0593	0.0353	0.0595	0.0834	0.0511
0.8	0.1271	0.0940	0.0921	0.0656	0.0678	0.0708	0.0380	0.0675	0.0992	0.0545
0.9	0.1524	0.1080	0.1131	0.0741	0.0752	0.0781	0.0426	0.0756	0.1165	0.0548
1.0	0.1631	0.1285	0.1343	0.0862	0.0832	0.0829	0.0479	0.0843	0.1373	0.0605
1.1	0.1803	0.1549	0.1561	0.0978	0.0912	0.0915	0.0554	0.0923	0.1526	0.0675
1.2	0.1980	0.1798	0.1753	0.1100	0.0993	0.1011	0.0634	0.0978	0.1680	0.0735
1.3	0.2142	0.2086	0.1886	0.1203	0.1095	0.1121	0.0700	0.1030	0.1885	0.0800
1.4	0.2346	0.2387	0.2030	0.1343	0.1155	0.1237	0.0763	0.1078	0.2062	0.0868
1.5	0.2533	0.2705	0.2096	0.1431	0.1236	0.1415	0.0844	0.1144	0.2299	0.0937

Table A- 1. Continuation

	Model 5					Model 6				
	DRIFT VALUES									
PGA	Mayaguez	SanJuan	Northridge	Centro	San Salvador	Mayaguez	SanJuan	Northridge	Centro	San Salvador
0.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.1	0.0032	0.0028	0.0028	0.0021	0.0054	0.0099	0.0049	0.0006	0.0091	0.0077
0.2	0.0107	0.0059	0.0087	0.0086	0.0094	0.0214	0.0043	0.0149	0.0126	0.0118
0.3	0.0244	0.0081	0.0132	0.0180	0.0174	0.0332	0.0195	0.0287	0.0413	0.0184
0.4	0.0311	0.0110	0.0218	0.0272	0.0267	0.0490	0.0352	0.0471	0.0610	0.0253
0.5	0.0370	0.0225	0.0293	0.0361	0.0341	0.0767	0.0579	0.0490	0.0780	0.0324
0.6	0.0462	0.0306	0.0371	0.0462	0.0398	0.1032	0.0828	0.0676	0.0990	0.0394
0.7	0.0542	0.0386	0.0460	0.0580	0.0440	0.1483	0.0953	0.0852	0.0879	0.0465
0.8	0.0641	0.0450	0.0519	0.0668	0.0479	0.1968	0.1130	0.0876	0.1000	0.0538
0.9	0.0729	0.0491	0.0638	0.0745	0.0506	0.2392	0.1508	0.0802	0.1371	0.0612
1.0	0.0810	0.0542	0.0794	0.0831	0.0596	0.2710	0.1947	0.0917	0.1713	0.0716
1.1	0.0861	0.0584	0.0952	0.0903	0.0725	0.2856	0.2534	0.1076	0.1744	0.0817
1.2	0.0936	0.0606	0.1046	0.0974	0.0804	0.2940	0.3078	0.1266	0.1663	0.0926
1.3	0.1054	0.0643	0.1124	0.1053	0.0831	0.3245	0.3731	0.1432	0.1640	0.0991
1.4	0.1151	0.0660	0.1207	0.1145	0.0833	0.3499	0.4263	0.1620	0.1903	0.1037
1.5	0.1243	0.0698	0.1286	0.1219	0.0892	0.3758	0.4743	0.1876	0.2116	0.1046

	Model 7					Model 8				
	DRIFT VALUES									
PGA	Mayaguez	SanJuan	Northridge	Centro	San Salvador	Mayaguez	SanJuan	Northridge	Centro	San Salvador
0.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.1	0.0093	0.0031	0.0064	0.0074	0.0063	0.0045	0.0022	0.0037	0.0038	0.0045
0.2	0.0153	0.0149	0.0129	0.0238	0.0163	0.0159	0.0111	0.0071	0.0197	0.0125
0.3	0.0249	0.0138	0.0228	0.0230	0.0168	0.0200	0.0099	0.0150	0.0194	0.0193
0.4	0.0298	0.0194	0.0310	0.0298	0.0246	0.0288	0.0161	0.0213	0.0289	0.0227
0.5	0.0408	0.0223	0.0385	0.0379	0.0297	0.0366	0.0241	0.0285	0.0349	0.0245
0.6	0.0452	0.0242	0.0439	0.0469	0.0289	0.0422	0.0298	0.0424	0.0424	0.0323
0.7	0.0593	0.0328	0.0465	0.0733	0.0347	0.0455	0.0314	0.0508	0.0529	0.0408
0.8	0.0739	0.0406	0.0518	0.0834	0.0408	0.0581	0.0329	0.0569	0.0628	0.0413
0.9	0.0800	0.0428	0.0606	0.1142	0.0467	0.0641	0.0368	0.0628	0.0715	0.0464
1.0	0.0858	0.0477	0.0751	0.1428	0.0528	0.0674	0.0432	0.0683	0.0829	0.0522
1.1	0.0915	0.0571	0.0924	0.1454	0.0587	0.0749	0.0464	0.0752	0.0950	0.0578
1.2	0.1076	0.0720	0.1048	0.1386	0.0638	0.0835	0.0531	0.0800	0.1079	0.0637
1.3	0.1212	0.0855	0.1124	0.1366	0.0701	0.1063	0.0569	0.0862	0.1202	0.0689
1.4	0.1356	0.0968	0.1151	0.1586	0.0756	0.1265	0.0609	0.0920	0.1330	0.0746
1.5	0.1527	0.1081	0.1150	0.1764	0.0813	0.1346	0.0663	0.1000	0.1426	0.0797

Table A- 1. Continuation

	Model 9					Model 10				
	DRIFT VALUES									
PGA	Mayaguez	SanJuan	Northridge	Centro	San Salvador	Mayaguez	SanJuan	Northridge	Centro	San Salvador
0.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.1	0.0092	0.0040	0.0064	0.0075	0.0053	0.0006	0.0009	0.0004	0.0005	0.0004
0.2	0.0229	0.0123	0.0178	0.0172	0.0119	0.0015	0.0020	0.0009	0.0008	0.0006
0.3	0.0373	0.0211	0.0274	0.0358	0.0160	0.0022	0.0026	0.0019	0.0019	0.0011
0.4	0.0808	0.0473	0.0398	0.0507	0.0215	0.0056	0.0049	0.0037	0.0028	0.0017
0.5	0.1299	0.0759	0.0512	0.0526	0.0270	0.0080	0.0075	0.0092	0.0051	0.0028
0.6	0.1659	0.1070	0.0429	0.1137	0.0326	0.0111	0.0104	0.0132	0.0062	0.0051
0.7	0.2137	0.1406	0.0626	0.1491	0.0436	0.0136	0.0135	0.0162	0.2236	0.0102
0.8	0.2268	0.1334	0.1085	0.0792	0.0499	0.0172	0.0172	0.0200	0.1188	0.0182
0.9	0.2333	0.1542	0.1490	0.1146	0.0515	0.0213	0.0187	0.0233	0.1719	0.0251
1.0	0.2333	0.1499	0.1626	0.1337	0.0543	0.0224	0.0215	0.0258	0.2006	0.0314
1.1	0.2264	0.2093	0.1977	0.2011	0.0595	0.0237	0.0254	0.0301	0.3016	0.0362
1.2	0.1577	0.3880	0.1994	-	0.0649	0.0276	0.0298	0.0338	N/A	0.0421
1.3	0.1387	0.4542	0.2221	-	0.0703	0.0305	0.0333	0.0396	N/A	0.0494
1.4	0.2232	0.3667	0.2426	-	0.0750	0.0337	0.0378	0.0424	N/A	0.0576
1.5	0.3183	0.1897	0.2575	-	0.0796	0.0415	0.0385	0.0457	N/A	0.0666

	Model 11					Model 12				
	DRIFT VALUES									
PGA	Mayaguez	SanJuan	Northridge	Centro	San Salvador	Mayaguez	SanJuan	Northridge	Centro	San Salvador
0.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.1	0.0003	0.0003	0.0002	0.0002	0.0001	0.0065	0.0033	0.0046	0.0045	0.0063
0.2	0.0006	0.0030	0.0003	0.0017	0.0013	0.0275	0.0040	0.0129	0.0028	0.0041
0.3	0.0011	0.0013	0.0004	0.0006	0.0004	0.0328	0.0134	0.0261	0.0333	0.0307
0.4	0.0017	0.0023	0.0006	0.0008	0.0006	0.0468	0.0219	0.0328	0.0483	0.0392
0.5	0.0023	0.0029	0.0011	0.0014	0.0008	0.0553	0.0365	0.0510	0.0602	0.0458
0.6	0.0027	0.0047	0.0015	0.0020	0.0011	0.0694	0.0456	0.0664	0.0712	0.0520
0.7	0.0041	0.0053	0.0023	0.0078	0.0015	0.0897	0.0529	0.0786	0.0804	0.0652
0.8	0.0047	0.0067	0.0032	0.0105	0.0021	0.1019	0.0629	0.0918	0.0942	0.0781
0.9	0.0059	0.0068	0.0039	0.0131	0.0034	0.1250	0.0696	0.1027	0.1105	0.0895
1.0	0.0081	0.0081	0.0051	0.0159	0.0036	0.1439	0.0767	0.1137	0.1279	0.0996
1.1	0.0097	0.0081	0.0067	0.0172	0.0040	0.1724	0.0804	0.1246	0.1445	0.1040
1.2	0.0131	0.0093	0.0074	0.0196	0.0046	0.1963	0.0822	0.1433	0.1603	0.1084
1.3	0.0176	0.0137	0.0098	0.0231	0.0057	0.2175	0.0851	0.1577	0.1748	0.1122
1.4	0.0242	0.0154	0.0166	0.0261	0.0090	0.2374	0.0895	0.1710	0.1868	0.1168
1.5	0.0247	0.0175	0.0214	0.0292	0.0114	0.2643	0.0999	0.1816	0.1972	0.1205

Table A- 1. Continuation

	Model 13					Model 14				
	DRIFT VALUES									
PGA	Mayaguez	SanJuan	Northridge	Centro	San Salvador	Mayaguez	SanJuan	Northridge	Centro	San Salvador
0.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.1	0.0009	0.0010	0.0008	0.0007	0.0004	0.0004	0.0005	0.0003	0.0003	0.0002
0.2	0.0030	0.0005	0.0029	0.0003	0.0003	0.0009	0.0014	0.0006	0.0007	0.0006
0.3	0.0054	0.0055	0.0060	0.0033	0.0039	0.0016	0.0021	0.0011	0.0009	0.0008
0.4	0.0071	0.0078	0.0082	0.0049	0.0095	0.0026	0.0028	0.0016	0.0013	0.0011
0.5	0.0121	0.0117	0.0120	0.0077	0.0160	0.0030	0.0035	0.0025	0.0022	0.0014
0.6	0.0174	0.0148	0.0158	0.0092	0.0248	0.0063	0.0048	0.0041	0.0033	0.0018
0.7	0.0213	0.0185	0.0192	0.0643	0.0360	0.0086	0.0071	0.0084	0.0143	0.0025
0.8	0.0262	0.0199	0.0227	0.0754	0.0451	0.0101	0.0098	0.0139	0.0205	0.0038
0.9	0.0306	0.0223	0.0245	0.0884	0.0533	0.0123	0.0132	0.0164	0.0248	0.0056
1.0	0.0354	0.0222	0.0267	0.1023	0.0606	0.0157	0.0157	0.0188	0.0301	0.0085
1.1	0.0395	0.0262	0.0281	0.1156	0.0685	0.0200	0.0182	0.0218	0.0367	0.0166
1.2	0.0414	0.0287	0.0378	0.1282	0.0747	0.0246	0.0208	0.0249	0.0434	0.0264
1.3	0.0502	0.0327	0.0438	0.1399	0.0815	0.0257	0.0222	0.0279	0.0499	0.0340
1.4	0.0579	0.0348	0.0506	0.1494	0.0887	0.0281	0.0251	0.0328	0.0566	0.0402
1.5	0.0714	0.0375	0.0559	0.1578	0.0968	0.0308	0.0297	0.0369	0.0641	0.0484

	Model 15					Model 16				
	DRIFT VALUES									
PGA	Mayaguez	SanJuan	Northridge	Centro	San Salvador	Mayaguez	SanJuan	Northridge	Centro	San Salvador
0.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.1	0.0096	0.0025	0.0059	0.0072	0.0071	0.0017	0.0014	0.0017	0.0012	0.0010
0.2	0.0182	0.0014	0.0149	0.0010	0.0005	0.0037	0.0066	0.0032	0.0182	0.0160
0.3	0.0314	0.0147	0.0265	0.0304	0.0244	0.0078	0.0065	0.0075	0.0044	0.0094
0.4	0.0415	0.0207	0.0359	0.0380	0.0333	0.0118	0.0094	0.0099	0.0092	0.0182
0.5	0.0508	0.0288	0.0443	0.0477	0.0394	0.0142	0.0103	0.0133	0.0121	0.0207
0.6	0.0629	0.0345	0.0445	0.0579	0.0388	0.0224	0.0130	0.0193	0.0182	0.0222
0.7	0.0847	0.0419	0.0510	0.0642	0.0412	0.0271	0.0152	0.0235	0.0535	0.0271
0.8	0.1066	0.0558	0.0611	0.0727	0.0476	0.0356	0.0165	0.0257	0.0606	0.0316
0.9	0.1205	0.0638	0.0729	0.0829	0.0541	0.0436	0.0195	0.0288	0.0691	0.0391
1.0	0.1342	0.0675	0.0869	0.1013	0.0616	0.0498	0.0228	0.0314	0.0844	0.0462
1.1	0.1464	0.0751	0.1060	0.1215	0.0676	0.0529	0.0253	0.0351	0.1013	0.0539
1.2	0.1596	0.0889	0.1242	0.1392	0.0739	0.0566	0.0288	0.0399	0.1160	0.0605
1.3	0.1969	0.1031	0.1433	0.1576	0.0819	0.0671	0.0318	0.0430	0.1313	0.0677
1.4	0.2290	0.1129	0.1621	0.1772	0.0882	0.0809	0.0355	0.0471	0.1477	0.0748
1.5	0.2629	0.1227	0.1800	0.1957	0.0945	0.0977	0.0393	0.0543	0.1630	0.0822

Table A- 1. Continuation

	Model 17					Model 18				
	DRIFT VALUES									
PGA	Mayaguez	SanJuan	Northridge	Centro	San Salvador	Mayaguez	SanJuan	Northridge	Centro	San Salvador
0.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.1	0.0005	0.0007	0.0003	0.0004	0.0002	0.0076	0.0040	0.0054	0.0079	0.0061
0.2	0.0015	0.0094	0.0011	0.0208	0.0148	0.0179	0.0106	0.0144	0.0145	0.0129
0.3	0.0029	0.0027	0.0019	0.0019	0.0011	0.0251	0.0131	0.0193	0.0217	0.0166
0.4	0.0048	0.0047	0.0044	0.0027	0.0018	0.0434	0.0223	0.0269	0.0289	0.0231
0.5	0.0075	0.0067	0.0074	0.0036	0.0030	0.0598	0.0310	0.0355	0.0397	0.0292
0.6	0.0087	0.0096	0.0106	0.0049	0.0061	0.0632	0.0380	0.0491	0.0523	0.0335
0.7	0.0112	0.0129	0.0130	0.0236	0.0130	0.0836	0.0464	0.0637	0.0689	0.0369
0.8	0.0163	0.0152	0.0162	0.0307	0.0203	0.0949	0.0522	0.0795	0.0837	0.0414
0.9	0.0202	0.0196	0.0197	0.0412	0.0272	0.1001	0.0564	0.0812	0.1000	0.0468
1.0	0.0254	0.0215	0.0222	0.0502	0.0348	0.1178	0.0648	0.0829	0.1157	0.0522
1.1	0.0283	0.0247	0.0252	0.0594	0.0425	0.1337	0.0800	0.0984	0.1356	0.0574
1.2	0.0324	0.0268	0.0273	0.0692	0.0490	0.1464	0.0956	0.1138	0.1571	0.0630
1.3	0.0356	0.0289	0.0300	0.0772	0.0549	0.1575	0.1164	0.1284	0.1804	0.0690
1.4	0.0385	0.0277	0.0317	0.0850	0.0594	0.1686	0.1389	0.1426	0.2028	0.0748
1.5	0.0430	0.0313	0.0321	0.0925	0.0621	0.1856	0.1685	0.1558	0.2209	0.0801

Table A- 2. Analysis Result: Drift Values of Two-Story Concrete Frame models

	Model 1					Model 2				
	DRIFT VALUES									
PGA	Mayaguez	SanJuan	Northridge	Centro	San Salvador	Mayaguez	SanJuan	Northridge	Centro	San Salvador
0.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.1	0.0002	0.0002	0.0001	0.0001	0.0002	0.0007	0.0005	0.0006	0.0006	0.0004
0.2	0.0005	0.0004	0.0005	0.0003	0.0006	0.0013	0.0008	0.0008	0.0015	0.0008
0.3	0.0010	0.0008	0.0007	0.0007	0.0012	0.0026	0.0018	0.0017	0.0026	0.0011
0.4	0.0016	0.0009	0.0012	0.0011	0.0013	0.0036	0.0028	0.0032	0.0036	0.0015
0.5	0.0021	0.0011	0.0018	0.0017	0.0019	0.0050	0.0039	0.0047	0.0045	0.0018
0.6	0.0025	0.0014	0.0020	0.0024	0.0024	0.0059	0.0064	0.0067	0.0050	0.0020
0.7	0.0030	0.0017	0.0023	0.0029	0.0028	0.0091	0.0082	0.0083	0.0053	0.0022
0.8	0.0036	0.0025	0.0027	0.0032	0.0031	0.0110	0.0096	0.0096	0.0067	0.0024
0.9	0.0042	0.0033	0.0032	0.0038	0.0034	0.0135	0.0117	0.0095	0.0083	0.0037
1.0	0.0050	0.0039	0.0039	0.0048	0.0035	0.0141	0.0145	0.0090	0.0103	0.0060
1.1	0.0055	0.0046	0.0046	0.0053	0.0035	0.0151	0.0177	0.0117	0.0062	0.0082
1.2	0.0059	0.0056	0.0051	0.0061	0.0037	0.0169	0.0227	0.0128	0.0163	0.0103
1.3	0.0061	0.0055	0.0056	0.0067	0.0041	0.0181	0.0263	0.0131	0.0186	0.0111
1.4	0.0063	0.0061	0.0058	0.0069	0.0045	0.0176	0.0261	0.0136	0.0201	0.0115
1.5	0.0065	0.0069	0.0068	0.0072	0.0048	0.0167	0.0245	0.0147	0.0211	0.0120

	Model 3					Model 4				
	DRIFT VALUES									
PGA	Mayaguez	SanJuan	Northridge	Centro	San Salvador	Mayaguez	SanJuan	Northridge	Centro	San Salvador
0.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.1	0.0003	0.0001	0.0002	0.0003	0.0003	0.0005	0.0003	0.0004	0.0004	0.0003
0.2	0.0009	0.0003	0.0004	0.0007	0.0005	0.0016	0.0007	0.0009	0.0013	0.0006
0.3	0.0020	0.0004	0.0005	0.0018	0.0017	0.0022	0.0002	0.0016	0.0021	0.0012
0.4	0.0028	0.0012	0.0014	0.0023	0.0026	0.0025	0.0014	0.0026	0.0027	0.0016
0.5	0.0034	0.0015	0.0022	0.0028	0.0029	0.0029	0.0020	0.0033	0.0031	0.0020
0.6	0.0041	0.0021	0.0026	0.0036	0.0032	0.0034	0.0024	0.0038	0.0040	0.0025
0.7	0.0050	0.0028	0.0035	0.0042	0.0032	0.0041	0.0058	0.0044	0.0049	0.0029
0.8	0.0058	0.0034	0.0040	0.0051	0.0030	0.0047	0.0065	0.0052	0.0057	0.0031
0.9	0.0065	0.0044	0.0049	0.0057	0.0034	0.0056	0.0060	0.0062	0.0065	0.0036
1.0	0.0064	0.0049	0.0059	0.0065	0.0039	0.0074	0.0097	0.0092	0.0074	0.0040
1.1	0.0064	0.0056	0.0067	0.0071	0.0044	0.0102	0.0104	0.0110	0.0084	0.0044
1.2	0.0073	0.0064	0.0070	0.0076	0.0049	0.0115	0.0109	0.0122	0.0090	0.0048
1.3	0.0076	0.0065	0.0078	0.0081	0.0055	0.0124	0.0133	0.0168	0.0093	0.0053
1.4	0.0084	0.0057	0.0080	0.0085	0.0060	0.0143	0.0012	0.0178	0.0104	0.0056
1.5	0.0086	0.0071	0.0086	0.0089	0.0065	0.0176	0.0152	0.0194	0.0098	0.0059

Table A- 2. Continuation

	Model 5					Model 6				
	DRIFT VALUES									
Model GA	Mayaguez	SanJuan	Northridge	Centro	San Salvador	Mayaguez	SanJuan	Northridge	Centro	San Salvador
0.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.1	0.0025	0.0020	0.0021	0.0025	0.0050	0.0184	0.0056	0.0083	0.0094	0.0104
0.2	0.0068	0.0037	0.0058	0.0067	0.0075	0.0266	0.0117	0.0146	0.0208	0.0219
0.3	0.0123	0.0062	0.0083	0.0125	0.0117	0.0332	0.0215	0.0240	0.0375	0.0260
0.4	0.0178	0.0077	0.0108	0.0188	0.0177	0.0551	0.0282	0.0490	0.0542	0.0333
0.5	0.0328	0.0087	0.0158	0.0271	0.0250	0.0698	0.0363	0.0494	0.0615	0.0385
0.6	0.0370	0.0144	0.0233	0.0359	0.0323	0.1664	0.2032	0.1257	0.0993	0.0626
0.7	0.0442	0.0209	0.0285	0.0420	0.0384	0.1479	0.3046	0.1333	0.2192	0.0735
0.8	0.0525	0.0258	0.0340	0.0474	0.0445	0.1112	0.4612	0.1381	#	0.0840
0.9	0.0644	0.0309	0.0393	0.0524	0.0497	0.1294	0.9067	0.1580	#	0.0929
1.0	0.0753	0.0366	0.0481	0.0602	0.0564	0.1829	1.4081	0.1699	#	0.0995
1.1	0.0823	0.0426	0.0612	0.0681	0.0642	0.2253	1.8745	0.1791	#	0.1019
1.2	0.0854	0.0464	0.0745	0.0759	0.0710	0.3023	1.9533	0.1889	#	0.0961
1.3	0.0929	0.0513	0.0841	0.0830	0.0790	0.3360	0.8354	0.1950	#	0.0869
1.4	0.1034	0.0551	0.0959	0.0907	0.0853	0.3694	1.3770	0.2077	#	0.0806
1.5	0.1122	0.0628	0.1048	0.0982	0.0929	0.3636	2.1198	0.2283	#	0.0830

	Model 7					Model 8				
	DRIFT VALUES									
Model GA	Mayaguez	SanJuan	Northridge	Centro	San Salvador	Mayaguez	SanJuan	Northridge	Centro	San Salvador
0.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.1	0.0059	0.0026	0.0042	0.0052	0.0042	0.0035	0.0017	0.0028	0.0028	0.0035
0.2	0.0118	0.0056	0.0104	0.0118	0.0083	0.0081	0.0032	0.0049	0.0090	0.0083
0.3	0.0190	0.0094	0.0146	0.0167	0.0125	0.0183	0.0057	0.0097	0.0146	0.0139
0.4	0.0242	0.0150	0.0201	0.0219	0.0188	0.0223	0.0090	0.0160	0.0188	0.0181
0.5	0.0295	0.0185	0.0157	0.0260	0.0240	0.0243	0.0130	0.0194	0.0236	0.0208
0.6	0.0361	0.0218	0.0315	0.0321	0.0285	0.0288	0.0171	0.0211	0.0285	0.0247
0.7	0.0414	0.0232	0.0348	0.0387	0.0305	0.0335	0.0213	0.0282	0.0339	0.0286
0.8	0.0471	0.0233	0.0357	0.0444	0.0346	0.0398	0.0245	0.0355	0.0390	0.0322
0.9	0.0510	0.0317	0.0409	0.0504	0.0411	0.0469	0.0282	0.0412	0.0438	0.0353
1.0	0.0648	0.0416	0.0482	0.0556	0.0466	0.0542	0.0336	0.0458	0.0492	0.0418
1.1	0.0822	0.0483	0.0590	0.0615	0.0514	0.0595	0.0363	0.0518	0.0552	0.0479
1.2	0.1021	0.0537	0.0709	0.0691	0.0577	0.0648	0.0381	0.0566	0.0614	0.0551
1.3	0.1239	0.0593	0.0829	0.0749	0.0641	0.0717	0.0408	0.0621	0.0681	0.0609
1.4	0.1450	0.0630	0.0995	0.0839	0.0713	0.0787	0.0434	0.0676	0.0746	0.0690
1.5	0.1623	0.0724	0.1151	0.0911	0.0769	0.0854	0.0482	0.0738	0.0806	0.0747

Table A- 2. Continuation

	Model 9					Model 10				
	DRIFT VALUES									
PGA	Mayaguez	SanJuan	Northridge	Centro	San Salvador	Mayaguez	SanJuan	Northridge	Centro	San Salvador
0.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.1	0.0001	0.0001	0.0000	0.0001	0.0000	0.0151	0.0237	0.0081	0.0095	0.0050
0.2	0.0002	0.0002	0.0001	0.0001	0.0001	0.0302	0.0473	0.0162	0.0189	0.0099
0.3	0.0003	0.0004	0.0002	0.0002	0.0001	0.0454	0.0709	0.0244	0.0284	0.0149
0.4	0.0009	0.0006	0.0006	0.0004	0.0002	0.0604	0.0944	0.0325	0.0378	0.0198
0.5	0.0013	0.0012	0.0013	0.0007	0.0005	0.0755	0.1179	0.0406	0.0474	0.0248
0.6	0.0015	0.0016	0.0018	-	0.0012	0.0905	0.1414	0.0487	0.0568	0.0298
0.7	0.0021	0.0019	0.0023	-	0.0026	0.1054	0.1644	0.0568	0.0663	0.0347
0.8	0.0028	0.0074	0.0027	-	0.0033	0.1203	0.1872	0.0650	0.0757	0.0397
0.9	0.0034	0.0127	-	-	0.0040	0.1352	0.1878	0.0731	0.0851	0.0446
1.0	0.0052	0.0095	-	-	0.0042	0.1500	0.1884	0.0812	0.0945	0.0496
1.1	0.0125	0.0127	-	-	0.0045	0.1646	0.1885	0.0894	0.1039	0.0546
1.2	0.0197	0.0135	-	-	0.0093	0.1793	0.1875	0.0975	0.1133	0.0595
1.3	0.0245	0.0133	-	-	0.0094	0.1874	0.1874	0.1056	0.1227	0.0645
1.4	0.0234	0.0134	-	-	0.0187	0.1880	0.1878	0.1138	0.1321	0.0694
1.5	0.0254	0.0117	-	-	0.0188	0.1876	0.1883	0.1219	0.1416	0.0744

	Model 11					Model 12				
	DRIFT VALUES									
PGA	Mayaguez	SanJuan	Northridge	Centro	San Salvador	Mayaguez	SanJuan	Northridge	Centro	San Salvador
0.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.1	0.0001	0.0002	0.0001	0.0001	0.0001	0.0006	0.0002	0.0003	0.0005	0.0005
0.2	0.0004	0.0003	0.0003	0.0002	0.0004	0.0014	0.0008	0.0009	0.0013	0.0008
0.3	0.0008	0.0007	0.0007	0.0005	0.0010	0.0017	0.0014	0.0017	0.0017	0.0012
0.4	0.0012	0.0007	0.0010	0.0009	0.0011	0.0023	0.0020	0.0022	0.0022	0.0015
0.5	0.0016	0.0009	0.0014	0.0014	0.0015	0.0027	0.0026	0.0029	0.0029	0.0019
0.6	0.0020	0.0011	0.0016	0.0019	0.0020	0.0030	0.0042	0.0035	0.0037	0.0024
0.7	0.0024	0.0014	0.0019	0.0023	0.0023	0.0051	0.0048	0.0050	0.0041	0.0029
0.8	0.0029	0.0020	0.0021	0.0025	0.0025	0.0069	0.0063	0.0079	0.0045	0.0034
0.9	0.0032	0.0027	0.0025	0.0030	0.0027	0.0107	0.0077	0.0092	0.0045	0.0038
1.0	0.0039	0.0032	0.0030	0.0038	0.0028	0.0112	0.0084	0.0103	0.0055	0.0048
1.1	0.0043	0.0036	0.0035	0.0042	0.0028	0.0143	0.0098	0.0115	0.0070	0.0062
1.2	0.0045	0.0042	0.0037	0.0045	0.0030	0.0183	0.0140	0.0126	0.0077	0.0084
1.3	0.0048	0.0045	0.0041	0.0051	0.0033	0.0207	0.0167	0.0135	0.0098	0.0168
1.4	0.0048	0.0044	0.0046	0.0053	0.0036	0.0226	0.0188	0.0132	0.0112	0.0216
1.5	0.0049	0.0050	0.0052	0.0057	0.0039	0.0234	0.0211	0.0158	0.0139	0.0250

Table A- 2. Continuation

	Model 13					Model 14				
	DRIFT VALUES									
PGA	Mayaguez	SanJuan	Northridge	Centro	San Salvador	Mayaguez	SanJuan	Northridge	Centro	San Salvador
0.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.1	0.0001	0.0001	0.0001	0.0001	0.0000	0.0017	0.0007	0.0014	0.0016	0.0009
0.2	0.0002	0.0003	0.0002	0.0002	0.0001	0.0030	0.0016	0.0031	0.0032	0.0023
0.3	0.0007	0.0007	0.0010	0.0004	0.0002	0.0051	0.0038	0.0038	0.0062	0.0028
0.4	0.0014	0.0014	0.0017	0.0007	0.0007	0.0082	0.0071	0.0073	0.0082	0.0040
0.5	0.0024	0.0021	0.0024	0.0012	0.0030	0.0114	0.0105	0.0101	0.0108	0.0051
0.6	0.0042	0.0028	0.0034	0.0018	0.0043	0.0161	0.0152	0.0152	0.0133	0.0062
0.7	0.0047	0.0036	0.0038	0.0025	0.0047	0.0183	0.0176	0.0172	0.0124	0.0069
0.8	0.0062	0.0043	0.0043	0.0038	0.0049	0.0198	0.0211	0.0193	0.0147	0.0077
0.9	0.0070	0.0046	0.0051	0.0038	0.0061	0.0201	0.0327	0.0182	0.0199	0.0154
1.0	0.0090	0.0057	0.0063	0.0074	0.0076	0.0267	0.0406	0.0193	0.0272	0.0214
1.1	0.0105	0.0062	0.0066	0.0083	0.0083	0.0318	0.0429	0.0248	0.0336	0.0257
1.2	0.0103	0.0074	0.0074	0.0096	0.0093	0.0326	0.0443	0.0297	0.0333	0.0287
1.3	0.0118	0.0088	0.0080	0.0097	0.0099	0.0319	0.0408	0.0318	0.0405	0.0298
1.4	0.0117	0.0107	0.0097	0.0101	0.0105	0.0270	0.0418	0.0351	0.0445	0.0295
1.5	0.0136	0.0114	0.0117	0.0110	0.0103	0.0281	0.0514	0.0395	0.0473	0.0335

	Model 15					Model 16				
	DRIFT VALUES									
PGA	Mayaguez	SanJuan	Northridge	Centro	San Salvador	Mayaguez	SanJuan	Northridge	Centro	San Salvador
0.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.1	0.0001	0.0001	0.0000	0.0000	0.0000	0.0002	0.0003	0.0001	0.0001	0.0001
0.2	0.0001	0.0001	0.0001	0.0001	0.0000	0.0009	0.0007	0.0005	0.0004	0.0002
0.3	0.0002	0.0002	0.0001	0.0001	0.0001	0.0022	0.0023	0.0025	0.0010	0.0009
0.4	0.0002	0.0003	0.0001	0.0001	0.0001	0.0049	0.0039	0.0044	0.0029	0.0055
0.5	0.0003	0.0003	0.0002	0.0002	0.0001	0.0080	0.0055	0.0055	0.0042	0.0064
0.6	0.0003	0.0004	0.0002	0.0002	0.0002	0.0116	0.0070	0.0066	0.0078	0.0080
0.7	0.0004	0.0005	0.0003	0.0003	0.0002	0.0172	0.0076	0.0094	0.0109	0.0117
0.8	0.0005	0.0006	0.0003	0.0003	0.0003	0.0188	0.0093	0.0113	0.0147	0.0141
0.9	0.0006	0.0008	0.0004	0.0004	0.0003	0.0247	0.0130	0.0134	0.0177	0.0167
1.0	0.0008	0.0010	0.0004	0.0005	0.0004	0.0310	0.0121	0.0169	0.0193	0.0188
1.1	0.0010	0.0013	0.0004	0.0005	0.0004	0.0346	0.0222	0.0213	0.0210	0.0197
1.2	0.0012	0.0015	0.0005	0.0006	0.0004	0.0353	0.0285	0.0221	0.0259	0.0200
1.3	0.0013	0.0018	0.0006	0.0006	0.0005	0.0361	0.0318	0.0260	0.0333	0.0210
1.4	0.0015	0.0022	0.0006	0.0007	0.0005	0.0294	0.0362	0.0283	0.0347	0.0248
1.5	0.0017	0.0026	0.0007	0.0010	0.0005	0.0293	0.0368	0.0304	0.0383	0.0270

Table A- 2. Continuation

	Model 17					Model 18				
	DRIFT VALUES									
PGA	Mayaguez	SanJuan	Northridge	Centro	San Salvador	Mayaguez	SanJuan	Northridge	Centro	San Salvador
0.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002	0.0003	0.0001	0.0002	0.0001
0.2	0.0000	0.0001	0.0000	0.0000	0.0000	0.0012	0.0012	0.0013	0.0006	0.0002
0.3	0.0001	0.0001	0.0000	0.0000	0.0000	0.0034	0.0027	0.0036	0.0013	0.0033
0.4	0.0001	0.0001	0.0000	0.0001	0.0000	0.0063	0.0037	0.0045	0.0030	0.0061
0.5	0.0001	0.0010	0.0001	0.0001	0.0001	0.0085	0.0044	0.0057	0.0069	0.0067
0.6	0.0001	0.0022	0.0001	0.0001	0.0001	0.0144	0.0077	0.0080	0.0101	0.0094
0.7	0.0001	0.0020	0.0001	0.0001	0.0001	0.0176	0.0082	0.0106	0.0128	0.0126
0.8	0.0001	0.0008	0.0001	0.0001	0.0001	0.0220	0.0089	0.0127	0.0160	0.0149
0.9	0.0002	0.0041	0.0001	0.0001	0.0001	0.0252	0.0148	0.0167	0.0179	0.0163
1.0	0.0016	0.0047	0.0001	0.0001	0.0001	0.0253	0.0222	0.0185	0.0200	0.0176
1.1	0.0018	0.0055	0.0001	0.0002	0.0001	0.0315	0.0266	0.0222	0.0263	0.0183
1.2	0.0039	0.0056	0.0001	0.0002	0.0001	0.0297	0.0294	0.0249	0.0264	0.0199
1.3	0.0063	0.0078	0.0001	0.0013	0.0001	0.0258	0.0346	0.0273	0.0356	0.0234
1.4	0.0065	0.0090	0.0002	0.0041	0.0001	0.0312	0.0340	0.0282	0.0377	0.0262
1.5	0.0084	0.0070	0.0002	0.0049	0.0002	0.0291	0.0403	0.0319	0.0382	0.0288

B. NONLINEAR ANALYSIS OF REINFORCED CONCRETE SHEAR WALL MODELS: DRIFT VALUES

Table B- 1. Analysis Result: Drift Values of One-Story Concrete Shear Wall models

.

	Model 1					Model 2				
	DRIFT VALUES									
PGA	Mayaguez	SanJuan	Northridge	Centro	San Salvador	Mayaguez	SanJuan	Northridge	Centro	San Salvador
0.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.1	0.0002	0.0002	0.0001	0.0001	0.0002	0.0007	0.0005	0.0006	0.0006	0.0004
0.2	0.0005	0.0004	0.0005	0.0003	0.0006	0.0013	0.0008	0.0008	0.0015	0.0008
0.3	0.0010	0.0008	0.0007	0.0007	0.0012	0.0026	0.0018	0.0017	0.0026	0.0011
0.4	0.0016	0.0009	0.0012	0.0011	0.0013	0.0036	0.0028	0.0032	0.0036	0.0015
0.5	0.0021	0.0011	0.0018	0.0017	0.0019	0.0050	0.0039	0.0047	0.0045	0.0018
0.6	0.0025	0.0014	0.0020	0.0024	0.0024	0.0059	0.0064	0.0067	0.0050	0.0020
0.7	0.0030	0.0017	0.0023	0.0029	0.0028	0.0091	0.0082	0.0083	0.0053	0.0022
0.8	0.0036	0.0025	0.0027	0.0032	0.0031	0.0110	0.0096	0.0096	0.0067	0.0024
0.9	0.0042	0.0033	0.0032	0.0038	0.0034	0.0135	0.0117	0.0095	0.0083	0.0037
1.0	0.0050	0.0039	0.0039	0.0048	0.0035	0.0141	0.0145	0.0090	0.0103	0.0060
1.1	0.0055	0.0046	0.0046	0.0053	0.0035	0.0151	0.0177	0.0117	0.0062	0.0082
1.2	0.0059	0.0056	0.0051	0.0061	0.0037	0.0169	0.0227	0.0128	0.0163	0.0103
1.3	0.0061	0.0055	0.0056	0.0067	0.0041	0.0181	0.0263	0.0131	0.0186	0.0111
1.4	0.0063	0.0061	0.0058	0.0069	0.0045	0.0176	0.0261	0.0136	0.0201	0.0115
1.5	0.0065	0.0069	0.0068	0.0072	0.0048	0.0167	0.0245	0.0147	0.0211	0.0120

	Model 3					Model 4				
	DRIFT VALUES									
PGA	Mayaguez	SanJuan	Northridge	Centro	San Salvador	Mayaguez	SanJuan	Northridge	Centro	San Salvador
0.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.1	0.0003	0.0001	0.0002	0.0003	0.0003	0.0005	0.0003	0.0004	0.0004	0.0003
0.2	0.0009	0.0003	0.0004	0.0007	0.0005	0.0016	0.0007	0.0009	0.0013	0.0006
0.3	0.0020	0.0004	0.0005	0.0018	0.0017	0.0022	0.0002	0.0016	0.0021	0.0012
0.4	0.0028	0.0012	0.0014	0.0023	0.0026	0.0025	0.0014	0.0026	0.0027	0.0016
0.5	0.0034	0.0015	0.0022	0.0028	0.0029	0.0029	0.0020	0.0033	0.0031	0.0020
0.6	0.0041	0.0021	0.0026	0.0036	0.0032	0.0034	0.0024	0.0038	0.0040	0.0025
0.7	0.0050	0.0028	0.0035	0.0042	0.0032	0.0041	0.0058	0.0044	0.0049	0.0029
0.8	0.0058	0.0034	0.0040	0.0051	0.0030	0.0047	0.0065	0.0052	0.0057	0.0031
0.9	0.0065	0.0044	0.0049	0.0057	0.0034	0.0056	0.0060	0.0062	0.0065	0.0036
1.0	0.0064	0.0049	0.0059	0.0065	0.0039	0.0074	0.0097	0.0092	0.0074	0.0040
1.1	0.0064	0.0056	0.0067	0.0071	0.0044	0.0102	0.0104	0.0110	0.0084	0.0044
1.2	0.0073	0.0064	0.0070	0.0076	0.0049	0.0115	0.0109	0.0122	0.0090	0.0048
1.3	0.0076	0.0065	0.0078	0.0081	0.0055	0.0124	0.0133	0.0168	0.0093	0.0053
1.4	0.0084	0.0057	0.0080	0.0085	0.0060	0.0143	0.0012	0.0178	0.0104	0.0056
1.5	0.0086	0.0071	0.0086	0.0089	0.0065	0.0176	0.0152	0.0194	0.0098	0.0059

Table B- 1. Continuation

	Model 5					Model 6				
	DRIFT VALUES									
PGA	Mayaguez	SanJuan	Northridge	Centro	San Salvador	Mayaguez	SanJuan	Northridge	Centro	San Salvador
0.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.1	0.0002	0.0002	0.0002	0.0001	0.0001	0.0011	0.0006	0.0011	0.0009	0.0013
0.2	0.0004	0.0004	0.0004	0.0002	0.0003	0.0046	0.0024	0.0028	0.0032	0.0032
0.3	0.0102	0.0077	0.0078	0.0004	0.0003	0.0071	0.0051	0.0050	0.0068	0.0039
0.4	0.0108	0.0094	0.0086	0.0005	0.0005	0.0070	0.0069	0.0085	0.0092	0.0062
0.5	0.0201	0.0121	0.0135	0.0159	0.0167	0.0100	0.0132	0.0111	0.0108	0.0079
0.6	0.0225	0.0131	0.0191	0.0178	0.0124	0.0165	0.0143	0.0134	0.0151	0.0094
0.7	0.0267	0.0141	0.0231	0.0241	0.0224	0.0168	0.0205	0.0171	0.0143	0.0111
0.8	0.0334	0.0152	0.0250	0.0220	0.0239	0.0251	0.0297	0.0261	0.0150	0.0124
0.9	0.0248	0.0136	0.0290	0.0220	0.0277	0.0417	0.0297	0.0266	0.0167	0.0130
1.0	0.0252	0.0249	0.0185	0.0274	0.0206	0.0443	0.0366	0.0296	0.0189	0.0162
1.1	0.0291	0.0271	0.0200	0.0365	0.0214	0.0535	0.0481	0.0342	0.0307	0.0330
1.2	0.0315	0.0324	0.0229	0.0405	0.0233	0.0562	0.0543	0.0390	0.0454	0.0445
1.3	0.0309	0.0340	0.0260	0.0407	0.0272	0.0528	0.0571	0.0404	0.0423	0.0560
1.4	0.0338	0.0382	0.0272	0.0456	0.0243	0.0427	0.0601	0.0439	0.0510	0.0636
1.5	0.0464	0.0406	0.0442	0.0489	0.0283	0.0458	0.0657	0.0451	0.0534	0.0622

	Model 7					Model 8				
	DRIFT VALUES									
PGA	Mayaguez	SanJuan	Northridge	Centro	San Salvador	Mayaguez	SanJuan	Northridge	Centro	San Salvador
0.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.1	0.0003	0.0002	0.0002	0.0003	0.0005	0.0003	0.0003	0.0003	0.0002	0.0002
0.2	0.0008	0.0003	0.0004	0.0007	0.0008	0.0049	0.0018	0.0014	0.0004	0.0005
0.3	0.0008	0.0005	0.0007	0.0009	0.0009	0.0133	0.0120	0.0118	0.0075	0.0185
0.4	0.0008	0.0008	0.0011	0.0007	0.0007	0.0286	0.0107	0.0159	0.0185	0.0153
0.5	0.0007	0.0007	0.0010	0.0011	0.0008	0.0319	0.0085	0.0261	0.0250	0.0198
0.6	0.0008	0.0008	0.0009	0.0011	0.0008	0.0233	0.0184	0.0263	0.0306	0.0279
0.7	0.0012	0.0008	0.0009	0.0008	0.0011	0.0401	0.0290	0.0241	0.0431	0.0365
0.8	0.0008	0.0008	0.0008	0.0009	0.0012	0.0440	0.0290	0.0216	0.0516	0.0405
0.9	0.0008	0.0010	0.0007	0.0009	0.0014	0.0488	0.0354	0.0276	0.0552	0.0432
1.0	0.0008	0.0011	0.0009	0.0008	0.0012	0.0535	0.0381	0.0324	0.0608	0.0450
1.1	0.0010	0.0020	0.0007	0.0008	0.0014	0.0561	0.0425	0.0431	0.0668	0.0466
1.2	0.0010	0.0007	0.0007	0.0008	0.0013	0.0648	0.0338	0.0705	0.0714	0.0438
1.3	0.0007	0.0015	0.0008	0.0012	0.0010	0.0698	0.0424	0.0745	0.0766	0.0452
1.4	0.0008	0.0007	0.0010	0.0016	0.0010	0.0793	0.0327	0.0570	0.0791	0.0457
1.5	0.0008	0.0007	0.0009	0.0012	0.0015	0.0787	0.0394	0.0614	0.0815	0.0581

Table B- 1. Continuation

	Model 9					Model 10				
	DRIFT VALUES									
PGA	Mayaguez	SanJuan	Northridge	Centro	San Salvador	Mayaguez	SanJuan	Northridge	Centro	San Salvador
0.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.1	0.0001	0.0001	0.0000	0.0001	0.0000	0.0151	0.0237	0.0081	0.0095	0.0050
0.2	0.0002	0.0002	0.0001	0.0001	0.0001	0.0302	0.0473	0.0162	0.0189	0.0099
0.3	0.0003	0.0004	0.0002	0.0002	0.0001	0.0454	0.0709	0.0244	0.0284	0.0149
0.4	0.0009	0.0006	0.0006	0.0004	0.0002	0.0604	0.0944	0.0325	0.0378	0.0198
0.5	0.0013	0.0012	0.0013	0.0007	0.0005	0.0755	0.1179	0.0406	0.0474	0.0248
0.6	0.0015	0.0016	0.0018	0.0008	0.0012	0.0905	0.1414	0.0487	0.0568	0.0298
0.7	0.0021	0.0019	0.0023	0.0012	0.0026	0.1054	0.1644	0.0568	0.0663	0.0347
0.8	0.0028	0.0074	0.0027	0.0016	0.0033	0.1203	0.1872	0.0650	0.0757	0.0397
0.9	0.0034	0.0127	0.0032	0.0019	0.0040	0.1352	0.1878	0.0731	0.0851	0.0446
1.0	0.0052	0.0095	0.0034	0.0023	0.0042	0.1500	0.1884	0.0812	0.0945	0.0496
1.1	0.0125	0.0127	0.0035	0.0028	0.0045	0.1646	0.1885	0.0894	0.1039	0.0546
1.2	0.0197	0.0135	0.0037	0.0035	0.0093	0.1793	0.1875	0.0975	0.1133	0.0595
1.3	0.0245	0.0133	0.0040	0.0115	0.0094	0.1874	0.1874	0.1056	0.1227	0.0645
1.4	0.0234	0.0134	0.0041	0.0175	0.0187	0.1880	0.1878	0.1138	0.1321	0.0694
1.5	0.0254	0.0117	0.0124	0.0215	0.0188	0.1876	0.1883	0.1219	0.1416	0.0744

	Model 11					Model 12				
	DRIFT VALUES									
PGA	Mayaguez	SanJuan	Northridge	Centro	San Salvador	Mayaguez	SanJuan	Northridge	Centro	San Salvador
0.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.1	0.0001	0.0002	0.0001	0.0001	0.0001	0.0006	0.0002	0.0003	0.0005	0.0005
0.2	0.0004	0.0003	0.0003	0.0002	0.0004	0.0014	0.0008	0.0009	0.0013	0.0008
0.3	0.0008	0.0007	0.0007	0.0005	0.0010	0.0017	0.0014	0.0017	0.0017	0.0012
0.4	0.0012	0.0007	0.0010	0.0009	0.0011	0.0023	0.0020	0.0022	0.0022	0.0015
0.5	0.0016	0.0009	0.0014	0.0014	0.0015	0.0027	0.0026	0.0029	0.0029	0.0019
0.6	0.0020	0.0011	0.0016	0.0019	0.0020	0.0030	0.0042	0.0035	0.0037	0.0024
0.7	0.0024	0.0014	0.0019	0.0023	0.0023	0.0051	0.0048	0.0050	0.0041	0.0029
0.8	0.0029	0.0020	0.0021	0.0025	0.0025	0.0069	0.0063	0.0079	0.0045	0.0034
0.9	0.0032	0.0027	0.0025	0.0030	0.0027	0.0107	0.0077	0.0092	0.0045	0.0038
1.0	0.0039	0.0032	0.0030	0.0038	0.0028	0.0112	0.0084	0.0103	0.0055	0.0048
1.1	0.0043	0.0036	0.0035	0.0042	0.0028	0.0143	0.0098	0.0115	0.0070	0.0062
1.2	0.0045	0.0042	0.0037	0.0045	0.0030	0.0183	0.0140	0.0126	0.0077	0.0084
1.3	0.0048	0.0045	0.0041	0.0051	0.0033	0.0207	0.0167	0.0135	0.0098	0.0168
1.4	0.0048	0.0044	0.0046	0.0053	0.0036	0.0226	0.0188	0.0132	0.0112	0.0216
1.5	0.0049	0.0050	0.0052	0.0057	0.0039	0.0234	0.0211	0.0158	0.0139	0.0250

Table B- 1. Continuation

	Model 13					Model 14				
	DRIFT VALUES									
PGA	Mayaguez	SanJuan	Northridge	Centro	San Salvador	Mayaguez	SanJuan	Northridge	Centro	San Salvador
0.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.1	0.0001	0.0001	0.0001	0.0001	0.0000	0.0017	0.0007	0.0014	0.0016	0.0009
0.2	0.0002	0.0003	0.0002	0.0002	0.0001	0.0030	0.0016	0.0031	0.0032	0.0023
0.3	0.0007	0.0007	0.0010	0.0004	0.0002	0.0051	0.0038	0.0038	0.0062	0.0028
0.4	0.0014	0.0014	0.0017	0.0007	0.0007	0.0082	0.0071	0.0073	0.0082	0.0040
0.5	0.0024	0.0021	0.0024	0.0012	0.0030	0.0114	0.0105	0.0101	0.0108	0.0051
0.6	0.0042	0.0028	0.0034	0.0018	0.0043	0.0161	0.0152	0.0152	0.0133	0.0062
0.7	0.0047	0.0036	0.0038	0.0025	0.0047	0.0183	0.0176	0.0172	0.0124	0.0069
0.8	0.0062	0.0043	0.0043	0.0038	0.0049	0.0198	0.0211	0.0193	0.0147	0.0077
0.9	0.0070	0.0046	0.0051	0.0038	0.0061	0.0201	0.0327	0.0182	0.0199	0.0154
1.0	0.0090	0.0057	0.0063	0.0074	0.0076	0.0267	0.0406	0.0193	0.0272	0.0214
1.1	0.0105	0.0062	0.0066	0.0083	0.0083	0.0318	0.0429	0.0248	0.0336	0.0257
1.2	0.0103	0.0074	0.0074	0.0096	0.0093	0.0326	0.0443	0.0297	0.0333	0.0287
1.3	0.0118	0.0088	0.0080	0.0097	0.0099	0.0319	0.0408	0.0318	0.0405	0.0298
1.4	0.0117	0.0107	0.0097	0.0101	0.0105	0.0270	0.0418	0.0351	0.0445	0.0295
1.5	0.0136	0.0114	0.0117	0.0110	0.0103	0.0281	0.0514	0.0395	0.0473	0.0335

	Model 15					Model 16				
	DRIFT VALUES									
PGA	Mayaguez	SanJuan	Northridge	Centro	San Salvador	Mayaguez	SanJuan	Northridge	Centro	San Salvador
0.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.1	0.0001	0.0001	0.0000	0.0000	0.0000	0.0002	0.0003	0.0001	0.0001	0.0001
0.2	0.0001	0.0001	0.0001	0.0001	0.0000	0.0009	0.0007	0.0005	0.0004	0.0002
0.3	0.0002	0.0002	0.0001	0.0001	0.0001	0.0022	0.0023	0.0025	0.0010	0.0009
0.4	0.0002	0.0003	0.0001	0.0001	0.0001	0.0049	0.0039	0.0044	0.0029	0.0055
0.5	0.0003	0.0003	0.0002	0.0002	0.0001	0.0080	0.0055	0.0055	0.0042	0.0064
0.6	0.0003	0.0004	0.0002	0.0002	0.0002	0.0116	0.0070	0.0066	0.0078	0.0080
0.7	0.0004	0.0005	0.0003	0.0003	0.0002	0.0172	0.0076	0.0094	0.0109	0.0117
0.8	0.0005	0.0006	0.0003	0.0003	0.0003	0.0188	0.0093	0.0113	0.0147	0.0141
0.9	0.0006	0.0008	0.0004	0.0004	0.0003	0.0247	0.0130	0.0134	0.0177	0.0167
1.0	0.0008	0.0010	0.0004	0.0005	0.0004	0.0310	0.0121	0.0169	0.0193	0.0188
1.1	0.0010	0.0013	0.0004	0.0005	0.0004	0.0346	0.0222	0.0213	0.0210	0.0197
1.2	0.0012	0.0015	0.0005	0.0006	0.0004	0.0353	0.0285	0.0221	0.0259	0.0200
1.3	0.0013	0.0018	0.0006	0.0006	0.0005	0.0361	0.0318	0.0260	0.0333	0.0210
1.4	0.0015	0.0022	0.0006	0.0007	0.0005	0.0294	0.0362	0.0283	0.0347	0.0248
1.5	0.0017	0.0026	0.0007	0.0010	0.0005	0.0293	0.0368	0.0304	0.0383	0.0270

Table B- 1. Continuation

	Model 17					Model 18				
	DRIFT VALUES									
PGA	Mayaguez	SanJuan	Northridge	Centro	San Salvador	Mayaguez	SanJuan	Northridge	Centro	San Salvador
0.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002	0.0003	0.0001	0.0002	0.0001
0.2	0.0000	0.0001	0.0000	0.0000	0.0000	0.0012	0.0012	0.0013	0.0006	0.0002
0.3	0.0001	0.0001	0.0000	0.0000	0.0000	0.0034	0.0027	0.0036	0.0013	0.0033
0.4	0.0001	0.0001	0.0000	0.0001	0.0000	0.0063	0.0037	0.0045	0.0030	0.0061
0.5	0.0001	0.0010	0.0001	0.0001	0.0001	0.0085	0.0044	0.0057	0.0069	0.0067
0.6	0.0001	0.0022	0.0001	0.0001	0.0001	0.0144	0.0077	0.0080	0.0101	0.0094
0.7	0.0001	0.0020	0.0001	0.0001	0.0001	0.0176	0.0082	0.0106	0.0128	0.0126
0.8	0.0001	0.0008	0.0001	0.0001	0.0001	0.0220	0.0089	0.0127	0.0160	0.0149
0.9	0.0002	0.0041	0.0001	0.0001	0.0001	0.0252	0.0148	0.0167	0.0179	0.0163
1.0	0.0016	0.0047	0.0001	0.0001	0.0001	0.0253	0.0222	0.0185	0.0200	0.0176
1.1	0.0018	0.0055	0.0001	0.0002	0.0001	0.0315	0.0266	0.0222	0.0263	0.0183
1.2	0.0039	0.0056	0.0001	0.0002	0.0001	0.0297	0.0294	0.0249	0.0264	0.0199
1.3	0.0063	0.0078	0.0001	0.0013	0.0001	0.0258	0.0346	0.0273	0.0356	0.0234
1.4	0.0065	0.0090	0.0002	0.0041	0.0001	0.0312	0.0340	0.0282	0.0377	0.0262
1.5	0.0084	0.0070	0.0002	0.0049	0.0002	0.0291	0.0403	0.0319	0.0382	0.0288

Table B- 2. Analysis Result: Drift Values of Two-Story Concrete Shear Wall models

	Model 1					Model 2				
	DRIFT VALUES									
PGA	Mayaguez	SanJuan	Northridge	Centro	San Salvador	Mayaguez	SanJuan	Northridge	Centro	San Salvador
0.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.1	0.0050	0.0028	0.0031	0.0042	0.0052	0.0025	0.0020	0.0021	0.0010	0.0031
0.2	0.0125	0.0052	0.0083	0.0135	0.0125	0.0057	0.0051	0.0052	0.0042	0.0104
0.3	0.0301	0.0091	0.0146	0.0240	0.0208	0.0083	0.0078	0.0073	0.0104	0.0156
0.4	0.0371	0.0161	0.0260	0.0323	0.0313	0.0189	0.0092	0.0135	0.0146	0.0167
0.5	0.0437	0.0213	0.0309	0.0417	0.0375	0.0262	0.0119	0.0167	0.0208	0.0219
0.6	0.0532	0.0281	0.0482	0.0471	0.0442	0.0320	0.0146	0.0214	0.0344	0.0319
0.7	0.0635	0.0359	0.0571	0.0519	0.0515	0.0494	0.0164	0.0278	0.0479	0.0409
0.8	0.0715	0.0449	0.0599	0.0599	0.0587	0.0696	0.0203	0.0401	0.0588	0.0504
0.9	0.0772	0.0463	0.0634	0.0697	0.0662	0.0762	0.0276	0.0514	0.0696	0.0585
1.0	0.0838	0.0486	0.0681	0.0778	0.0732	0.0821	0.0367	0.0580	0.0782	0.0676
1.1	0.0940	0.0590	0.0754	0.0898	0.0842	0.0885	0.0452	0.0632	0.0873	0.0758
1.2	0.1070	0.0703	0.0844	0.1025	0.0953	0.0976	0.0496	0.0672	0.0957	0.0845
1.3	0.1200	0.0832	0.0910	0.1090	0.1064	0.1089	0.0536	0.0743	0.1049	0.0941
1.4	0.1321	0.0953	0.1038	0.1205	0.1146	0.1178	0.0579	0.0829	0.1118	0.1019
1.5	0.1491	0.0987	0.1173	0.1299	0.1268	0.1288	0.0632	0.0952	0.1192	0.1112

	Model 3					Model 4				
	DRIFT VALUES									
PGA	Mayaguez	SanJuan	Northridge	Centro	San Salvador	Mayaguez	SanJuan	Northridge	Centro	San Salvador
0.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.1	0.0112	0.0045	0.0094	0.0104	0.0094	0.0058	0.0021	0.0033	0.0063	0.0052
0.2	0.0218	0.0132	0.0188	0.0208	0.0260	0.0139	0.0056	0.0094	0.0115	0.0115
0.3	0.0361	0.0227	0.0271	0.0333	0.0323	0.0178	0.0101	0.0146	0.0188	0.0177
0.4	0.0516	0.0349	0.0448	0.0448	0.0365	0.0260	0.0138	0.0208	0.0260	0.0219
0.5	0.0658	0.0392	0.0658	0.0719	0.0469	0.0346	0.0210	0.0267	0.0344	0.0260
0.6	0.0910	0.0518	0.0920	0.0915	0.0573	0.0424	0.0283	0.0360	0.0427	0.0331
0.7	0.1083	0.0619	0.1146	0.1188	0.0671	0.0484	0.0319	0.0454	0.0497	0.0467
0.8	0.1195	0.0704	0.1317	0.1404	0.0766	0.0658	0.0308	0.0512	0.0572	0.0583
0.9	0.1297	0.0777	0.1432	0.1668	0.0867	0.0844	0.0366	0.0559	0.0652	0.0652
1.0	0.1523	0.0937	0.1629	0.1934	0.0973	0.0884	0.0445	0.0619	0.0725	0.0732
1.1	0.1817	0.1146	0.1835	0.2150	0.1078	0.0931	0.0541	0.0711	0.0806	0.0794
1.2	0.2097	0.1335	0.2053	0.2446	0.1181	0.0964	0.0614	0.0792	0.0902	0.0864
1.3	0.2393	0.1524	0.2272	0.2827	0.1288	0.0981	0.0693	0.0869	0.1004	0.0931
1.4	0.2761	0.1667	0.2472	0.3301	0.1390	0.1043	0.0704	0.0928	0.1101	0.0989
1.5	0.3157	0.1813	0.2658	0.3821	0.1490	0.1144	0.0786	0.1023	0.1187	0.1072

Table B- 2. Continuation

	Model 5					Model 6				
	DRIFT VALUES									
PGA	Mayaguez	SanJuan	Northridge	Centro	San Salvador	Mayaguez	SanJuan	Northridge	Centro	San Salvador
0.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.1	0.0025	0.0020	0.0021	0.0025	0.0050	0.0184	0.0056	0.0083	0.0094	0.0104
0.2	0.0068	0.0037	0.0058	0.0067	0.0075	0.0266	0.0117	0.0146	0.0208	0.0219
0.3	0.0123	0.0062	0.0083	0.0125	0.0117	0.0332	0.0215	0.0240	0.0375	0.0260
0.4	0.0178	0.0077	0.0108	0.0188	0.0177	0.0551	0.0282	0.0490	0.0542	0.0333
0.5	0.0328	0.0087	0.0158	0.0271	0.0250	0.0698	0.0363	0.0494	0.0615	0.0385
0.6	0.0370	0.0144	0.0233	0.0359	0.0323	0.1664	0.2032	0.1257	0.0993	0.0626
0.7	0.0442	0.0209	0.0285	0.0420	0.0384	0.1479	0.3046	0.1333	0.2192	0.0735
0.8	0.0525	0.0258	0.0340	0.0474	0.0445	0.1112	0.4612	0.1381	-	0.0840
0.9	0.0644	0.0309	0.0393	0.0524	0.0497	0.1294	0.9067	0.1580	-	0.0929
1.0	0.0753	0.0366	0.0481	0.0602	0.0564	0.1829	1.4081	0.1699	-	0.0995
1.1	0.0823	0.0426	0.0612	0.0681	0.0642	0.2253	1.8745	0.1791	-	0.1019
1.2	0.0854	0.0464	0.0745	0.0759	0.0710	0.3023	1.9533	0.1889	-	0.0961
1.3	0.0929	0.0513	0.0841	0.0830	0.0790	0.3360	0.8354	0.1950	-	0.0869
1.4	0.1034	0.0551	0.0959	0.0907	0.0853	0.3694	1.3770	0.2077	-	0.0806
1.5	0.1122	0.0628	0.1048	0.0982	0.0929	0.3636	2.1198	0.2283	-	0.0830

	Model 7					Model 8				
	DRIFT VALUES									
PGA	Mayaguez	SanJuan	Northridge	Centro	San Salvador	Mayaguez	SanJuan	Northridge	Centro	San Salvador
0.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.1	0.0059	0.0026	0.0042	0.0052	0.0042	0.0035	0.0017	0.0028	0.0028	0.0035
0.2	0.0118	0.0056	0.0104	0.0118	0.0083	0.0081	0.0032	0.0049	0.0090	0.0083
0.3	0.0190	0.0094	0.0146	0.0167	0.0125	0.0183	0.0057	0.0097	0.0146	0.0139
0.4	0.0242	0.0150	0.0201	0.0219	0.0188	0.0223	0.0090	0.0160	0.0188	0.0181
0.5	0.0295	0.0185	0.0157	0.0260	0.0240	0.0243	0.0130	0.0194	0.0236	0.0208
0.6	0.0361	0.0218	0.0315	0.0321	0.0285	0.0288	0.0171	0.0211	0.0285	0.0247
0.7	0.0414	0.0232	0.0348	0.0387	0.0305	0.0335	0.0213	0.0282	0.0339	0.0286
0.8	0.0471	0.0233	0.0357	0.0444	0.0346	0.0398	0.0245	0.0355	0.0390	0.0322
0.9	0.0510	0.0317	0.0409	0.0504	0.0411	0.0469	0.0282	0.0412	0.0438	0.0353
1.0	0.0648	0.0416	0.0482	0.0556	0.0466	0.0542	0.0336	0.0458	0.0492	0.0418
1.1	0.0822	0.0483	0.0590	0.0615	0.0514	0.0595	0.0363	0.0518	0.0552	0.0479
1.2	0.1021	0.0537	0.0709	0.0691	0.0577	0.0648	0.0381	0.0566	0.0614	0.0551
1.3	0.1239	0.0593	0.0829	0.0749	0.0641	0.0717	0.0408	0.0621	0.0681	0.0609
1.4	0.1450	0.0630	0.0995	0.0839	0.0713	0.0787	0.0434	0.0676	0.0746	0.0690
1.5	0.1623	0.0724	0.1151	0.0911	0.0769	0.0854	0.0482	0.0738	0.0806	0.0747

Table B- 2. Continuation

	Model 9					Model 10				
	DRIFT VALUES									
PGA	Mayaguez	SanJuan	Northridge	Centro	San Salvador	Mayaguez	SanJuan	Northridge	Centro	San Salvador
0.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.1	0.0130	0.0037	0.0063	0.0056	0.0063	0.0025	0.0023	0.0021	0.0010	0.0031
0.2	0.0172	0.0096	0.0115	0.0135	0.0260	0.0058	0.0048	0.0052	0.0042	0.0229
0.3	0.0330	0.0168	0.0271	0.0260	0.0156	0.0110	0.0068	0.0094	0.0094	0.0115
0.4	0.0580	0.0256	0.0542	0.0365	0.0208	0.0177	0.0086	0.0125	0.0177	0.0156
0.5	0.0724	0.0315	0.0305	0.0510	0.0260	0.0239	0.0110	0.0156	0.0260	0.0229
0.6	0.1016	1.8437	0.0551	-	0.0320	0.0372	0.0140	0.0199	0.0330	0.0297
0.7	0.2671	2.4327	0.0718	-	0.0340	0.0461	0.0171	0.0266	0.0402	0.0369
0.8	0.5434	1.2099	0.0848	-	0.0368	0.0533	0.0207	0.0335	0.0468	0.0441
0.9	1.1454	0.2274	-	-	0.0397	0.0604	0.0270	0.0387	0.0532	0.0514
1.0	2.2420	17.5903	-	-	0.0448	0.0665	0.0307	0.0447	0.0585	0.0583
1.1	3.8032	57.4970	-	-	0.0535	0.0720	0.0359	0.0511	0.0674	0.0654
1.2	5.1299	96.2274	-	-	0.0637	0.0776	0.0405	0.0582	0.0770	0.0729
1.3	6.0845	223.9771	-	-	0.0748	0.0893	0.0443	0.0652	0.0847	0.0797
1.4	6.3432	538.9052	-	-	0.0925	0.1001	0.0475	0.0726	0.0935	0.0870
1.5	6.4615	1175.1354	-	-	353565.6250	0.1098	0.0505	0.0799	0.1015	0.0938

	Model 11					Model 12				
	DRIFT VALUES									
PGA	Mayaguez	SanJuan	Northridge	Centro	San Salvador	Mayaguez	SanJuan	Northridge	Centro	San Salvador
0.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.1	0.0011	0.0013	0.0010	0.0010	0.0010	0.0068	0.0033	0.0052	0.0073	0.0052
0.2	0.0034	0.0031	0.0031	0.0021	0.0146	0.0159	0.0066	0.0135	0.0156	0.0406
0.3	0.0046	0.0049	0.0042	0.0031	0.0052	0.0252	0.0139	0.0240	0.0240	0.0271
0.4	0.0070	0.0071	0.0083	0.0052	0.0094	0.0352	0.0167	0.0260	0.0313	0.0365
0.5	0.0108	0.0089	0.0104	0.0073	0.0146	0.0406	0.0215	0.0286	0.0427	0.0406
0.6	0.0141	0.0119	0.0128	0.0095	0.0209	0.0522	0.0307	0.0362	0.0493	0.0446
0.7	0.0173	0.0138	0.0156	0.0135	0.0248	0.0618	0.0387	0.0401	0.0000	0.0482
0.8	0.0215	0.0155	0.0151	0.0158	0.0272	0.0642	0.0447	0.0453	0.0708	0.0530
0.9	0.0237	0.0168	0.0200	0.0204	0.0294	0.0728	0.0477	0.0591	0.0807	0.0571
1.0	0.0289	0.0184	0.0254	0.0237	0.0319	0.0854	0.0521	0.0705	0.0916	0.0621
1.1	0.0344	0.0219	0.0298	0.0287	0.0364	0.0994	0.0562	0.0819	0.1007	0.0679
1.2	0.0409	0.0245	0.0327	0.0371	0.0406	0.1077	0.0630	0.0944	0.1111	0.0750
1.3	0.0481	0.0268	0.0366	0.0462	0.0463	0.1248	0.0709	0.1068	0.1190	0.0809
1.4	0.0555	0.0295	0.0400	0.0552	0.0524	0.1475	0.0772	0.1207	0.1261	0.0854
1.5	0.0620	0.0321	0.0418	0.0639	0.0587	0.1687	0.0836	0.1367	0.1340	0.0900

Table B- 2. Continuation

	Model 13					Model 14				
	DRIFT VALUES									
PGA	Mayaguez	SanJuan	Northridge	Centro	San Salvador	Mayaguez	SanJuan	Northridge	Centro	San Salvador
0.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.1	0.0027	0.0021	0.0021	0.0021	0.0042	0.0014	0.0014	0.0010	0.0010	0.0010
0.2	0.0076	0.0046	0.0052	0.0063	0.0240	0.0031	0.0034	0.0042	0.0021	0.0146
0.3	0.0132	0.0056	0.0083	0.0135	0.0125	0.0062	0.0053	0.0052	0.0042	0.0083
0.4	0.0226	0.0083	0.0146	0.0198	0.0188	0.0086	0.0073	0.0075	0.0063	0.0135
0.5	0.0258	0.0113	0.0177	0.0240	0.0240	0.0118	0.0082	0.0094	0.0094	0.0146
0.6	0.0310	0.0171	0.0232	0.0286	0.0290	0.0159	0.0099	0.0138	0.0131	0.0159
0.7	0.0373	0.0220	0.0283	0.0350	0.0331	0.0217	0.0121	0.0175	0.0177	0.0217
0.8	0.0416	0.0262	0.0337	0.0407	0.0375	0.0282	0.0142	0.0197	0.0253	0.0282
0.9	0.0477	0.0295	0.0392	0.0455	0.0410	0.0326	0.0162	0.0219	0.0326	0.0326
1.0	0.0549	0.0322	0.0448	0.0506	0.0444	0.0381	0.0189	0.0250	0.0391	0.0381
1.1	0.0619	0.0359	0.0502	0.0555	0.0473	0.0480	0.0217	0.0279	0.0452	0.0480
1.2	0.0697	0.0404	0.0565	0.0609	0.0506	0.0597	0.0243	0.0328	0.0516	0.0597
1.3	0.0790	0.0431	0.0639	0.0667	0.0562	0.0696	0.0271	0.0376	0.0574	0.0696
1.4	0.0874	0.0457	0.0714	0.0731	0.0626	0.0790	0.0295	0.0429	0.0635	0.0790
1.5	0.0951	0.0495	0.0784	0.0787	0.0692	0.0875	0.0325	0.0486	0.0687	0.0875

	Model 15					Model 16				
	DRIFT VALUES									
PGA	Mayaguez	SanJuan	Northridge	Centro	San Salvador	Mayaguez	SanJuan	Northridge	Centro	San Salvador
0.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.1	0.0064	0.0027	0.0042	0.0067	0.0050	0.0033	0.0021	0.0031	0.0031	0.0042
0.2	0.0144	0.0076	0.0133	0.0133	0.0267	0.0102	0.0035	0.0052	0.0083	0.0198
0.3	0.0221	0.0113	0.0200	0.0192	0.0167	0.0133	0.0061	0.0104	0.0125	0.0125
0.4	0.0302	0.0152	0.0250	0.0275	0.0219	0.0191	0.0099	0.0135	0.0177	0.0167
0.5	0.0410	0.0245	0.0406	0.0358	0.0267	0.0230	0.0144	0.0188	0.0229	0.0198
0.6	0.0553	0.0327	0.0347	0.0432	0.0324	0.0290	0.0169	0.0237	0.0271	0.0222
0.7	0.0664	0.0361	0.0450	0.0506	0.0372	0.0356	0.0207	0.0296	0.0313	0.0251
0.8	0.0713	0.0415	0.0583	0.0576	0.0413	0.0402	0.0244	0.0365	0.0359	0.0284
0.9	0.0750	0.0544	0.0696	0.0691	0.0458	0.0452	0.0268	0.0430	0.0397	0.0342
1.0	0.0899	0.0629	0.0775	0.0816	0.0498	0.0488	0.0285	0.0482	0.0446	0.0396
1.1	0.1106	0.0711	0.0822	0.0944	0.0541	0.0522	0.0306	0.0536	0.0504	0.0440
1.2	0.1213	0.0819	0.0866	0.1086	0.0579	0.0570	0.0324	0.0585	0.0539	0.0491
1.3	0.1322	0.0909	0.0950	0.1223	0.0623	0.0607	0.0331	0.0637	0.0583	0.0518
1.4	0.1454	0.1007	0.1064	0.1400	0.0673	0.0658	0.0351	0.0678	0.0632	0.0537
1.5	0.1574	0.1108	0.1172	0.1579	0.0728	0.0729	0.0380	0.0717	0.0676	0.0553

Table B- 2. Continuation

	Model 17					Model 18				
	DRIFT VALUES									
PGA	Mayaguez	SanJuan	Northridge	Centro	San Salvador	Mayaguez	SanJuan	Northridge	Centro	San Salvador
0.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.1	0.0016	0.0016	0.0021	0.0010	0.0021	0.0067	0.0035	0.0063	0.0063	0.0042
0.2	0.0040	0.0036	0.0042	0.0031	0.0146	0.0137	0.0070	0.0125	0.0125	0.0236
0.3	0.0062	0.0052	0.0052	0.0063	0.0090	0.0216	0.0135	0.0153	0.0188	0.0132
0.4	0.0107	0.0061	0.0090	0.0090	0.0104	0.0390	0.0196	0.0257	0.0271	0.0188
0.5	0.0156	0.0073	0.0111	0.0146	0.0146	0.0450	0.0243	0.0397	0.0319	0.0236
0.6	0.0200	0.0087	0.0134	0.0204	0.0192	0.0556	0.0313	0.0538	0.0558	0.0270
0.7	0.0292	0.0106	0.0166	0.0257	0.0238	0.0669	0.0393	0.0575	0.0705	0.0309
0.8	0.0350	0.0129	0.0213	0.0297	0.0282	0.0783	0.0507	0.0638	0.0828	0.0354
0.9	0.0393	0.0155	0.0253	0.0335	0.0324	0.0889	0.0625	0.0757	0.0949	0.0404
1.0	0.0417	0.0199	0.0285	0.0375	0.0369	0.0981	0.0781	0.0862	0.1082	0.0448
1.1	0.0463	0.0239	0.0319	0.0410	0.0414	0.1065	0.0986	0.0956	0.1206	0.0498
1.2	0.0514	0.0281	0.0359	0.0454	0.0452	0.1145	0.1181	0.1047	0.1321	0.0543
1.3	0.0563	0.0322	0.0402	0.0511	0.0494	0.1234	0.1378	0.1110	0.1411	0.0592
1.4	0.0611	0.0359	0.0446	0.0567	0.0530	0.1369	0.1551	0.1157	0.1502	0.0639
1.5	0.0668	0.0391	0.0495	0.0606	0.0566	0.1488	0.1701	0.1186	0.1573	0.0685

Table B- 3. Analysis Result: Drift Values of Multistory Concrete Shear Wall models

	Model 1					Model 2				
	DRIFT VALUES									
PGA	Mayaguez	SanJuan	Northridge	Centro	San Salvador	Mayaguez	SanJuan	Northridge	Centro	San Salvador
0.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.1	0.0002	0.0002	0.0001	0.0001	0.0002	0.0007	0.0005	0.0006	0.0006	0.0004
0.2	0.0005	0.0004	0.0005	0.0003	0.0006	0.0013	0.0008	0.0008	0.0015	0.0008
0.3	0.0010	0.0008	0.0007	0.0007	0.0012	0.0026	0.0018	0.0017	0.0026	0.0011
0.4	0.0016	0.0009	0.0012	0.0011	0.0013	0.0036	0.0028	0.0032	0.0036	0.0015
0.5	0.0021	0.0011	0.0018	0.0017	0.0019	0.0050	0.0039	0.0047	0.0045	0.0018
0.6	0.0025	0.0014	0.0020	0.0024	0.0024	0.0059	0.0064	0.0067	0.0050	0.0020
0.7	0.0030	0.0017	0.0023	0.0029	0.0028	0.0091	0.0082	0.0083	0.0053	0.0022
0.8	0.0036	0.0025	0.0027	0.0032	0.0031	0.0110	0.0096	0.0096	0.0067	0.0024
0.9	0.0042	0.0033	0.0032	0.0038	0.0034	0.0135	0.0117	0.0095	0.0083	0.0037
1.0	0.0050	0.0039	0.0039	0.0048	0.0035	0.0141	0.0145	0.0090	0.0103	0.0060
1.1	0.0055	0.0046	0.0046	0.0053	0.0035	0.0151	0.0177	0.0117	0.0062	0.0082
1.2	0.0059	0.0056	0.0051	0.0061	0.0037	0.0169	0.0227	0.0128	0.0163	0.0103
1.3	0.0061	0.0055	0.0056	0.0067	0.0041	0.0181	0.0263	0.0131	0.0186	0.0111
1.4	0.0063	0.0061	0.0058	0.0069	0.0045	0.0176	0.0261	0.0136	0.0201	0.0115
1.5	0.0065	0.0069	0.0068	0.0072	0.0048	0.0167	0.0245	0.0147	0.0211	0.0120

	Model 3					Model 4				
	DRIFT VALUES									
PGA	Mayaguez	SanJuan	Northridge	Centro	San Salvador	Mayaguez	SanJuan	Northridge	Centro	San Salvador
0.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.1	0.0003	0.0001	0.0002	0.0003	0.0003	0.0005	0.0003	0.0004	0.0004	0.0003
0.2	0.0009	0.0003	0.0004	0.0007	0.0005	0.0016	0.0007	0.0009	0.0013	0.0006
0.3	0.0020	0.0004	0.0005	0.0018	0.0017	0.0022	0.0002	0.0016	0.0021	0.0012
0.4	0.0028	0.0012	0.0014	0.0023	0.0026	0.0025	0.0014	0.0026	0.0027	0.0016
0.5	0.0034	0.0015	0.0022	0.0028	0.0029	0.0029	0.0020	0.0033	0.0031	0.0020
0.6	0.0041	0.0021	0.0026	0.0036	0.0032	0.0034	0.0024	0.0038	0.0040	0.0025
0.7	0.0050	0.0028	0.0035	0.0042	0.0032	0.0041	0.0058	0.0044	0.0049	0.0029
0.8	0.0058	0.0034	0.0040	0.0051	0.0030	0.0047	0.0065	0.0052	0.0057	0.0031
0.9	0.0065	0.0044	0.0049	0.0057	0.0034	0.0056	0.0060	0.0062	0.0065	0.0036
1.0	0.0064	0.0049	0.0059	0.0065	0.0039	0.0074	0.0097	0.0092	0.0074	0.0040
1.1	0.0064	0.0056	0.0067	0.0071	0.0044	0.0102	0.0104	0.0110	0.0084	0.0044
1.2	0.0073	0.0064	0.0070	0.0076	0.0049	0.0115	0.0109	0.0122	0.0090	0.0048
1.3	0.0076	0.0065	0.0078	0.0081	0.0055	0.0124	0.0133	0.0168	0.0093	0.0053
1.4	0.0084	0.0057	0.0080	0.0085	0.0060	0.0143	0.0012	0.0178	0.0104	0.0056
1.5	0.0086	0.0071	0.0086	0.0089	0.0065	0.0176	0.0152	0.0194	0.0098	0.0059

Table B- 3. Continuation

PGA	Model 5					Model 6				
	DRIFT VALUES									
	Mayaguez	SanJuan	Northridge	Centro	San Salvador	Mayaguez	SanJuan	Northridge	Centro	San Salvador
0.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.1	0.0002	0.0002	0.0002	0.0001	0.0001	0.0011	0.0006	0.0011	0.0009	0.0013
0.2	0.0004	0.0004	0.0004	0.0002	0.0003	0.0046	0.0024	0.0028	0.0032	0.0032
0.3	0.0102	0.0077	0.0078	0.0004	0.0003	0.0071	0.0051	0.0050	0.0068	0.0039
0.4	0.0108	0.0094	0.0086	0.0005	0.0005	0.0070	0.0069	0.0085	0.0092	0.0062
0.5	0.0201	0.0121	0.0135	0.0159	0.0167	0.0100	0.0132	0.0111	0.0108	0.0079
0.6	0.0225	0.0131	0.0191	0.0178	0.0124	0.0165	0.0143	0.0134	0.0151	0.0094
0.7	0.0267	0.0141	0.0231	0.0241	0.0224	0.0168	0.0205	0.0171	0.0143	0.0111
0.8	0.0334	0.0152	0.0250	0.0220	0.0239	0.0251	0.0297	0.0261	0.0150	0.0124
0.9	0.0248	0.0136	0.0290	0.0220	0.0277	0.0417	0.0297	0.0266	0.0167	0.0130
1.0	0.0252	0.0249	0.0185	0.0274	0.0206	0.0443	0.0366	0.0296	0.0189	0.0162
1.1	0.0291	0.0271	0.0200	0.0365	0.0214	0.0535	0.0481	0.0342	0.0307	0.0330
1.2	0.0315	0.0324	0.0229	0.0405	0.0233	0.0562	0.0543	0.0390	0.0454	0.0445
1.3	0.0309	0.0340	0.0260	0.0407	0.0272	0.0528	0.0571	0.0404	0.0423	0.0560
1.4	0.0338	0.0382	0.0272	0.0456	0.0243	0.0427	0.0601	0.0439	0.0510	0.0636
1.5	0.0464	0.0406	0.0442	0.0489	0.0283	0.0458	0.0657	0.0451	0.0534	0.0622

PGA	Model 7					Model 8				
	DRIFT VALUES									
	Mayaguez	SanJuan	Northridge	Centro	San Salvador	Mayaguez	SanJuan	Northridge	Centro	San Salvador
0.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.1	0.0003	0.0002	0.0002	0.0003	0.0005	0.0003	0.0003	0.0003	0.0002	0.0002
0.2	0.0008	0.0003	0.0004	0.0007	0.0008	0.0049	0.0018	0.0014	0.0004	0.0005
0.3	0.0008	0.0005	0.0007	0.0009	0.0009	0.0133	0.0120	0.0118	0.0075	0.0185
0.4	0.0008	0.0008	0.0011	0.0007	0.0007	0.0286	0.0107	0.0159	0.0185	0.0153
0.5	0.0007	0.0007	0.0010	0.0011	0.0008	0.0319	0.0085	0.0261	0.0250	0.0198
0.6	0.0008	0.0008	0.0009	0.0011	0.0008	0.0233	0.0184	0.0263	0.0306	0.0279
0.7	0.0012	0.0008	0.0009	0.0008	0.0011	0.0401	0.0290	0.0241	0.0431	0.0365
0.8	0.0008	0.0008	0.0008	0.0009	0.0012	0.0440	0.0290	0.0216	0.0516	0.0405
0.9	0.0008	0.0010	0.0007	0.0009	0.0014	0.0488	0.0354	0.0276	0.0552	0.0432
1.0	0.0008	0.0011	0.0009	0.0008	0.0012	0.0535	0.0381	0.0324	0.0608	0.0450
1.1	0.0010	0.0020	0.0007	0.0008	0.0014	0.0561	0.0425	0.0431	0.0668	0.0466
1.2	0.0010	0.0007	0.0007	0.0008	0.0013	0.0648	0.0338	0.0705	0.0714	0.0438
1.3	0.0007	0.0015	0.0008	0.0012	0.0010	0.0698	0.0424	0.0745	0.0766	0.0452
1.4	0.0008	0.0007	0.0010	0.0016	0.0010	0.0793	0.0327	0.0570	0.0791	0.0457
1.5	0.0008	0.0007	0.0009	0.0012	0.0015	0.0787	0.0394	0.0614	0.0815	0.0581

Table B- 3. Continuation

	Model 9					Model 10				
	DRIFT VALUES									
PGA	Mayaguez	SanJuan	Northridge	Centro	San Salvador	Mayaguez	SanJuan	Northridge	Centro	San Salvador
0.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.1	0.0001	0.0001	0.0000	0.0001	0.0000	0.0151	0.0237	0.0081	0.0095	0.0050
0.2	0.0002	0.0002	0.0001	0.0001	0.0001	0.0302	0.0473	0.0162	0.0189	0.0099
0.3	0.0003	0.0004	0.0002	0.0002	0.0001	0.0454	0.0709	0.0244	0.0284	0.0149
0.4	0.0009	0.0006	0.0006	0.0004	0.0002	0.0604	0.0944	0.0325	0.0378	0.0198
0.5	0.0013	0.0012	0.0013	0.0007	0.0005	0.0755	0.1179	0.0406	0.0474	0.0248
0.6	0.0015	0.0016	0.0018	0.0008	0.0012	0.0905	0.1414	0.0487	0.0568	0.0298
0.7	0.0021	0.0019	0.0023	0.0012	0.0026	0.1054	0.1644	0.0568	0.0663	0.0347
0.8	0.0028	0.0074	0.0027	0.0016	0.0033	0.1203	0.1872	0.0650	0.0757	0.0397
0.9	0.0034	0.0127	0.0032	0.0019	0.0040	0.1352	0.1878	0.0731	0.0851	0.0446
1.0	0.0052	0.0095	0.0034	0.0023	0.0042	0.1500	0.1884	0.0812	0.0945	0.0496
1.1	0.0125	0.0127	0.0035	0.0028	0.0045	0.1646	0.1885	0.0894	0.1039	0.0546
1.2	0.0197	0.0135	0.0037	0.0035	0.0093	0.1793	0.1875	0.0975	0.1133	0.0595
1.3	0.0245	0.0133	0.0040	0.0115	0.0094	0.1874	0.1874	0.1056	0.1227	0.0645
1.4	0.0234	0.0134	0.0041	0.0175	0.0187	0.1880	0.1878	0.1138	0.1321	0.0694
1.5	0.0254	0.0117	0.0124	0.0215	0.0188	0.1876	0.1883	0.1219	0.1416	0.0744

	Model 11					Model 12				
	DRIFT VALUES									
PGA	Mayaguez	SanJuan	Northridge	Centro	San Salvador	Mayaguez	SanJuan	Northridge	Centro	San Salvador
0.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.1	0.0001	0.0002	0.0001	0.0001	0.0001	0.0006	0.0002	0.0003	0.0005	0.0005
0.2	0.0004	0.0003	0.0003	0.0002	0.0004	0.0014	0.0008	0.0009	0.0013	0.0008
0.3	0.0008	0.0007	0.0007	0.0005	0.0010	0.0017	0.0014	0.0017	0.0017	0.0012
0.4	0.0012	0.0007	0.0010	0.0009	0.0011	0.0023	0.0020	0.0022	0.0022	0.0015
0.5	0.0016	0.0009	0.0014	0.0014	0.0015	0.0027	0.0026	0.0029	0.0029	0.0019
0.6	0.0020	0.0011	0.0016	0.0019	0.0020	0.0030	0.0042	0.0035	0.0037	0.0024
0.7	0.0024	0.0014	0.0019	0.0023	0.0023	0.0051	0.0048	0.0050	0.0041	0.0029
0.8	0.0029	0.0020	0.0021	0.0025	0.0025	0.0069	0.0063	0.0079	0.0045	0.0034
0.9	0.0032	0.0027	0.0025	0.0030	0.0027	0.0107	0.0077	0.0092	0.0045	0.0038
1.0	0.0039	0.0032	0.0030	0.0038	0.0028	0.0112	0.0084	0.0103	0.0055	0.0048
1.1	0.0043	0.0036	0.0035	0.0042	0.0028	0.0143	0.0098	0.0115	0.0070	0.0062
1.2	0.0045	0.0042	0.0037	0.0045	0.0030	0.0183	0.0140	0.0126	0.0077	0.0084
1.3	0.0048	0.0045	0.0041	0.0051	0.0033	0.0207	0.0167	0.0135	0.0098	0.0168
1.4	0.0048	0.0044	0.0046	0.0053	0.0036	0.0226	0.0188	0.0132	0.0112	0.0216
1.5	0.0049	0.0050	0.0052	0.0057	0.0039	0.0234	0.0211	0.0158	0.0139	0.0250

Table B- 3. Continuation

	Model 13					Model 14				
	DRIFT VALUES									
PGA	Mayaguez	SanJuan	Northridge	Centro	San Salvador	Mayaguez	SanJuan	Northridge	Centro	San Salvador
0.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.1	0.0001	0.0001	0.0001	0.0001	0.0000	0.0017	0.0007	0.0014	0.0016	0.0009
0.2	0.0002	0.0003	0.0002	0.0002	0.0001	0.0030	0.0016	0.0031	0.0032	0.0023
0.3	0.0007	0.0007	0.0010	0.0004	0.0002	0.0051	0.0038	0.0038	0.0062	0.0028
0.4	0.0014	0.0014	0.0017	0.0007	0.0007	0.0082	0.0071	0.0073	0.0082	0.0040
0.5	0.0024	0.0021	0.0024	0.0012	0.0030	0.0114	0.0105	0.0101	0.0108	0.0051
0.6	0.0042	0.0028	0.0034	0.0018	0.0043	0.0161	0.0152	0.0152	0.0133	0.0062
0.7	0.0047	0.0036	0.0038	0.0025	0.0047	0.0183	0.0176	0.0172	0.0124	0.0069
0.8	0.0062	0.0043	0.0043	0.0038	0.0049	0.0198	0.0211	0.0193	0.0147	0.0077
0.9	0.0070	0.0046	0.0051	0.0038	0.0061	0.0201	0.0327	0.0182	0.0199	0.0154
1.0	0.0090	0.0057	0.0063	0.0074	0.0076	0.0267	0.0406	0.0193	0.0272	0.0214
1.1	0.0105	0.0062	0.0066	0.0083	0.0083	0.0318	0.0429	0.0248	0.0336	0.0257
1.2	0.0103	0.0074	0.0074	0.0096	0.0093	0.0326	0.0443	0.0297	0.0333	0.0287
1.3	0.0118	0.0088	0.0080	0.0097	0.0099	0.0319	0.0408	0.0318	0.0405	0.0298
1.4	0.0117	0.0107	0.0097	0.0101	0.0105	0.0270	0.0418	0.0351	0.0445	0.0295
1.5	0.0136	0.0114	0.0117	0.0110	0.0103	0.0281	0.0514	0.0395	0.0473	0.0335

	Model 15					Model 16				
	DRIFT VALUES									
PGA	Mayaguez	SanJuan	Northridge	Centro	San Salvador	Mayaguez	SanJuan	Northridge	Centro	San Salvador
0.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.1	0.0001	0.0001	0.0000	0.0000	0.0000	0.0002	0.0003	0.0001	0.0001	0.0001
0.2	0.0001	0.0001	0.0001	0.0001	0.0000	0.0009	0.0007	0.0005	0.0004	0.0002
0.3	0.0002	0.0002	0.0001	0.0001	0.0001	0.0022	0.0023	0.0025	0.0010	0.0009
0.4	0.0002	0.0003	0.0001	0.0001	0.0001	0.0049	0.0039	0.0044	0.0029	0.0055
0.5	0.0003	0.0003	0.0002	0.0002	0.0001	0.0080	0.0055	0.0055	0.0042	0.0064
0.6	0.0003	0.0004	0.0002	0.0002	0.0002	0.0116	0.0070	0.0066	0.0078	0.0080
0.7	0.0004	0.0005	0.0003	0.0003	0.0002	0.0172	0.0076	0.0094	0.0109	0.0117
0.8	0.0005	0.0006	0.0003	0.0003	0.0003	0.0188	0.0093	0.0113	0.0147	0.0141
0.9	0.0006	0.0008	0.0004	0.0004	0.0003	0.0247	0.0130	0.0134	0.0177	0.0167
1.0	0.0008	0.0010	0.0004	0.0005	0.0004	0.0310	0.0121	0.0169	0.0193	0.0188
1.1	0.0010	0.0013	0.0004	0.0005	0.0004	0.0346	0.0222	0.0213	0.0210	0.0197
1.2	0.0012	0.0015	0.0005	0.0006	0.0004	0.0353	0.0285	0.0221	0.0259	0.0200
1.3	0.0013	0.0018	0.0006	0.0006	0.0005	0.0361	0.0318	0.0260	0.0333	0.0210
1.4	0.0015	0.0022	0.0006	0.0007	0.0005	0.0294	0.0362	0.0283	0.0347	0.0248
1.5	0.0017	0.0026	0.0007	0.0010	0.0005	0.0293	0.0368	0.0304	0.0383	0.0270

Table B- 3. Continuation

	Model 17					Model 18				
	DRIFT VALUES									
PGA	Mayaguez	SanJuan	Northridge	Centro	San Salvador	Mayaguez	SanJuan	Northridge	Centro	San Salvador
0.0	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000	0.0000
0.1	0.0000	0.0000	0.0000	0.0000	0.0000	0.0002	0.0003	0.0001	0.0002	0.0001
0.2	0.0000	0.0001	0.0000	0.0000	0.0000	0.0012	0.0012	0.0013	0.0006	0.0002
0.3	0.0001	0.0001	0.0000	0.0000	0.0000	0.0034	0.0027	0.0036	0.0013	0.0033
0.4	0.0001	0.0001	0.0000	0.0001	0.0000	0.0063	0.0037	0.0045	0.0030	0.0061
0.5	0.0001	0.0010	0.0001	0.0001	0.0001	0.0085	0.0044	0.0057	0.0069	0.0067
0.6	0.0001	0.0022	0.0001	0.0001	0.0001	0.0144	0.0077	0.0080	0.0101	0.0094
0.7	0.0001	0.0020	0.0001	0.0001	0.0001	0.0176	0.0082	0.0106	0.0128	0.0126
0.8	0.0001	0.0008	0.0001	0.0001	0.0001	0.0220	0.0089	0.0127	0.0160	0.0149
0.9	0.0002	0.0041	0.0001	0.0001	0.0001	0.0252	0.0148	0.0167	0.0179	0.0163
1.0	0.0016	0.0047	0.0001	0.0001	0.0001	0.0253	0.0222	0.0185	0.0200	0.0176
1.1	0.0018	0.0055	0.0001	0.0002	0.0001	0.0315	0.0266	0.0222	0.0263	0.0183
1.2	0.0039	0.0056	0.0001	0.0002	0.0001	0.0297	0.0294	0.0249	0.0264	0.0199
1.3	0.0063	0.0078	0.0001	0.0013	0.0001	0.0258	0.0346	0.0273	0.0356	0.0234
1.4	0.0065	0.0090	0.0002	0.0041	0.0001	0.0312	0.0340	0.0282	0.0377	0.0262
1.5	0.0084	0.0070	0.0002	0.0049	0.0002	0.0291	0.0403	0.0319	0.0382	0.0288

C. ANALYSIS RESULTS USING ALGAN LIMITS

For all tables, the following legend are used:

Direction 1 means that all columns oriented in both directions (Both Directions)
Direction 2 means that all columns oriented in the direction of shaking. (Strong Direction)
Direction 3 means that all columns oriented in the direction opposite to shaking (Weak Direction)
R_i is the story drift index .
T_i is the wall damage index .
DI is the Damage index of the model
DS is the Damage State of the model

C.1 ONE-STORY CONCRETE FRAME MODELS

Table C- 1. Analysis Result: Mayagüez Earthquake (0.1g) of One-Story Concrete Frame models

MODEL	Column (%)	Direction	PGA (%G)	Story Height(ft)	R_i	DI (%)	DS	DS
1	0.7	1	0.1	8	0.0042	0.42	0.00	None
2	0.7	2	0.1	8	0.0023	0.23	0.00	None
3	0.7	3	0.1	8	0.0105	1.05	0.37	Moderate
4	0.7	1	0.1	10	0.0066	0.66	0.11	Minor
5	0.7	2	0.1	10	0.0032	0.32	0.00	None
6	0.7	3	0.1	10	0.0099	0.99	0.33	Minor
7	0.7	1	0.1	12	0.0093	0.93	0.29	Minor
8	0.7	2	0.1	12	0.0045	0.45	0.00	None
9	0.7	3	0.1	12	0.0092	0.92	0.28	Minor
10	1.5	1	0.1	8	0.0006	0.06	0.00	None
11	1.5	2	0.1	8	0.0003	0.03	0.00	None
12	1.5	3	0.1	8	0.0065	0.65	0.10	Minor
13	1.5	1	0.1	10	0.0009	0.09	0.00	None
14	1.5	2	0.1	10	0.0004	0.04	0.00	None
15	1.5	3	0.1	10	0.0096	0.96	0.31	Minor
16	1.5	1	0.1	12	0.0017	0.17	0.00	None
17	1.5	2	0.1	12	0.0005	0.05	0.00	None
18	1.5	3	0.1	12	0.0076	0.76	0.17	Minor

Table C- 2. Analysis Result: Mayagüez Earthquake (0.2g) of One-Story Concrete Frame models

MODEL	Column (%)	Direction	PGA (%G)	Story Height(ft)	R_i	DI(%)	DS	DS
1	0.7	1	0.2	8	0.0128	1.28	0.52	Moderate
2	0.7	2	0.2	8	0.0079	0.79	0.19	Minor
3	0.7	3	0.2	8	0.0231	2.31	1.00	Mayor
4	0.7	1	0.2	10	0.0176	1.76	0.84	Mayor
5	0.7	2	0.2	10	0.0107	1.07	0.38	Moderate
6	0.7	3	0.2	10	0.0214	2.14	1.00	Mayor
7	0.7	1	0.2	12	0.0153	1.53	0.69	Substantial
8	0.7	2	0.2	12	0.0159	1.59	0.72	Substantial
9	0.7	3	0.2	12	0.0229	2.29	1.00	Mayor
10	1.5	1	0.2	8	0.0015	0.15	0.00	None
11	1.5	2	0.2	8	0.0006	0.06	0.00	None
12	1.5	3	0.2	8	0.0275	2.75	1.00	Mayor
13	1.5	1	0.2	10	0.0030	0.30	0.00	None
14	1.5	2	0.2	10	0.0009	0.09	0.00	None
15	1.5	3	0.2	10	0.0182	1.82	0.88	Mayor
16	1.5	1	0.2	12	0.0037	0.37	0.00	None
17	1.5	2	0.2	12	0.0015	0.15	0.00	None
18	1.5	3	0.2	12	0.0179	1.79	0.86	Mayor

Table C- 3. Analysis Result: Mayagüez Earthquake (0.3g) of One-Story Concrete Frame models

MODEL	Column (%)	Direction	PGA (%G)	Story Height(ft)	R_i	DI(%)	DS	DS
1	0.7	1	0.3	8	0.0229	2.29	1.00	Mayor
2	0.7	2	0.3	8	0.0137	1.37	0.58	Substantial
3	0.7	3	0.3	8	0.0368	3.68	1.00	Mayor
4	0.7	1	0.3	10	0.0262	2.62	1.00	Mayor
5	0.7	2	0.3	10	0.0244	2.44	1.00	Mayor
6	0.7	3	0.3	10	0.0332	3.32	1.00	Mayor
7	0.7	1	0.3	12	0.0249	2.49	1.00	Mayor
8	0.7	2	0.3	12	0.0200	2.00	1.00	Mayor
9	0.7	3	0.3	12	0.0373	3.73	1.00	Mayor
10	1.5	1	0.3	8	0.0022	0.22	0.00	None
11	1.5	2	0.3	8	0.0011	0.11	0.00	None
12	1.5	3	0.3	8	0.0328	3.28	1.00	Mayor
13	1.5	1	0.3	10	0.0054	0.54	0.03	None
14	1.5	2	0.3	10	0.0016	0.16	0.00	None
15	1.5	3	0.3	10	0.0314	3.14	1.00	Mayor
16	1.5	1	0.3	12	0.0078	0.78	0.18	Minor
17	1.5	2	0.3	12	0.0029	0.29	0.00	None
18	1.5	3	0.3	12	0.0251	2.51	1.00	Mayor

Table C- 4. Analysis Result: Mayagüez Earthquake (0.4g) of One-Story Concrete Frame models

MODEL	Column (%)	Direction	PGA (%G)	Story Height(ft)	R_i	DI(%)	DS	DS
1	0.7	1	0.4	8	0.0409	4.09	1.00	Mayor
2	0.7	2	0.4	8	0.0233	2.33	1.00	Mayor
3	0.7	3	0.4	8	0.0536	5.36	1.00	Mayor
4	0.7	1	0.4	10	0.0359	3.59	1.00	Mayor
5	0.7	2	0.4	10	0.0311	3.11	1.00	Mayor
6	0.7	3	0.4	10	0.0490	4.90	1.00	Mayor
7	0.7	1	0.4	12	0.0298	2.98	1.00	Mayor
8	0.7	2	0.4	12	0.0288	2.88	1.00	Mayor
9	0.7	3	0.4	12	0.0808	8.08	1.00	Mayor
10	1.5	1	0.4	8	0.0056	0.56	0.04	None
11	1.5	2	0.4	8	0.0017	0.17	0.00	None
12	1.5	3	0.4	8	0.0468	4.68	1.00	Mayor
13	1.5	1	0.4	10	0.0071	0.71	0.14	Minor
14	1.5	2	0.4	10	0.0026	0.26	0.00	None
15	1.5	3	0.4	10	0.0415	4.15	1.00	Mayor
16	1.5	1	0.4	12	0.0118	1.18	0.45	Moderate
17	1.5	2	0.4	12	0.0048	0.48	0.00	None
18	1.5	3	0.4	12	0.0434	4.34	1.00	Mayor

Table C- 5. Analysis Result: Mayagüez Earthquake (0.5g) of One-Story Concrete Frame models

MODEL	Column (%)	Direction	PGA (%G)	Story Height(ft)	R_i	DI(%)	DS	DS
1	0.7	1	0.5	8	0.0473	4.73	1.00	Mayor
2	0.7	2	0.5	8	0.0354	3.54	1.00	Mayor
3	0.7	3	0.5	8	0.0648	6.48	1.00	Mayor
4	0.7	1	0.5	10	0.0458	4.58	1.00	Mayor
5	0.7	2	0.5	10	0.0370	3.70	1.00	Mayor
6	0.7	3	0.5	10	0.0767	7.67	1.00	Mayor
7	0.7	1	0.5	12	0.0408	4.08	1.00	Mayor
8	0.7	2	0.5	12	0.0366	3.66	1.00	Mayor
9	0.7	3	0.5	12	0.1299	12.99	1.00	Mayor
10	1.5	1	0.5	8	0.0080	0.80	0.20	Minor
11	1.5	2	0.5	8	0.0023	0.23	0.00	None
12	1.5	3	0.5	8	0.0553	5.53	1.00	Mayor
13	1.5	1	0.5	10	0.0121	1.21	0.47	Moderate
14	1.5	2	0.5	10	0.0030	0.30	0.00	None
15	1.5	3	0.5	10	0.0508	5.08	1.00	Mayor
16	1.5	1	0.5	12	0.0142	1.42	0.62	Substantial
17	1.5	2	0.5	12	0.0075	0.75	0.16	Minor
18	1.5	3	0.5	12	0.0598	5.98	1.00	Mayor

Table C- 6. Analysis Result: Mayagüez Earthquake (0.6-0.8g) of One-Story Concrete Frame models

MODEL	Column (%)	Direction	PGA (%G)	Story Height(ft)	R_i	DI(%)	DS	DS
10	1.5	1	0.6	8	0.0111	1.11	0.41	Moderate
11	1.5	2	0.6	8	0.0027	0.27	0.00	None
13	1.5	1	0.6	10	0.0174	1.74	0.83	Mayor
14	1.5	2	0.6	10	0.0063	0.63	0.09	Minor
16	1.5	1	0.6	12	0.0224	2.24	1.00	Mayor
17	1.5	2	0.6	12	0.0087	0.87	0.25	Minor
10	1.5	1	0.7	8	0.0136	1.36	0.57	Substantial
11	1.5	2	0.7	8	0.0041	0.41	0.00	None
13	1.5	1	0.7	10	0.0213	2.13	1.00	Mayor
14	1.5	2	0.7	10	0.0086	0.86	0.24	Minor
16	1.5	1	0.7	12	0.0271	2.71	1.00	Mayor
17	1.5	2	0.7	12	0.0112	1.12	0.42	Moderate
10	1.5	1	0.8	8	0.0172	1.72	0.81	Mayor
11	1.5	2	0.8	8	0.0047	0.47	0.00	None
13	1.5	1	0.8	10	0.0262	2.62	1.00	Mayor
14	1.5	2	0.8	10	0.0101	1.01	0.34	Minor
16	1.5	1	0.8	12	0.0356	3.56	1.00	Mayor
17	1.5	2	0.8	12	0.0163	1.63	0.76	Mayor

Table C- 7. Analysis Result: Mayagüez Earthquake (0.9-1.5g) of One-Story Concrete Frame models

MODEL	Column (%)	Direction	PGA (%G)	Story Height(ft)	R_i	DI(%)	DS	DS
10	1.5	1	0.9	8	0.0213	2.13	1.00	Mayor
11	1.5	2	0.9	8	0.0059	0.59	0.06	Minor
13	1.5	1	0.9	10	0.0306	3.06	1.00	Mayor
14	1.5	2	0.9	10	0.0123	1.23	0.49	Moderate
16	1.5	1	0.9	12	0.0436	4.36	1.00	Mayor
17	1.5	2	0.9	12	0.0202	2.02	1.00	Mayor
10	1.5	1	1	8	0.0224	2.24	1.00	Mayor
11	1.5	2	1	8	0.0081	0.81	0.21	Minor
13	1.5	1	1	10	0.0354	3.54	1.00	Mayor
14	1.5	2	1	10	0.0157	1.57	0.71	Substantial
16	1.5	1	1	12	0.0498	4.98	1.00	Mayor
17	1.5	2	1	12	0.0254	2.54	1.00	Mayor
11	1.5	2	1.1	8	0.0097	0.97	0.31	Minor
14	1.5	2	1.1	10	0.0200	2.00	1.00	Mayor
11	1.5	2	1.2	8	0.0093	0.93	0.28	Minor
11	1.5	2	1.3	8	0.0137	1.37	0.58	Substantial
12	1.5	2	1.4	8	0.0154	1.54	0.69	Substantial
13	1.5	2	1.5	8	0.0175	1.75	0.83	Mayor

Table C- 8. Analysis Result: San Juan Earthquake (0.1g) of One-Story Concrete Frame models

MODEL	Column (%)	Direction	PGA (%G)	Story Height(ft)	R_i	DI(%)	DS	DS
1	0.7	1	0.1	8	0.0038	0.38	0.00	None
2	0.7	2	0.1	8	0.0023	0.23	0.00	None
3	0.7	3	0.1	8	0.0052	0.52	0.01	None
4	0.7	1	0.1	10	0.0029	0.29	0.00	None
5	0.7	2	0.1	10	0.0028	0.28	0.00	None
6	0.7	3	0.1	10	0.0049	0.49	0.00	None
7	0.7	1	0.1	12	0.0031	0.31	0.00	None
8	0.7	2	0.1	12	0.0022	0.22	0.00	None
9	0.7	3	0.1	12	0.0040	0.40	0.00	None
10	1.5	1	0.1	8	0.0009	0.09	0.00	None
11	1.5	2	0.1	8	0.0003	0.03	0.00	None
12	1.5	3	0.1	8	0.0033	0.33	0.00	None
13	1.5	1	0.1	10	0.0010	0.10	0.00	None
14	1.5	2	0.1	10	0.0005	0.05	0.00	None
15	1.5	3	0.1	10	0.0025	0.25	0.00	None
16	1.5	1	0.1	12	0.0014	0.14	0.00	None
17	1.5	2	0.1	12	0.0007	0.07	0.00	None
18	1.5	3	0.1	12	0.0040	0.40	0.00	None

Table C- 9. Analysis Result: San Juan Earthquake (0.2g) of One-Story Concrete Frame models

MODEL	Column (%)	Direction	PGA (%G)	Story Height(ft)	R_i	DI(%)	DS	DS
1	0.7	1	0.2	8	0.0074	0.74	0.16	Minor
4	0.7	2	0.2	8	0.0066	0.66	0.10	Minor
7	0.7	3	0.2	8	0.0149	1.49	0.66	Substantial
2	0.7	1	0.2	10	0.0053	0.53	0.02	None
5	0.7	2	0.2	10	0.0059	0.59	0.06	Minor
8	0.7	3	0.2	10	0.0111	1.11	0.41	Moderate
3	0.7	1	0.2	12	0.0082	0.82	0.22	Minor
6	0.7	2	0.2	12	0.0043	0.43	0.00	None
9	0.7	3	0.2	12	0.0123	1.23	0.49	Moderate
10	1.5	1	0.2	8	0.0020	0.20	0.00	None
13	1.5	2	0.2	8	0.0005	0.05	0.00	None
16	1.5	3	0.2	8	0.0066	0.66	0.11	Minor
11	1.5	1	0.2	10	0.0030	0.30	0.00	None
14	1.5	2	0.2	10	0.0014	0.14	0.00	None
17	1.5	3	0.2	10	0.0094	0.94	0.30	Minor
12	1.5	1	0.2	12	0.0040	0.40	0.00	None
15	1.5	2	0.2	12	0.0014	0.14	0.00	None
18	1.5	3	0.2	12	0.0106	1.06	0.37	Moderate

Table C- 10. Analysis Result: San Juan Earthquake (0.3g) of One-Story Concrete Frame models

MODEL	Column (%)	Direction	PGA (%G)	Story Height(ft)	R_i	DI(%)	DS	DS
1	0.7	1	0.3	8	0.0097	0.97	0.32	Minor
2	0.7	2	0.3	8	0.0113	1.13	0.42	Moderate
3	0.7	3	0.3	8	0.0190	1.90	0.93	Mayor
4	0.7	1	0.3	10	0.0124	1.24	0.49	Moderate
5	0.7	2	0.3	10	0.0081	0.81	0.21	Minor
6	0.7	3	0.3	10	0.0195	1.95	0.96	Mayor
7	0.7	1	0.3	12	0.0138	1.38	0.58	Substantial
8	0.7	2	0.3	12	0.0099	0.99	0.33	Minor
9	0.7	3	0.3	12	0.0211	2.11	1.00	Mayor
10	1.5	1	0.3	8	0.0026	0.26	0.00	None
11	1.5	2	0.3	8	0.0013	0.13	0.00	None
12	1.5	3	0.3	8	0.0134	1.34	0.56	Substantial
13	1.5	1	0.3	10	0.0055	0.55	0.03	None
14	1.5	2	0.3	10	0.0021	0.21	0.00	None
15	1.5	3	0.3	10	0.0147	1.47	0.65	Substantial
16	1.5	1	0.3	12	0.0065	0.65	0.10	Minor
17	1.5	2	0.3	12	0.0027	0.27	0.00	None
18	1.5	3	0.3	12	0.0131	1.31	0.54	Moderate

Table C- 11. Analysis Result: San Juan Earthquake (0.4g) of One-Story Concrete Frame models

MODEL	Column (%)	Direction	PGA (%G)	Story Height(ft)	R_i	DI(%)	DS	DS
1	0.7	1	0.4	8	0.0134	1.34	0.56	Substantial
2	0.7	2	0.4	8	0.0124	1.24	0.50	Moderate
3	0.7	3	0.4	8	0.0312	3.12	1.00	Mayor
4	0.7	1	0.4	10	0.0207	2.07	1.00	Mayor
5	0.7	2	0.4	10	0.0110	1.10	0.40	Moderate
6	0.7	3	0.4	10	0.0352	3.52	1.00	Mayor
7	0.7	1	0.4	12	0.0194	1.94	0.96	Mayor
8	0.7	2	0.4	12	0.0161	1.61	0.74	Substantial
9	0.7	3	0.4	12	0.0473	4.73	1.00	Mayor
10	1.5	1	0.4	8	0.0049	0.49	0.00	None
11	1.5	2	0.4	8	0.0023	0.23	0.00	None
12	1.5	3	0.4	8	0.0219	2.19	1.00	Mayor
13	1.5	1	0.4	10	0.0078	0.78	0.19	Minor
14	1.5	2	0.4	10	0.0028	0.28	0.00	None
15	1.5	3	0.4	10	0.0207	2.07	1.00	Mayor
16	1.5	1	0.4	12	0.0094	0.94	0.29	Minor
17	1.5	2	0.4	12	0.0047	0.47	0.00	None
18	1.5	3	0.4	12	0.0223	2.23	1.00	Mayor

Table C- 12. Analysis Result: San Juan Earthquake (0.5g) of One-Story Concrete Frame models

MODEL	Column (%)	Direction	PGA (%G)	Story Height(ft)	R_i	DI(%)	DS	DS
1	0.7	1	0.5	8	0.0207	2.07	1.00	Mayor
2	0.7	2	0.5	8	0.0171	1.71	0.81	Mayor
3	0.7	3	0.5	8	0.0329	3.29	1.00	Mayor
4	0.7	1	0.5	10	0.0276	2.76	1.00	Mayor
5	0.7	2	0.5	10	0.0225	2.25	1.00	Mayor
6	0.7	3	0.5	10	0.0579	5.79	1.00	Mayor
7	0.7	1	0.5	12	0.0223	2.23	1.00	Mayor
8	0.7	2	0.5	12	0.0241	2.41	1.00	Mayor
9	0.7	3	0.5	12	0.0759	7.59	1.00	Mayor
10	1.5	1	0.5	8	0.0075	0.75	0.17	Minor
11	1.5	2	0.5	8	0.0029	0.29	0.00	None
12	1.5	3	0.5	8	0.0365	3.65	1.00	Mayor
13	1.5	1	0.5	10	0.0117	1.17	0.44	Moderate
14	1.5	2	0.5	10	0.0035	0.35	0.00	None
15	1.5	3	0.5	10	0.0288	2.88	1.00	Mayor
16	1.5	1	0.5	12	0.0103	1.03	0.35	Moderate
17	1.5	2	0.5	12	0.0067	0.67	0.11	Minor
18	1.5	3	0.5	12	0.0310	3.10	1.00	Mayor

Table C- 13. Analysis Result: San Juan Earthquake (0.6-0.8g) of One-Story Concrete Frame models

MODEL	Column (%)	Direction	PGA (%G)	Story Height(ft)	R_i	DI(%)	DS	DS
10	1.5	1	0.6	8	0.0104	1.04	0.36	Moderate
11	1.5	2	0.6	8	0.0047	0.47	0.00	None
13	1.5	1	0.6	10	0.0148	1.48	0.66	Substantial
14	1.5	2	0.6	10	0.0048	0.48	0.00	None
16	1.5	1	0.6	12	0.0130	1.30	0.53	Moderate
17	1.5	2	0.6	12	0.0096	0.96	0.31	Minor
10	1.5	1	0.7	8	0.0135	1.35	0.56	Substantial
11	1.5	2	0.7	8	0.0053	0.53	0.02	None
13	1.5	1	0.7	10	0.0185	1.85	0.90	Mayor
14	1.5	2	0.7	10	0.0071	0.71	0.14	Minor
16	1.5	1	0.7	12	0.0152	1.52	0.68	Substantial
17	1.5	2	0.7	12	0.0129	1.29	0.53	Moderate
10	1.5	1	0.8	8	0.0172	1.72	0.81	Mayor
11	1.5	2	0.8	8	0.0067	0.67	0.12	Minor
13	1.5	1	0.8	10	0.0199	1.99	0.99	Mayor
14	1.5	2	0.8	10	0.0098	0.98	0.32	Minor
16	1.5	1	0.8	12	0.0165	1.65	0.77	Mayor
17	1.5	2	0.8	12	0.0152	1.52	0.68	Substantial

Table C- 14. Analysis Result: San Juan Earthquake (0.9-1.5g) of One-Story Concrete Frame models

MODEL	Column (%)	Direction	PGA (%G)	Story Height(ft)	R_i	DI(%)	DS	DS
10	1.5	1	0.9	8	0.0187	1.87	0.91	Mayor
11	1.5	2	0.9	8	0.0068	0.68	0.12	Minor
13	1.5	1	0.9	10	0.0223	2.23	1.00	Mayor
14	1.5	2	0.9	10	0.0132	1.32	0.54	Moderate
16	1.5	1	0.9	12	0.0195	1.95	0.97	Mayor
17	1.5	2	0.9	12	0.0196	1.96	0.97	Mayor
10	1.5	1	1	8	0.0215	2.15	1.00	Mayor
11	1.5	2	1	8	0.0081	0.81	0.21	Minor
13	1.5	1	1	10	0.0222	2.22	1.00	Mayor
14	1.5	2	1	10	0.0157	1.57	0.72	Substantial
16	1.5	1	1	12	0.0228	2.28	1.00	Mayor
17	1.5	2	1	12	0.0215	2.15	1.00	Mayor
11	1.5	2	1.1	8	0.0081	0.81	0.21	Minor
14	1.5	2	1.1	10	0.0182	1.82	0.88	Mayor
11	1.5	2	1.2	8	0.0093	0.93	0.28	Minor
11	1.5	2	1.3	8	0.0137	1.37	0.58	Substantial
11	1.5	2	1.4	8	0.0154	1.54	0.69	Substantial
11	1.5	2	1.5	8	0.0175	1.75	0.83	Mayor

Table C- 15. Analysis Result: Northridge Earthquake (0.1g) of One-Story Concrete Frame models

MODEL	Column (%)	Direction	PGA (%G)	Story Height(ft)	R_i	DI(%)	DS	DS
1	0.7	1	0.1	8	0.0068	0.68	0.12	Minor
2	0.7	2	0.1	8	0.0023	0.23	0.00	None
3	0.7	3	0.1	8	0.0088	0.88	0.26	Minor
4	0.7	1	0.1	10	0.0041	0.41	0.00	None
5	0.7	2	0.1	10	0.0028	0.28	0.00	None
6	0.7	3	0.1	10	0.0006	0.06	0.00	None
7	0.7	1	0.1	12	0.0064	0.64	0.09	Minor
8	0.7	2	0.1	12	0.0037	0.37	0.00	None
9	0.7	3	0.1	12	0.0064	0.64	0.09	Minor
10	1.5	1	0.1	8	0.0004	0.04	0.00	None
11	1.5	2	0.1	8	0.0002	0.02	0.00	None
12	1.5	3	0.1	8	0.0046	0.46	0.00	None
13	1.5	1	0.1	10	0.0008	0.08	0.00	None
14	1.5	2	0.1	10	0.0003	0.03	0.00	None
15	1.5	3	0.1	10	0.0059	0.59	0.06	Minor
16	1.5	1	0.1	12	0.0017	0.17	0.00	None
17	1.5	2	0.1	12	0.0003	0.03	0.00	None
18	1.5	3	0.1	12	0.0054	0.54	0.02	None

Table C- 16. Analysis Result: Northridge Earthquake (0.2g) of One-Story Concrete Frame models

MODEL	Column (%)	Direction	PGA (%G)	Story Height(ft)	R_i	DI(%)	DS	DS
1	0.7	1	0.2	8	0.0105	1.05	0.37	Moderate
2	0.7	2	0.2	8	0.0071	0.71	0.14	Minor
3	0.7	3	0.2	8	0.0234	2.34	1.00	Mayor
4	0.7	1	0.2	10	0.0114	1.14	0.43	Moderate
5	0.7	2	0.2	10	0.0087	0.87	0.25	Minor
6	0.7	3	0.2	10	0.0149	1.49	0.66	Substantial
7	0.7	1	0.2	12	0.0129	1.29	0.53	Moderate
8	0.7	2	0.2	12	0.0071	0.71	0.14	Minor
9	0.7	3	0.2	12	0.0178	1.78	0.85	Mayor
10	1.5	1	0.2	8	0.0009	0.09	0.00	None
11	1.5	2	0.2	8	0.0003	0.03	0.00	None
12	1.5	3	0.2	8	0.0129	1.29	0.53	Moderate
13	1.5	1	0.2	10	0.0029	0.29	0.00	None
14	1.5	2	0.2	10	0.0006	0.06	0.00	None
15	1.5	3	0.2	10	0.0149	1.49	0.66	Substantial
16	1.5	1	0.2	12	0.0032	0.32	0.00	None
17	1.5	2	0.2	12	0.0011	0.11	0.00	None
18	1.5	3	0.2	12	0.0144	1.44	0.63	Substantial

Table C- 17. Analysis Result: Northridge Earthquake (0.3g) of One-Story Concrete Frame models

MODEL	Column (%)	Direction	PGA (%G)	Story Height(ft)	R_i	DI(%)	DS	DS
1	0.7	1	0.3	8	0.0159	1.59	0.73	Substantial
2	0.7	2	0.3	8	0.0112	1.12	0.41	Moderate
3	0.7	3	0.3	8	0.0327	3.27	1.00	Mayor
4	0.7	1	0.3	10	0.0020	0.20	0.00	None
5	0.7	2	0.3	10	0.0132	1.32	0.55	Moderate
6	0.7	3	0.3	10	0.0287	2.87	1.00	Mayor
7	0.7	1	0.3	12	0.0228	2.28	1.00	Mayor
8	0.7	2	0.3	12	0.0150	1.50	0.66	Substantial
9	0.7	3	0.3	12	0.0274	2.74	1.00	Mayor
10	1.5	1	0.3	8	0.0019	0.19	0.00	None
11	1.5	2	0.3	8	0.0004	0.04	0.00	None
12	1.5	3	0.3	8	0.0261	2.61	1.00	Mayor
13	1.5	1	0.3	10	0.0060	0.60	0.07	Minor
14	1.5	2	0.3	10	0.0011	0.11	0.00	None
15	1.5	3	0.3	10	0.0265	2.65	1.00	Mayor
16	1.5	1	0.3	12	0.0075	0.75	0.16	Minor
17	1.5	2	0.3	12	0.0019	0.19	0.00	None
18	1.5	3	0.3	12	0.0193	1.93	0.95	Mayor

Table C- 18. Analysis Result: Northridge Earthquake (0.4g) of One-Story Concrete Frame models

MODEL	Column (%)	Direction	PGA (%G)	Story Height(ft)	R_i	DI(%)	DS	DS
1	0.7	1	0.4	8	0.0253	2.53	1.00	Mayor
2	0.7	2	0.4	8	0.0197	1.97	0.98	Mayor
3	0.7	3	0.4	8	0.0447	4.47	1.00	Mayor
4	0.7	1	0.4	10	0.0267	2.67	1.00	Mayor
5	0.7	2	0.4	10	0.0218	2.18	1.00	Mayor
6	0.7	3	0.4	10	0.0471	4.71	1.00	Mayor
7	0.7	1	0.4	12	0.0310	3.10	1.00	Mayor
8	0.7	2	0.4	12	0.0213	2.13	1.00	Mayor
9	0.7	3	0.4	12	0.0398	3.98	1.00	Mayor
10	1.5	1	0.4	8	0.0037	0.37	0.00	None
11	1.5	2	0.4	8	0.0006	0.06	0.00	None
12	1.5	3	0.4	8	0.0328	3.28	1.00	Mayor
13	1.5	1	0.4	10	0.0082	0.82	0.21	Minor
14	1.5	2	0.4	10	0.0016	0.16	0.00	None
15	1.5	3	0.4	10	0.0359	3.59	1.00	Mayor
16	1.5	1	0.4	12	0.0099	0.99	0.33	Minor
17	1.5	2	0.4	12	0.0044	0.44	0.00	None
18	1.5	3	0.4	12	0.0269	2.69	1.00	Mayor

Table C- 19. Analysis Result: Northridge Earthquake (0.5g) of One-Story Concrete Frame models

MODEL	Column (%)	Direction	PGA (%G)	Story Height	R_i	DI(%)	DS	DS
1	0.7	1	0.5	8	0.0326	3.26	1.00	Mayor
2	0.7	2	0.5	8	0.0243	2.43	1.00	Mayor
3	0.7	3	0.5	8	0.0555	5.55	1.00	Mayor
4	0.7	1	0.5	10	0.0367	3.67	1.00	Mayor
5	0.7	2	0.5	10	0.0293	2.93	1.00	Mayor
6	0.7	3	0.5	10	0.0490	4.90	1.00	Mayor
7	0.7	1	0.5	12	0.0385	3.85	1.00	Mayor
8	0.7	2	0.5	12	0.0285	2.85	1.00	Mayor
9	0.7	3	0.5	12	0.0512	5.12	1.00	Mayor
10	1.5	1	0.5	8	0.0092	0.92	0.28	Minor
11	1.5	2	0.5	8	0.0011	0.11	0.00	None
12	1.5	3	0.5	8	0.0510	5.10	1.00	Mayor
13	1.5	1	0.5	10	0.0120	1.20	0.46	Moderate
14	1.5	2	0.5	10	0.0025	0.25	0.00	None
15	1.5	3	0.5	10	0.0443	4.43	1.00	Mayor
16	1.5	1	0.5	12	0.0133	1.33	0.55	Substantial
17	1.5	2	0.5	12	0.0074	0.74	0.16	Minor
18	1.5	3	0.5	12	0.0355	3.55	1.00	Mayor

Table C- 20. Analysis Result: Northridge Earthquake (0.60.8g) of One-Story Concrete Frame models

MODEL	Column (%)	Direction	PGA (%G)	Story Height	R_i	DI(%)	DS	DS
10	1.50	1.00	0.60	8.00	0.0132	1.32	0.55	Moderate
11	1.50	2.00	0.60	8.00	0.0015	0.15	0.00	None
13	1.50	1.00	0.60	10.00	0.0158	1.58	0.72	Substantial
14	1.50	2.00	0.60	10.00	0.0041	0.41	0.00	None
16	1.50	1.00	0.60	12.00	0.0193	1.93	0.95	Mayor
17	1.50	2.00	0.60	12.00	0.0106	1.06	0.37	Moderate
10	1.50	1.00	0.70	8.00	0.0162	1.62	0.74	Substantial
11	1.50	2.00	0.70	8.00	0.0023	0.23	0.00	None
13	1.50	1.00	0.70	10.00	0.0192	1.92	0.94	Mayor
14	1.50	2.00	0.70	10.00	0.0084	0.84	0.23	Minor
16	1.50	1.00	0.70	12.00	0.0235	2.35	1.00	Mayor
17	1.50	2.00	0.70	12.00	0.0130	1.30	0.54	Moderate
10	1.50	1.00	0.80	8.00	0.0200	2.00	1.00	Mayor
11	1.50	2.00	0.80	8.00	0.0032	0.32	0.00	None
13	1.50	1.00	0.80	10.00	0.0227	2.27	1.00	Mayor
14	1.50	2.00	0.80	10.00	0.0139	1.39	0.60	Substantial
16	1.50	1.00	0.80	12.00	0.0257	2.57	1.00	Mayor
17	1.50	2.00	0.80	12.00	0.0162	1.62	0.74	Substantial

Table C- 21. Analysis Result: Northridge Earthquake (0.9-1.5g) of One-Story Concrete Frame models

MODEL	Column(%)	Direction	PGA (%G)	Story Height(ft)	R_i	DI(%)	DS	DS
10.00	1.50	1.00	0.90	8.00	0.0233	2.33	1.00	Mayor
11.00	1.50	2.00	0.90	8.00	0.0039	0.39	0.00	None
13.00	1.50	1.00	0.90	10.00	0.0245	2.45	1.00	Mayor
14.00	1.50	2.00	0.90	10.00	0.0164	1.64	0.76	Mayor
16.00	1.50	1.00	0.90	12.00	0.0288	2.88	1.00	Mayor
17.00	1.50	2.00	0.90	12.00	0.0197	1.97	0.98	Mayor
10.00	1.50	1.00	1.00	8.00	0.0258	2.58	1.00	Mayor
11.00	1.50	2.00	1.00	8.00	0.0051	0.51	0.01	None
13.00	1.50	1.00	1.00	10.00	0.0267	2.67	1.00	Mayor
14.00	1.50	2.00	1.00	10.00	0.0188	1.88	0.92	Mayor
16.00	1.50	1.00	1.00	12.00	0.0314	3.14	1.00	Mayor
17.00	1.50	2.00	1.00	12.00	0.0222	2.22	1.00	Mayor
11.00	1.50	2.00	1.10	8.00	0.0067	0.67	0.11	Minor
11.00	1.50	2.00	1.20	8.00	0.0074	0.74	0.16	Minor
11.00	1.50	2.00	1.30	8.00	0.0098	0.98	0.32	Minor
11.00	1.50	2.00	1.40	8.00	0.0166	1.66	0.77	Mayor
11.00	1.50	2.00	1.50	8.00	0.0214	2.14	1.00	Mayor

Table C- 22. Analysis Result: Centro Earthquake (0.1g) of One-Story Concrete Frame models

MODEL	Column (%)	Direction	PGA (%G)	Story Height(ft)	R_i	DI(%)	DS	DS
1	0.7	1	0.1	8	0.0030	0.30	0.00	None
2	0.7	2	0.1	8	0.0012	0.12	0.00	None
3	0.7	3	0.1	8	0.0114	1.14	0.43	Moderate
4	0.7	1	0.1	10	0.0052	0.52	0.01	None
5	0.7	2	0.1	10	0.0021	0.21	0.00	None
6	0.7	3	0.1	10	0.0091	0.91	0.27	Minor
7	0.7	1	0.1	12	0.0074	0.74	0.16	Minor
8	0.7	2	0.1	12	0.0038	0.38	0.00	None
9	0.7	3	0.1	12	0.0075	0.75	0.17	Minor
10	1.5	1	0.1	8	0.0005	0.05	0.00	None
11	1.5	2	0.1	8	0.0002	0.02	0.00	None
12	1.5	3	0.1	8	0.0045	0.45	0.00	None
13	1.5	1	0.1	10	0.0007	0.07	0.00	None
14	1.5	2	0.1	10	0.0003	0.03	0.00	None
15	1.5	3	0.1	10	0.0072	0.72	0.15	Minor
16	1.5	1	0.1	12	0.0012	0.12	0.00	None
17	1.5	2	0.1	12	0.0004	0.04	0.00	None
18	1.5	3	0.1	12	0.0079	0.79	0.19	Minor

Table C- 23. Analysis Result: Centro Earthquake (0.2g) of One-Story Concrete Frame models

MODEL	Column (%)	Direction	PGA (%G)	Story Height(ft)	R_i	DI(%)	DS	DS
1	0.7	1	0.2	8	0.0108	1.08	0.39	Moderate
2	0.7	2	0.2	8	0.0042	0.42	0.00	None
3	0.7	3	0.2	8	0.0238	2.38	1.00	Mayor
4	0.7	1	0.2	10	0.0157	1.57	0.72	Substantial
5	0.7	2	0.2	10	0.0086	0.86	0.24	Minor
6	0.7	3	0.2	10	0.0197	1.97	0.98	Mayor
7	0.7	1	0.2	12	0.0160	1.60	0.74	Substantial
8	0.7	2	0.2	12	0.0126	1.26	0.51	Moderate
9	0.7	3	0.2	12	0.0172	1.72	0.82	Mayor
10	1.5	1	0.2	8	0.0008	0.08	0.00	None
11	1.5	2	0.2	8	0.0003	0.03	0.00	None
12	1.5	3	0.2	8	0.0182	1.82	0.88	Mayor
13	1.5	1	0.2	10	0.0017	0.17	0.00	None
14	1.5	2	0.2	10	0.0007	0.07	0.00	None
15	1.5	3	0.2	10	0.0208	2.08	1.00	Mayor
16	1.5	1	0.2	12	0.0028	0.28	0.00	None
17	1.5	2	0.2	12	0.0010	0.10	0.00	None
18	1.5	3	0.2	12	0.0145	1.45	0.63	Substantial

Table C- 24. Analysis Result: Centro Earthquake (0.3g) of One-Story Concrete Frame models

MODEL	Column (%)	Direction	PGA (%G)	Story Height(ft)	R_i	DI(%)	DS	DS
1	0.7	1	0.3	8	0.0222	2.22	1.00	Mayor
2	0.7	2	0.3	8	0.0099	0.99	0.33	Minor
3	0.7	3	0.3	8	0.0374	3.74	1.00	Mayor
4	0.7	1	0.3	10	0.0256	2.56	1.00	Mayor
5	0.7	2	0.3	10	0.0180	1.80	0.86	Mayor
6	0.7	3	0.3	10	0.0413	4.13	1.00	Mayor
7	0.7	1	0.3	12	0.0230	2.30	1.00	Mayor
8	0.7	2	0.3	12	0.0194	1.94	0.96	Mayor
9	0.7	3	0.3	12	0.0358	3.58	1.00	Mayor
10	1.5	1	0.3	8	0.0019	0.19	0.00	None
11	1.5	2	0.3	8	0.0006	0.06	0.00	None
12	1.5	3	0.3	8	0.0333	3.33	1.00	Mayor
13	1.5	1	0.3	10	0.0033	0.33	0.00	None
14	1.5	2	0.3	10	0.0009	0.09	0.00	None
15	1.5	3	0.3	10	0.0304	3.04	1.00	Mayor
16	1.5	1	0.3	12	0.0044	0.44	0.00	None
17	1.5	2	0.3	12	0.0019	0.19	0.00	None
18	1.5	3	0.3	12	0.0217	2.17	1.00	Mayor

Table C- 25. Analysis Result: Centro Earthquake (0.4g) of One-Story Concrete Frame models

MODEL	Column (%)	Direction	PGA (%G)	Story Height(ft)	R_i	DI(%)	DS	DS
1	0.7	1	0.4	8	0.0350	3.50	1.00	Mayor
2	0.7	2	0.4	8	0.0163	1.63	0.76	Mayor
3	0.7	3	0.4	8	0.0522	5.22	1.00	Mayor
4	0.7	1	0.4	10	0.0348	3.48	1.00	Mayor
5	0.7	2	0.4	10	0.0272	2.72	1.00	Mayor
6	0.7	3	0.4	10	0.0610	6.10	1.00	Mayor
7	0.7	1	0.4	12	0.0298	2.98	1.00	Mayor
8	0.7	2	0.4	12	0.0289	2.89	1.00	Mayor
9	0.7	3	0.4	12	0.0507	5.07	1.00	Mayor
10	1.5	1	0.4	8	0.0028	0.28	0.00	None
11	1.5	2	0.4	8	0.0008	0.08	0.00	None
12	1.5	3	0.4	8	0.0483	4.83	1.00	Mayor
13	1.5	1	0.4	10	0.0049	0.49	0.00	None
14	1.5	2	0.4	10	0.0013	0.13	0.00	None
15	1.5	3	0.4	10	0.0380	3.80	1.00	Mayor
16	1.5	1	0.4	12	0.0092	0.92	0.28	Minor
17	1.5	2	0.4	12	0.0027	0.27	0.00	None
18	1.5	3	0.4	12	0.0289	2.89	1.00	Mayor

Table C- 26. Analysis Result: Centro Earthquake (0.5g) of One-Story Concrete Frame models

MODEL	Column (%)	Direction	PGA (%G)	Story Height(ft)	R_i	DI(%)	DS	DS
1	0.7	1	0.5	8	0.0425	4.25	1.00	Mayor
2	0.7	2	0.5	8	0.0217	2.17	1.00	Mayor
3	0.7	3	0.5	8	0.0699	6.99	1.00	Mayor
4	0.7	1	0.5	10	0.0429	4.29	1.00	Mayor
5	0.7	2	0.5	10	0.0361	3.61	1.00	Mayor
6	0.7	3	0.5	10	0.0780	7.80	1.00	Mayor
7	0.7	1	0.5	12	0.0379	3.79	1.00	Mayor
8	0.7	2	0.5	12	0.0349	3.49	1.00	Mayor
9	0.7	3	0.5	12	0.0526	5.26	1.00	Mayor
10	1.5	1	0.5	8	0.0051	0.51	0.01	None
11	1.5	2	0.5	8	0.0014	0.14	0.00	None
12	1.5	3	0.5	8	0.0602	6.02	1.00	Mayor
13	1.5	1	0.5	10	0.0077	0.77	0.18	Minor
14	1.5	2	0.5	10	0.0022	0.22	0.00	None
15	1.5	3	0.5	10	0.0477	4.77	1.00	Mayor
16	1.5	1	0.5	12	0.0121	1.21	0.47	Moderate
17	1.5	2	0.5	12	0.0036	0.36	0.00	None
18	1.5	3	0.5	12	0.0397	3.97	1.00	Mayor

Table C- 27. Analysis Result: Centro Earthquake (0.6-0.8g) of One-Story Concrete Frame models

MODEL	Column (%)	Direction	PGA (%G)	Story Height(ft)	R_i	DI(%)	DS	DS
10	1.5	1	0.6	8	0.0062	0.62	0.08	Minor
11	1.5	2	0.6	8	0.0020	0.20	0.00	None
13	1.5	1	0.6	10	0.0092	0.92	0.28	Minor
14	1.5	2	0.6	10	0.0033	0.33	0.00	None
16	1.5	1	0.6	12	0.0182	1.82	0.88	Mayor
17	1.5	2	0.6	12	0.0049	0.49	0.00	None
10	1.5	1	0.7	8	0.0078	0.78	0.18	Minor
11	1.5	2	0.7	8	0.0028	0.28	0.00	None
13	1.5	1	0.7	10	0.0143	1.43	0.62	Substantial
14	1.5	2	0.7	10	0.0042	0.42	0.00	None
16	1.5	1	0.7	12	0.0236	2.36	1.00	Mayor
17	1.5	2	0.7	12	0.0061	0.61	0.07	Minor
10	1.5	1	0.8	8	0.0105	1.05	0.37	Moderate
11	1.5	2	0.8	8	0.0036	0.36	0.00	None
13	1.5	1	0.8	10	0.0205	2.05	1.00	Mayor
14	1.5	2	0.8	10	0.0065	0.65	0.10	Minor
16	1.5	1	0.8	12	0.0307	3.07	1.00	Mayor
17	1.5	2	0.8	12	0.0083	0.83	0.22	Minor

Table C- 28. Analysis Result: Centro Earthquake (0.9-1.2g) of One-Story Concrete Frame models

MODEL	Column (%)	Direction	PGA	Story Height(ft)	R_i	DI(%)	DS	DS
10	1.5	1	0.9	8	0.0131	1.31	0.54	Moderate
11	1.5	2	0.9	8	0.0042	0.42	0.00	None
13	1.5	1	0.9	10	0.0248	2.48	1.00	Mayor
14	1.5	2	0.9	10	0.0073	0.73	0.15	Minor
16	1.5	1	0.9	12	0.0412	4.12	1.00	Mayor
17	1.5	2	0.9	12	0.0105	1.05	0.37	Moderate
10	1.5	1	1	8	0.0159	1.59	0.73	Substantial
11	1.5	2	1	8	0.0044	0.44	0.00	None
13	1.5	1	1	10	0.0301	3.01	1.00	Mayor
14	1.5	2	1	10	0.0080	0.80	0.20	Minor
16	1.5	1	1	12	0.0502	5.02	1.00	Mayor
17	1.5	2	1	12	0.0130	1.30	0.53	Moderate
11	1.5	2	1.1	8	0.0050	0.50	0.00	None
14	1.5	2	1.1	10	0.0128	1.28	0.52	Moderate
17	1.5	2	1.1	12	0.0161	1.61	0.74	Substantial
11	1.5	2	1.2	8	0.0058	0.58	0.05	Minor
14	1.5	2	1.2	10	0.0132	1.32	0.55	Moderate
17	1.5	2	1.2	12	0.0211	2.11	1.00	Mayor

Table C- 29. Analysis Result: Centro Earthquake (1.3-1.8g) of One-Story Concrete Frame models

MODEL	Column (%)	Direction	PGA	Story Height(ft)	R_i	DI(%)	DS	DS
11	1.5	2	1.3	8	0.0079	0.79	0.19	Minor
14	1.5	2	1.3	10	0.0144	1.44	0.63	Substantial
17	1.5	2	1.3	12	0.0252	2.52	1.00	Mayor
11	1.5	2	1.4	8	0.0102	1.02	0.35	Minor
14	1.5	2	1.4	10	0.0164	1.64	0.76	Mayor
17	1.5	2	1.4	12	0.0284	2.84	1.00	Mayor
11	1.5	2	1.5	8	0.0102	1.02	0.35	Minor
14	1.5	2	1.5	10	0.0164	1.64	0.76	Mayor
17	1.5	2	1.5	12	0.0284	2.84	1.00	Mayor
10	1.5	1	1.1	8	0.0172	1.72	0.81	Mayor
11	1.5	2	1.6	8	0.0150	1.50	0.66	Substantial
11	1.5	2	1.7	8	0.0153	1.53	0.68	Substantial
11	1.5	2	1.8	8	0.0177	1.77	0.85	Mayor

Table C- 30. Analysis Result: San Salvador Earthquake (0.1g) of One-Story Concrete Frame models

MODEL	Column (%)	Direction	PGA (%G)	Story Height(ft)	R_i	DI(%)	DS	DS
1	0.7	1	0.1	8	0.0074	0.74	0.16	Minor
2	0.7	2	0.1	8	0.0011	0.11	0.00	None
3	0.7	3	0.1	8	0.0100	1.00	0.34	Minor
4	0.7	1	0.1	10	0.0059	0.59	0.06	Minor
5	0.7	2	0.1	10	0.0054	0.54	0.02	None
6	0.7	3	0.1	10	0.0077	0.77	0.18	Minor
7	0.7	1	0.1	12	0.0063	0.63	0.09	Minor
8	0.7	2	0.1	12	0.0045	0.45	0.00	None
9	0.7	3	0.1	12	0.0053	0.53	0.02	None
10	1.5	1	0.1	8	0.0004	0.04	0.00	None
11	1.5	2	0.1	8	0.0001	0.01	0.00	None
12	1.5	3	0.1	8	0.0063	0.63	0.09	Minor
13	1.5	1	0.1	10	0.0004	0.04	0.00	None
14	1.5	2	0.1	10	0.0002	0.02	0.00	None
15	1.5	3	0.1	10	0.0071	0.71	0.14	Minor
16	1.5	1	0.1	12	0.0010	0.10	0.00	None
17	1.5	2	0.1	12	0.0002	0.02	0.00	None
18	1.5	3	0.1	12	0.0061	0.61	0.07	Minor

Table C- 31. Analysis Result: San Salvador Earthquake (0.2g) of One-Story Concrete Frame models

MODEL	Column (%)	Direction	PGA (%G)	Story Height(ft)	R_i	DI(%)	DS	DS
1	0.7	1	0.2	8	0.0121	1.21	0.47	Moderate
4	0.7	2	0.2	8	0.0083	0.83	0.22	Minor
7	0.7	3	0.2	8	0.0163	1.63	0.75	Mayor
2	0.7	1	0.2	10	0.0151	1.51	0.67	Substantial
5	0.7	2	0.2	10	0.0094	0.94	0.29	Minor
8	0.7	3	0.2	10	0.0125	1.25	0.50	Moderate
3	0.7	1	0.2	12	0.0130	1.30	0.53	Moderate
6	0.7	2	0.2	12	0.0118	1.18	0.46	Moderate
9	0.7	3	0.2	12	0.0119	1.19	0.46	Moderate
10	1.5	1	0.2	8	0.0006	0.06	0.00	None
13	1.5	2	0.2	8	0.0003	0.03	0.00	None
16	1.5	3	0.2	8	0.0160	1.60	0.73	Substantial
11	1.5	1	0.2	10	0.0013	0.13	0.00	None
14	1.5	2	0.2	10	0.0006	0.06	0.00	None
17	1.5	3	0.2	10	0.0148	1.48	0.65	Substantial
12	1.5	1	0.2	12	0.0041	0.41	0.00	None
15	1.5	2	0.2	12	0.0005	0.05	0.00	None
18	1.5	3	0.2	12	0.0129	1.29	0.53	Moderate

Table C- 32. Analysis Result: San Salvador Earthquake (0.3g) of One-Story Concrete Frame models

MODEL	Column (%)	Direction	PGA (%G)	Story Height(ft)	R_i	DI(%)	DS	DS
1	0.7	1	0.3	8	0.0213	2.13	1.00	Mayor
2	0.7	2	0.3	8	0.0187	1.87	0.91	Mayor
3	0.7	3	0.3	8	0.0252	2.52	1.00	Mayor
4	0.7	1	0.3	10	0.0223	2.23	1.00	Mayor
5	0.7	2	0.3	10	0.0174	1.74	0.83	Mayor
6	0.7	3	0.3	10	0.0184	1.84	0.89	Mayor
7	0.7	1	0.3	12	0.0168	1.68	0.78	Mayor
8	0.7	2	0.3	12	0.0193	1.93	0.95	Mayor
9	0.7	3	0.3	12	0.0160	1.60	0.73	Substantial
10	1.5	1	0.3	8	0.0011	0.11	0.00	None
11	1.5	2	0.3	8	0.0004	0.04	0.00	None
12	1.5	3	0.3	8	0.0307	3.07	1.00	Mayor
13	1.5	1	0.3	10	0.0039	0.39	0.00	None
14	1.5	2	0.3	10	0.0008	0.08	0.00	None
15	1.5	3	0.3	10	0.0244	2.44	1.00	Mayor
16	1.5	1	0.3	12	0.0094	0.94	0.29	Minor
17	1.5	2	0.3	12	0.0011	0.11	0.00	None
18	1.5	3	0.3	12	0.0166	1.66	0.77	Mayor

Table C- 33. Analysis Result: San Salvador Earthquake (0.4g) of One-Story Concrete Frame models

MODEL	Column (%)	Direction	PGA (%G)	Story Height(ft)	R_i	DI(%)	DS	DS
1	0.7	1	0.4	8	0.0329	3.29	1.00	Mayor
2	0.7	2	0.4	8	0.0196	1.96	0.97	Mayor
3	0.7	3	0.4	8	0.0304	3.04	1.00	Mayor
4	0.7	1	0.4	10	0.0268	2.68	1.00	Mayor
5	0.7	2	0.4	10	0.0267	2.67	1.00	Mayor
6	0.7	3	0.4	10	0.0253	2.53	1.00	Mayor
7	0.7	1	0.4	12	0.0246	2.46	1.00	Mayor
8	0.7	2	0.4	12	0.0227	2.27	1.00	Mayor
9	0.7	3	0.4	12	0.0215	2.15	1.00	Mayor
10	1.5	1	0.4	8	0.0017	0.17	0.00	None
11	1.5	2	0.4	8	0.0006	0.06	0.00	None
12	1.5	3	0.4	8	0.0392	3.92	1.00	Mayor
13	1.5	1	0.4	10	0.0095	0.95	0.30	Minor
14	1.5	2	0.4	10	0.0011	0.11	0.00	None
15	1.5	3	0.4	10	0.0333	3.33	1.00	Mayor
16	1.5	1	0.4	12	0.0182	1.82	0.88	Mayor
17	1.5	2	0.4	12	0.0018	0.18	0.00	None
18	1.5	3	0.4	12	0.0231	2.31	1.00	Mayor

Table C- 34. Analysis Result: San Salvador Earthquake (0.5g) of One-Story Concrete Frame models

MODEL	Column (%)	Direction	PGA (%G)	Story Height(ft)	R_i	DI(%)	DS	DS
1	0.7	1	0.5	8	0.0430	4.30	1.00	Mayor
2	0.7	2	0.5	8	0.0297	2.97	1.00	Mayor
3	0.7	3	0.5	8	0.0399	3.99	1.00	Mayor
4	0.7	1	0.5	10	0.0291	2.91	1.00	Mayor
5	0.7	2	0.5	10	0.0341	3.41	1.00	Mayor
6	0.7	3	0.5	10	0.0324	3.24	1.00	Mayor
7	0.7	1	0.5	12	0.0297	2.97	1.00	Mayor
8	0.7	2	0.5	12	0.0245	2.45	1.00	Mayor
9	0.7	3	0.5	12	0.0270	2.70	1.00	Mayor
10	1.5	1	0.5	8	0.0028	0.28	0.00	None
11	1.5	2	0.5	8	0.0008	0.08	0.00	None
12	1.5	3	0.5	8	0.0458	4.58	1.00	Mayor
13	1.5	1	0.5	10	0.0160	1.60	0.73	Substantial
14	1.5	2	0.5	10	0.0014	0.14	0.00	None
15	1.5	3	0.5	10	0.0394	3.94	1.00	Mayor
16	1.5	1	0.5	12	0.0207	2.07	1.00	Mayor
17	1.5	2	0.5	12	0.0030	0.30	0.00	None
18	1.5	3	0.5	12	0.0292	2.92	1.00	Mayor

ATable C- 35. Analysis Result: San Salvador Earthquake (0.6-0.8g) of One-Story Concrete Frame models

MODEL	Column (%)	Direction	PGA (%G)	Story Height(ft)	R_i	DI(%)	DS	DS
10	1.5	1	0.6	8	0.0051	0.51	0.01	None
11	1.5	2	0.6	8	0.0011	0.11	0.00	None
13	1.5	1	0.6	10	0.0248	2.48	1.00	Mayor
14	1.5	2	0.6	10	0.0018	0.18	0.00	None
17	1.5	2	0.6	12	0.0061	0.61	0.07	Minor
10	1.5	1	0.7	8	0.0102	1.02	0.35	Minor
11	1.5	2	0.7	8	0.0015	0.15	0.00	None
13	1.5	1	0.7	10	0.0360	3.60	1.00	Mayor
14	1.5	2	0.7	10	0.0025	0.25	0.00	None
17	1.5	2	0.7	12	0.0130	1.30	0.53	Moderate
10	1.5	1	0.8	8	0.0182	1.82	0.88	Mayor
11	1.5	2	0.8	8	0.0021	0.21	0.00	None
13	1.5	1	0.8	10	0.0451	4.51	1.00	Mayor
14	1.5	2	0.8	10	0.0038	0.38	0.00	None
17	1.5	2	0.8	12	0.0203	2.03	1.00	Mayor

Table C- 36. Analysis Result: San Salvador Earthquake (0.9-1.3g) of One-Story Concrete Frame models

MODEL	Column (%)	Direction	PGA (%G)	Story Height(ft)	R_i	DI(%)	DS	DS
10	1.5	1	0.9	8	0.0251	2.51	1.00	Mayor
11	1.5	2	0.9	8	0.0034	0.34	0.00	None
13	1.5	1	0.9	10	0.0533	5.33	1.00	Mayor
14	1.5	2	0.9	10	0.0056	0.56	0.04	None
17	1.5	2	0.9	12	0.0272	2.72	1.00	Mayor
10	1.5	1	1	8	0.0314	3.14	1.00	Mayor
11	1.5	2	1	8	0.0036	0.36	0.00	None
13	1.5	1	1	10	0.0606	6.06	1.00	Mayor
14	1.5	2	1	10	0.0085	0.85	0.24	Minor
17	1.5	2	1	12	0.0348	3.48	1.00	Mayor
11	1.5	2	1.1	8	0.0040	0.40	0.00	None
14	1.5	2	1.1	10	0.0166	1.66	0.78	Mayor
11	1.5	2	1.2	8	0.0046	0.46	0.00	None
14	1.5	2	1.2	10	0.0264	2.64	1.00	Mayor
11	1.5	2	1.3	8	0.0494	4.94	1.00	Mayor
14	1.5	2	1.3	10	0.0815	8.15	1	Mayor

C.2 TWO-STORY CONCRETE MOMENT FRAME MODELS

Table C- 37. Analysis Result: Mayagüez Earthquake (0.1g) of Two-Story Concrete Frame models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	R_i	DI(%)	DS	DS
1	1	1	0.1	8	0.0050	0.50	0.00	none
2	1	2	0.1	8	0.0025	0.25	0.00	none
3	1	3	0.1	8	0.0112	1.12	0.42	Moderate
4	1	1	0.1	10	0.0058	0.58	0.05	Minor
5	1	2	0.1	10	0.0025	0.25	0.00	none
6	1	3	0.1	10	0.0184	1.84	0.89	Major
7	1	1	0.1	12	0.0059	0.59	0.06	Minor
8	1	2	0.1	12	0.0035	0.35	0.00	none
9	1	3	0.1	12	0.0130	1.30	0.53	Moderate
10	1.5	1	0.1	8	0.0025	0.25	0.00	none
11	1.5	2	0.1	8	0.0011	0.11	0.00	none
12	1.5	3	0.1	8	0.0068	0.68	0.12	Minor
13	1.5	1	0.1	10	0.0027	0.27	0.00	none
14	1.5	2	0.1	10	0.0014	0.14	0.00	none
15	1.5	3	0.1	10	0.0064	0.64	0.09	Minor
16	1.5	1	0.1	12	0.0033	0.33	0.00	none
17	1.5	2	0.1	12	0.0016	0.16	0.00	none
18	1.5	3	0.1	12	0.0067	0.67	0.11	Minor

Table C- 38. Analysis Result: Mayagüez Earthquake (0.2g) of Two-Story Concrete Frame models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	R_i	DI(%)	DS	DS
1	1	1	0.2	8	0.0125	1.25	0.50	Moderate
2	1	2	0.2	8	0.0057	0.57	0.04	none
3	1	3	0.2	8	0.0218	2.18	1.00	Major
4	1	1	0.2	10	0.0139	1.39	0.59	Substantial
5	1	2	0.2	10	0.0068	0.68	0.12	Minor
6	1	3	0.2	10	0.0266	2.66	1.00	Major
7	1	1	0.2	12	0.0118	1.18	0.45	Moderate
8	1	2	0.2	12	0.0081	0.81	0.21	Minor
9	1	3	0.2	12	0.0172	1.72	0.81	Major
10	1.5	1	0.2	8	0.0058	0.58	0.06	Minor
11	1.5	2	0.2	8	0.0034	0.34	0.00	none
12	1.5	3	0.2	8	0.0159	1.59	0.73	Substantial
13	1.5	1	0.2	10	0.0076	0.76	0.17	Minor
14	1.5	2	0.2	10	0.0031	0.31	0.00	none
15	1.5	3	0.2	10	0.0144	1.44	0.63	Substantial
16	1.5	1	0.2	12	0.0102	1.02	0.35	Minor
17	1.5	2	0.2	12	0.0040	0.40	0.00	none
18	1.5	3	0.2	12	0.0137	1.37	0.58	Substantial

Table C- 39. Analysis Result: Mayagüez Earthquake (0.3g) of Two-Story Concrete Frame models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	R_i	DI(%)	DS	DS
1	1	1	0.3	8	0.0301	3.01	1.00	Major
2	1	2	0.3	8	0.0083	0.83	0.22	Minor
3	1	3	0.3	8	0.0361	3.61	1.00	Major
4	1	1	0.3	10	0.0178	1.78	0.85	Major
5	1	2	0.3	10	0.0123	1.23	0.49	Moderate
6	1	3	0.3	10	0.0332	3.32	1.00	Major
7	1	1	0.3	12	0.0190	1.90	0.93	Major
8	1	2	0.3	12	0.0183	1.83	0.88	Major
9	1	3	0.3	12	0.0330	3.30	1.00	Major
10	1.5	1	0.3	8	0.0110	1.10	0.40	Moderate
11	1.5	2	0.3	8	0.0046	0.46	0.00	none
12	1.5	3	0.3	8	0.0252	2.52	1.00	Major
13	1.5	1	0.3	10	0.0132	1.32	0.55	Moderate
14	1.5	2	0.3	10	0.0062	0.62	0.08	Minor
15	1.5	3	0.3	10	0.0221	2.21	1.00	Major
16	1.5	1	0.3	12	0.0133	1.33	0.56	Substantial
17	1.5	2	0.3	12	0.0062	0.62	0.08	Minor
18	1.5	3	0.3	12	0.0216	2.16	1.00	Major

Table C- 40. Analysis Result: Mayagüez Earthquake (0.4g) of Two-Story Concrete Frame models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	R_i	DI(%)	DS	DS
1	1	1	0.4	8	0.0371	3.71	1.00	Major
2	1	2	0.4	8	0.0189	1.89	0.93	Major
3	1	3	0.4	8	0.0516	5.16	1.00	Major
4	1	1	0.4	10	0.0260	2.60	1.00	Major
5	1	2	0.4	10	0.0178	1.78	0.85	Major
6	1	3	0.4	10	0.0551	5.51	1.00	Major
7	1	1	0.4	12	0.0242	2.42	1.00	Major
8	1	2	0.4	12	0.0223	2.23	1.00	Major
9	1	3	0.4	12	0.0580	5.80	1.00	Major
10	1.5	1	0.4	8	0.0177	1.77	0.85	Major
11	1.5	2	0.4	8	0.0070	0.70	0.13	Minor
12	1.5	3	0.4	8	0.0352	3.52	1.00	Major
13	1.5	1	0.4	10	0.0226	2.26	1.00	Major
14	1.5	2	0.4	10	0.0086	0.86	0.24	Minor
15	1.5	3	0.4	10	0.0302	3.02	1.00	Major
16	1.5	1	0.4	12	0.0191	1.91	0.94	Major
17	1.5	2	0.4	12	0.0107	1.07	0.38	Moderate
18	1.5	3	0.4	12	0.0390	3.90	1.00	Major

Table C- 41. Analysis Result: Mayagüez Earthquake (0.5g) of Two-Story Concrete Frame models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	R_i	DI(%)	DS	DS
1	1	1	0.5	8	0.0437	4.37	1.00	Major
2	1	2	0.5	8	0.0262	2.62	1.00	Major
3	1	3	0.5	8	0.0658	6.58	1.00	Major
4	1	1	0.5	10	0.0346	3.46	1.00	Major
5	1	2	0.5	10	0.0328	3.28	1.00	Major
6	1	3	0.5	10	0.0698	6.98	1.00	Major
7	1	1	0.5	12	0.0295	2.95	1.00	Major
8	1	2	0.5	12	0.0243	2.43	1.00	Major
9	1	3	0.5	12	0.0724	7.24	1.00	Major
10	1.5	1	0.5	8	0.0239	2.39	1.00	Major
11	1.5	2	0.5	8	0.0108	1.08	0.39	Moderate
12	1.5	3	0.5	8	0.0406	4.06	1.00	Major
13	1.5	1	0.5	10	0.0258	2.58	1.00	Major
14	1.5	2	0.5	10	0.0118	1.18	0.46	Moderate
15	1.5	3	0.5	10	0.0410	4.10	1.00	Major
16	1.5	1	0.5	12	0.0230	2.30	1.00	Major
17	1.5	2	0.5	12	0.0156	1.56	0.71	Substantial
18	1.5	3	0.5	12	0.0450	4.50	1.00	Major

Table C- 42. Analysis Result: Mayagüez Earthquake (0.6-1 g) of Two-Story Concrete Frame models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	R_i	DI(%)	DS	DS
11	1.5	2	0.6	8	0.0146	1.46	0.64	Substantial
14	1.5	2	0.6	10	0.0167	1.67	0.78	Major
17	1.5	2	0.6	12	0.0198	1.98	0.99	Major
11	1.5	2	0.7	8	0.0177	1.77	0.85	Major
14	1.5	2	0.7	10	0.0219	2.19	1.00	Major
17	1.5	2	0.7	12	0.0285	2.85	1.00	Major
11	1.5	2	0.8	8	0.0219	2.19	1.00	Major
14	1.5	2	0.8	10	0.0323	3.23	1.00	Major
17	1.5	2	0.8	12	0.0389	3.89	1.00	Major
11	1.5	2	0.9	8	0.0292	2.92	1.00	Major
14	1.5	2	0.9	10	0.0385	3.85	1.00	Major
17	1.5	2	0.9	12	0.0417	4.17	1.00	Major
11	1.5	2	1	8	0.0146	1.46	0.64	Substantial
14	1.5	2	1	10	0.0208	2.08	1.00	Major
17	1.5	2	1	12	0.0135	1.35	0.57	Substantial

Table C- 43. Analysis Result: San Juan Earthquake (0.1g) of Two-Story Concrete Frame models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	R_i	DI(%)	DS	DS
1	1	1	0.1	8	0.0028	0.28	0.00	none
2	1	2	0.1	8	0.0020	0.20	0.00	none
3	1	3	0.1	8	0.0045	0.45	0.00	none
4	1	1	0.1	10	0.0021	0.21	0.00	none
5	1	2	0.1	10	0.0020	0.20	0.00	none
6	1	3	0.1	10	0.0056	0.56	0.04	none
7	1	1	0.1	12	0.0026	0.26	0.00	none
8	1	2	0.1	12	0.0017	0.17	0.00	none
9	1	3	0.1	12	0.0037	0.37	0.00	none
10	1.5	1	0.1	8	0.0023	0.23	0.00	none
11	1.5	2	0.1	8	0.0013	0.13	0.00	none
12	1.5	3	0.1	8	0.0033	0.33	0.00	none
13	1.5	1	0.1	10	0.0021	0.21	0.00	none
14	1.5	2	0.1	10	0.0014	0.14	0.00	none
15	1.5	3	0.1	10	0.0027	0.27	0.00	none
16	1.5	1	0.1	12	0.0021	0.21	0.00	none
17	1.5	2	0.1	12	0.0016	0.16	0.00	none
18	1.5	3	0.1	12	0.0035	0.35	0.00	none

Table C- 44. Analysis Result: San Juan Earthquake (0.2g) of Two-Story Concrete Frame models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	R_i	DI(%)	DS	DS
1	1	1	0.2	8	0.0052	0.52	0.01	none
2	1	2	0.2	8	0.0051	0.51	0.00	none
3	1	3	0.2	8	0.0132	1.32	0.54	Moderate
4	1	1	0.2	10	0.0056	0.56	0.04	none
5	1	2	0.2	10	0.0037	0.37	0.00	none
6	1	3	0.2	10	0.0117	1.17	0.45	Moderate
7	1	1	0.2	12	0.0056	0.56	0.04	none
8	1	2	0.2	12	0.0032	0.32	0.00	none
9	1	3	0.2	12	0.0096	0.96	0.30	Minor
10	1.5	1	0.2	8	0.0048	0.48	0.00	none
11	1.5	2	0.2	8	0.0031	0.31	0.00	none
12	1.5	3	0.2	8	0.0066	0.66	0.10	Minor
13	1.5	1	0.2	10	0.0046	0.46	0.00	none
14	1.5	2	0.2	10	0.0034	0.34	0.00	none
15	1.5	3	0.2	10	0.0076	0.76	0.18	Minor
16	1.5	1	0.2	12	0.0035	0.35	0.00	none
17	1.5	2	0.2	12	0.0036	0.36	0.00	none
18	1.5	3	0.2	12	0.0070	0.70	0.13	Minor

Table C- 45. Analysis Result: San Juan Earthquake (0.3g) of Two-Story Concrete Frame models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	R_i	DI(%)	DS	DS
1	1	1	0.3	8	0.0091	0.91	0.27	Minor
2	1	2	0.3	8	0.0078	0.78	0.18	Minor
3	1	3	0.3	8	0.0227	2.27	1.00	Major
4	1	1	0.3	10	0.0101	1.01	0.34	Minor
5	1	2	0.3	10	0.0062	0.62	0.08	Minor
6	1	3	0.3	10	0.0215	2.15	1.00	Major
7	1	1	0.3	12	0.0094	0.94	0.30	Minor
8	1	2	0.3	12	0.0057	0.57	0.05	none
9	1	3	0.3	12	0.0168	1.68	0.79	Major
10	1.5	1	0.3	8	0.0068	0.68	0.12	Minor
11	1.5	2	0.3	8	0.0049	0.49	0.00	none
12	1.5	3	0.3	8	0.0139	1.39	0.60	Substantial
13	1.5	1	0.3	10	0.0056	0.56	0.04	none
14	1.5	2	0.3	10	0.0053	0.53	0.02	none
15	1.5	3	0.3	10	0.0113	1.13	0.42	Moderate
16	1.5	1	0.3	12	0.0061	0.61	0.08	Minor
17	1.5	2	0.3	12	0.0052	0.52	0.02	none
18	1.5	3	0.3	12	0.0135	1.35	0.57	Substantial

Table C- 46. Analysis Result: San Juan Earthquake (0.4g) of Two-Story Concrete Frame models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	R_i	DI(%)	DS	DS
1	1	1	0.4	8	0.0161	1.61	0.74	Substantial
2	1	2	0.4	8	0.0092	0.92	0.28	Minor
3	1	3	0.4	8	0.0349	3.49	1.00	Major
4	1	1	0.4	10	0.0138	1.38	0.58	Substantial
5	1	2	0.4	10	0.0077	0.77	0.18	Minor
6	1	3	0.4	10	0.0282	2.82	1.00	Major
7	1	1	0.4	12	0.0150	1.50	0.67	Substantial
8	1	2	0.4	12	0.0090	0.90	0.27	Minor
9	1	3	0.4	12	0.0256	2.56	1.00	Major
10	1.5	1	0.4	8	0.0086	0.86	0.24	Minor
11	1.5	2	0.4	8	0.0071	0.71	0.14	Minor
12	1.5	3	0.4	8	0.0167	1.67	0.78	Major
13	1.5	1	0.4	10	0.0083	0.83	0.22	Minor
14	1.5	2	0.4	10	0.0073	0.73	0.15	Minor
15	1.5	3	0.4	10	0.0152	1.52	0.68	Substantial
16	1.5	1	0.4	12	0.0099	0.99	0.32	Minor
17	1.5	2	0.4	12	0.0061	0.61	0.07	Minor
18	1.5	3	0.4	12	0.0196	1.96	0.97	Major

Table C- 47. Analysis Result: San Juan Earthquake (0.5g) of Two-Story Concrete Frame models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	R_i	DI(%)	DS	DS
1	1	1	0.5	8	0.0213	2.13	1.00	Major
2	1	2	0.5	8	0.0119	1.19	0.46	Moderate
3	1	3	0.5	8	0.0392	3.92	1.00	Major
4	1	1	0.5	10	0.0210	2.10	1.00	Major
5	1	2	0.5	10	0.0087	0.87	0.25	Minor
6	1	3	0.5	10	0.0363	3.63	1.00	Major
7	1	1	0.5	12	0.0185	1.85	0.90	Major
8	1	2	0.5	12	0.0130	1.30	0.53	Moderate
9	1	3	0.5	12	0.0315	3.15	1.00	Major
10	1.5	1	0.5	8	0.0110	1.10	0.40	Moderate
11	1.5	2	0.5	8	0.0089	0.89	0.26	Minor
12	1.5	3	0.5	8	0.0215	2.15	1.00	Major
13	1.5	1	0.5	10	0.0113	1.13	0.42	Moderate
14	1.5	2	0.5	10	0.0082	0.82	0.21	Minor
15	1.5	3	0.5	10	0.0245	2.45	1.00	Major
16	1.5	1	0.5	12	0.0144	1.44	0.63	Substantial
17	1.5	2	0.5	12	0.0073	0.73	0.15	Minor
18	1.5	3	0.5	12	0.0243	2.43	1.00	Major

Table C- 48. Analysis Result: San Juan Earthquake (0.6-0.7g) of Two-Story Concrete Frame models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	R_i	DI(%)	DS	DS
2	1	2	0.6	8	0.0146	1.46	0.64	Substantial
5	1	2	0.6	10	0.0142	1.42	0.61	Substantial
8	1	2	0.6	12	0.0174	1.74	0.82	Major
10	1.5	1	0.6	8	0.0135	1.35	0.57	Substantial
11	1.5	2	0.6	8	0.0115	1.15	0.43	Moderate
13	1.5	1	0.6	10	0.0167	1.67	0.78	Major
14	1.5	2	0.6	10	0.0104	1.04	0.36	Moderate
16	1.5	1	0.6	12	0.0167	1.67	0.78	Major
17	1.5	2	0.6	12	0.0090	0.90	0.27	Minor
2	1	2	0.7	8	0.0167	1.67	0.78	Major
5	1	2	0.7	10	0.0208	2.08	1.00	Major
8	1	2	0.7	12	0.0215	2.15	1.00	Major
10	1.5	1	0.7	8	0.0167	1.67	0.78	Major
11	1.5	2	0.7	8	0.0135	1.35	0.57	Substantial
13	1.5	1	0.7	10	0.0219	2.19	1.00	Major
14	1.5	2	0.7	10	0.0125	1.25	0.50	Moderate
16	1.5	1	0.7	12	0.0208	2.08	1.00	Major
17	1.5	2	0.7	12	0.0104	1.04	0.36	Moderate

Table C- 49. Analysis Result: San Juan Earthquake (0.8-0.9g) of Two-Story Concrete Frame models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	R_i	DI(%)	DS	DS
2	1	2	0.8	8	0.0198	1.98	0.99	Major
5	1	2	0.8	10	0.0260	2.60	1.00	Major
8	1	2	0.8	12	0.0243	2.43	1.00	Major
10	1.5	1	0.8	8	0.0208	2.08	1.00	Major
11	1.5	2	0.8	8	0.0156	1.56	0.71	Substantial
13	1.5	1	0.8	10	0.0260	2.60	1.00	Major
14	1.5	2	0.8	10	0.0146	1.46	0.64	Substantial
16	1.5	1	0.8	12	0.0240	2.40	1.00	Major
17	1.5	2	0.8	12	0.0125	1.25	0.50	Moderate
2	1	2	0.9	8	0.0271	2.71	1.00	Major
5	1	2	0.9	10	0.0313	3.13	1.00	Major
8	1	2	0.9	12	0.0285	2.85	1.00	Major
10	1.5	1	0.9	8	0.0271	2.71	1.00	Major
11	1.5	2	0.9	8	0.0167	1.67	0.78	Major
13	1.5	1	0.9	10	0.0292	2.92	1.00	Major
14	1.5	2	0.9	10	0.0167	1.67	0.78	Major
16	1.5	1	0.9	12	0.0271	2.71	1.00	Major
17	1.5	2	0.9	12	0.0156	1.56	0.71	Substantial

Table C- 50. Analysis Result: San Juan Earthquake (1-1.5g) of Two-Story Concrete Frame models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	R_i	DI(%)	DS	DS
2	1	2	1	8	0.0365	3.65	1.00	Major
5	1	2	1	10	0.0365	3.65	1.00	Major
8	1	2	1	12	0.0333	3.33	1.00	Major
10	1.5	1	1	8	0.0313	3.13	1.00	Major
11	1.5	2	1	8	0.0188	1.88	0.92	Major
13	1.5	1	1	10	0.0323	3.23	1.00	Major
14	1.5	2	1	10	0.0188	1.88	0.92	Major
16	1.5	1	1	12	0.0281	2.81	1.00	Major
17	1.5	2	1	12	0.0201	2.01	1.00	Major

Table C- 51. Analysis Result: Northridge Earthquake (0.1g) of Two-Story Concrete Frame models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	R_i	DI(%)	DS	DS
1	1	1	0.1	8	0.0031	0.31	0.00	none
2	1	2	0.1	8	0.0021	0.21	0.00	none
3	1	3	0.1	8	0.0094	0.94	0.29	Minor
4	1	1	0.1	10	0.0033	0.33	0.00	none
5	1	2	0.1	10	0.0021	0.21	0.00	none
6	1	3	0.1	10	0.0083	0.83	0.22	Minor
7	1	1	0.1	12	0.0042	0.42	0.00	none
8	1	2	0.1	12	0.0028	0.28	0.00	none
9	1	3	0.1	12	0.0063	0.63	0.08	Minor
10	1.5	1	0.1	8	0.0021	0.21	0.00	none
11	1.5	2	0.1	8	0.0010	0.10	0.00	none
12	1.5	3	0.1	8	0.0052	0.52	0.01	none
13	1.5	1	0.1	10	0.0021	0.21	0.00	none
14	1.5	2	0.1	10	0.0010	0.10	0.00	none
15	1.5	3	0.1	10	0.0042	0.42	0.00	none
16	1.5	1	0.1	12	0.0031	0.31	0.00	none
17	1.5	2	0.1	12	0.0021	0.21	0.00	none
18	1.5	3	0.1	12	0.0031	0.31	0.00	none

Table C- 52. Analysis Result: Northridge Earthquake (0.2g) of Two-Story Concrete Frame models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	R_i	DI(%)	DS	DS
1	1	1	0.2	8	0.0083	0.83	0.22	Minor
2	1	2	0.2	8	0.0052	0.52	0.01	none
3	1	3	0.2	8	0.0188	1.88	0.92	Major
4	1	1	0.2	10	0.0094	0.94	0.29	Minor
5	1	2	0.2	10	0.0058	0.58	0.06	Minor
6	1	3	0.2	10	0.0146	1.46	0.64	Substantial
7	1	1	0.2	12	0.0104	1.04	0.36	Moderate
8	1	2	0.2	12	0.0049	0.49	0.00	none
9	1	3	0.2	12	0.0115	1.15	0.43	Moderate
10	1.5	1	0.2	8	0.0052	0.52	0.01	none
11	1.5	2	0.2	8	0.0031	0.31	0.00	none
12	1.5	3	0.2	8	0.0135	1.35	0.57	Substantial
13	1.5	1	0.2	10	0.0052	0.52	0.01	none
14	1.5	2	0.2	10	0.0042	0.42	0.00	none
15	1.5	3	0.2	10	0.0133	1.33	0.56	Substantial
16	1.5	1	0.2	12	0.0052	0.52	0.01	none
17	1.5	2	0.2	12	0.0042	0.42	0.00	none
18	1.5	3	0.2	12	0.0125	1.25	0.50	Moderate

Table C- 53. Analysis Result: Northridge Earthquake (0.3g) of Two-Story Concrete Frame models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	R_i	DI(%)	DS	DS
1	1	1	0.3	8	0.0146	1.46	0.64	Substantial
2	1	2	0.3	8	0.0073	0.73	0.15	Minor
3	1	3	0.3	8	0.0271	2.71	1.00	Major
4	1	1	0.3	10	0.0146	1.46	0.64	Substantial
5	1	2	0.3	10	0.0083	0.83	0.22	Minor
6	1	3	0.3	10	0.0240	2.40	1.00	Major
7	1	1	0.3	12	0.0146	1.46	0.64	Substantial
8	1	2	0.3	12	0.0097	0.97	0.31	Minor
9	1	3	0.3	12	0.0271	2.71	1.00	Major
10	1.5	1	0.3	8	0.0094	0.94	0.29	Minor
11	1.5	2	0.3	8	0.0042	0.42	0.00	none
12	1.5	3	0.3	8	0.0240	2.40	1.00	Major
13	1.5	1	0.3	10	0.0083	0.83	0.22	Minor
14	1.5	2	0.3	10	0.0052	0.52	0.01	none
15	1.5	3	0.3	10	0.0200	2.00	1.00	Major
16	1.5	1	0.3	12	0.0104	1.04	0.36	Moderate
17	1.5	2	0.3	12	0.0052	0.52	0.01	none
18	1.5	3	0.3	12	0.0153	1.53	0.69	Substantial

Table C- 54. Analysis Result: Northridge Earthquake (0.4g) of Two-Story Concrete Frame models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	R_i	DI(%)	DS	DS
1	1	1	0.4	8	0.0260	2.60	1.00	Major
2	1	2	0.4	8	0.0135	1.35	0.57	Substantial
3	1	3	0.4	8	0.0448	4.48	1.00	Major
4	1	1	0.4	10	0.0208	2.08	1.00	Major
5	1	2	0.4	10	0.0108	1.08	0.39	Moderate
6	1	3	0.4	10	0.0490	4.90	1.00	Major
7	1	1	0.4	12	0.0201	2.01	1.00	Major
8	1	2	0.4	12	0.0160	1.60	0.73	Substantial
9	1	3	0.4	12	0.0542	5.42	1.00	Major
10	1.5	1	0.4	8	0.0125	1.25	0.50	Moderate
11	1.5	2	0.4	8	0.0083	0.83	0.22	Minor
12	1.5	3	0.4	8	0.0260	2.60	1.00	Major
13	1.5	1	0.4	10	0.0146	1.46	0.64	Substantial
14	1.5	2	0.4	10	0.0075	0.75	0.17	Minor
15	1.5	3	0.4	10	0.0250	2.50	1.00	Major
16	1.5	1	0.4	12	0.0135	1.35	0.57	Substantial
17	1.5	2	0.4	12	0.0090	0.90	0.27	Minor
18	1.5	3	0.4	12	0.0257	2.57	1.00	Major

Table C- 55. Analysis Result: Northridge Earthquake (0.5g) of Two-Story Concrete Frame models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	R_i	DI(%)	DS	DS
2	1	2	0.5	8	0.0167	1.67	0.78	Major
5	1	2	0.5	10	0.0158	1.58	0.72	Substantial
8	1	2	0.5	12	0.0194	1.94	0.96	Major
10	1.5	1	0.5	8	0.0156	1.56	0.71	Substantial
11	1.5	2	0.5	8	0.0104	1.04	0.36	Moderate
13	1.5	1	0.5	10	0.0177	1.77	0.85	Major
14	1.5	2	0.5	10	0.0094	0.94	0.29	Minor
16	1.5	1	0.5	12	0.0188	1.88	0.92	Major
17	1.5	2	0.5	12	0.0111	1.11	0.41	Moderate
2	1	2	0.6	8	0.0219	2.19	1.00	Major
5	1	2	0.6	10	0.0229	2.29	1.00	Major
8	1	2	0.6	12	0.0208	2.08	1.00	Major
10	1.5	1	0.6	8	0.0198	1.98	0.99	Major
11	1.5	2	0.6	8	0.0125	1.25	0.50	Moderate
13	1.5	1	0.6	10	0.0229	2.29	1.00	Major
14	1.5	2	0.6	10	0.0135	1.35	0.57	Substantial
16	1.5	1	0.6	12	0.0240	2.40	1.00	Major
17	1.5	2	0.6	12	0.0135	1.35	0.57	Substantial

Table C- 56. Analysis Result: Northridge Earthquake (0.7-0.8g) of Two-Story Concrete Frame models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	R_i	DI(%)	DS	DS
2	1	2	0.7	8	0.0281	2.81	1.00	Major
5	1	2	0.7	10	0.0281	2.81	1.00	Major
8	1	2	0.7	12	0.0285	2.85	1.00	Major
10	1.5	1	0.7	8	0.0271	2.71	1.00	Major
11	1.5	2	0.7	8	0.0156	1.56	0.71	Substantial
13	1.5	1	0.7	10	0.0177	1.77	0.85	Major
14	1.5	2	0.7	10	0.0342	3.42	1.00	Major
16	1.5	1	0.7	12	0.0167	1.67	0.78	Major
17	1.5	2	0.7	12	0.0281	2.81	1.00	Major
2	1	2	0.8	8	0.0396	3.96	1.00	Major
5	1	2	0.8	10	0.0344	3.44	1.00	Major
8	1	2	0.8	12	0.0354	3.54	1.00	Major
10	1.5	1	0.8	8	0.0333	3.33	1.00	Major
11	1.5	2	0.8	8	0.0146	1.46	0.64	Substantial
13	1.5	1	0.8	10	0.0333	3.33	1.00	Major
14	1.5	2	0.8	10	0.0198	1.98	0.99	Major
16	1.5	1	0.8	12	0.0365	3.65	1.00	Major
17	1.5	2	0.8	12	0.0215	2.15	1.00	Major

Table C- 57. Analysis Result: Northridge Earthquake (0.9-1 g) of Two-Story Concrete Frame models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	R_i	DI(%)	DS	DS
2	1	2	0.9	8	0.0510	5.10	1.00	Major
5	1	2	0.9	10	0.0396	3.96	1.00	Major
8	1	2	0.9	12	0.0410	4.10	1.00	Major
10	1.5	1	0.9	8	0.0385	3.85	1.00	Major
11	1.5	2	0.9	8	0.0146	1.46	0.64	Substantial
13	1.5	1	0.9	10	0.0396	3.96	1.00	Major
14	1.5	2	0.9	10	0.0198	1.98	0.99	Major
16	1.5	1	0.9	12	0.0427	4.27	1.00	Major
17	1.5	2	0.9	12	0.0215	2.15	1.00	Major
2	1	2	1	8	0.0583	5.83	1.00	Major
5	1	2	1	10	0.0479	4.79	1.00	Major
8	1	2	1	12	0.0458	4.58	1.00	Major
10	1.5	1	1	8	0.0448	4.48	1.00	Major
11	1.5	2	1	8	0.0250	2.50	1.00	Major
13	1.5	1	1	10	0.0448	4.48	1.00	Major
14	1.5	2	1	10	0.0250	2.50	1.00	Major
16	1.5	1	1	12	0.0479	4.79	1.00	Major
17	1.5	2	1	12	0.0285	2.85	1.00	Major

Table C- 58. Analysis Result: Centro Earthquake (0.1g) of Two-Story Concrete Frame models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	R_i	DI(%)	DS	DS
1	1	1	0.1	8	0.0042	0.42	0.00	none
2	1	2	0.1	8	0.0010	0.10	0.00	none
3	1	3	0.1	8	0.0104	1.04	0.36	Moderate
4	1	1	0.1	10	0.0063	0.63	0.08	Minor
5	1	2	0.1	10	0.0025	0.25	0.00	none
6	1	3	0.1	10	0.0094	0.94	0.29	Minor
7	1	1	0.1	12	0.0052	0.52	0.01	none
8	1	2	0.1	12	0.0028	0.28	0.00	none
9	1	3	0.1	12	0.0056	0.56	0.04	none
10	1.5	1	0.1	8	0.0010	0.10	0.00	none
11	1.5	2	0.1	8	0.0010	0.10	0.00	none
12	1.5	3	0.1	8	0.0073	0.73	0.15	Minor
13	1.5	1	0.1	10	0.0021	0.21	0.00	none
14	1.5	2	0.1	10	0.0010	0.10	0.00	none
15	1.5	3	0.1	10	0.0067	0.67	0.11	Minor
16	1.5	1	0.1	12	0.0031	0.31	0.00	none
17	1.5	2	0.1	12	0.0010	0.10	0.00	none
18	1.5	3	0.1	12	0.0063	0.63	0.08	Minor

Table C- 59. Analysis Result: Centro Earthquake (0.2g) of Two-Story Concrete Frame models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	R_i	DI(%)	DS	DS
1	1	1	0.2	8	0.0135	1.35	0.57	Substantial
2	1	2	0.2	8	0.0042	0.42	0.00	none
3	1	3	0.2	8	0.0208	2.08	1.00	Major
4	1	1	0.2	10	0.0115	1.15	0.43	Moderate
5	1	2	0.2	10	0.0067	0.67	0.11	Minor
6	1	3	0.2	10	0.0208	2.08	1.00	Major
7	1	1	0.2	12	0.0118	1.18	0.45	Moderate
8	1	2	0.2	12	0.0090	0.90	0.27	Minor
9	1	3	0.2	12	0.0135	1.35	0.57	Substantial
10	1.5	1	0.2	8	0.0042	0.42	0.00	none
11	1.5	2	0.2	8	0.0021	0.21	0.00	none
12	1.5	3	0.2	8	0.0156	1.56	0.71	Substantial
13	1.5	1	0.2	10	0.0063	0.63	0.08	Minor
14	1.5	2	0.2	10	0.0021	0.21	0.00	none
15	1.5	3	0.2	10	0.0133	1.33	0.56	Substantial
16	1.5	1	0.2	12	0.0083	0.83	0.22	Minor
17	1.5	2	0.2	12	0.0031	0.31	0.00	none
18	1.5	3	0.2	12	0.0125	1.25	0.50	Moderate

Table C- 60. Analysis Result: Centro Earthquake (0.3g) of Two-Story Concrete Frame models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	R_i	DI(%)	DS	DS
1	1	1	0.3	8	0.0240	2.40	1.00	Major
2	1	2	0.3	8	0.0104	1.04	0.36	Moderate
3	1	3	0.3	8	0.0333	3.33	1.00	Major
4	1	1	0.3	10	0.0188	1.88	0.92	Major
5	1	2	0.3	10	0.0125	1.25	0.50	Moderate
6	1	3	0.3	10	0.0375	3.75	1.00	Major
7	1	1	0.3	12	0.0167	1.67	0.78	Major
8	1	2	0.3	12	0.0146	1.46	0.64	Substantial
9	1	3	0.3	12	0.0260	2.60	1.00	Major
10	1.5	1	0.3	8	0.0094	0.94	0.29	Minor
11	1.5	2	0.3	8	0.0031	0.31	0.00	none
12	1.5	3	0.3	8	0.0240	2.40	1.00	Major
13	1.5	1	0.3	10	0.0135	1.35	0.57	Substantial
14	1.5	2	0.3	10	0.0042	0.42	0.00	none
15	1.5	3	0.3	10	0.0192	1.92	0.94	Major
16	1.5	1	0.3	12	0.0125	1.25	0.50	Moderate
17	1.5	2	0.3	12	0.0063	0.63	0.08	Minor
18	1.5	3	0.3	12	0.0188	1.88	0.92	Major

Table C- 61. Analysis Result: Centro Earthquake (0.4g) of Two-Story Concrete Frame models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	R_i	DI(%)	DS	DS
1	1	1	0.4	8	0.0323	3.23	1.00	Major
2	1	2	0.4	8	0.0146	1.46	0.64	Substantial
3	1	3	0.4	8	0.0448	4.48	1.00	Major
4	1	1	0.4	10	0.0260	2.60	1.00	Major
5	1	2	0.4	10	0.0188	1.88	0.92	Major
6	1	3	0.4	10	0.0542	5.42	1.00	Major
7	1	1	0.4	12	0.0219	2.19	1.00	Major
8	1	2	0.4	12	0.0188	1.88	0.92	Major
9	1	3	0.4	12	0.0365	3.65	1.00	Major
10	1.5	1	0.4	8	0.0177	1.77	0.85	Major
11	1.5	2	0.4	8	0.0052	0.52	0.01	none
12	1.5	3	0.4	8	0.0313	3.13	1.00	Major
13	1.5	1	0.4	10	0.0198	1.98	0.99	Major
14	1.5	2	0.4	10	0.0063	0.63	0.08	Minor
15	1.5	3	0.4	10	0.0275	2.75	1.00	Major
16	1.5	1	0.4	12	0.0177	1.77	0.85	Major
17	1.5	2	0.4	12	0.0090	0.90	0.27	Minor
18	1.5	3	0.4	12	0.0271	2.71	1.00	Major

Table C- 62. Analysis Result: Centro Earthquake (0.5g) of Two-Story Concrete Frame models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	R_i	DI(%)	DS	DS
1	1	1	0.5	8	0.0417	4.17	1.00	Major
2	1	2	0.5	8	0.0208	2.08	1.00	Major
3	1	3	0.5	8	0.0719	7.19	1.00	Major
4	1	1	0.5	10	0.0344	3.44	1.00	Major
5	1	2	0.5	10	0.0271	2.71	1.00	Major
6	1	3	0.5	10	0.0615	6.15	1.00	Major
7	1	1	0.5	12	0.0260	2.60	1.00	Major
8	1	2	0.5	12	0.0236	2.36	1.00	Major
9	1	3	0.5	12	0.0510	5.10	1.00	Major
10	1.5	1	0.5	8	0.0260	2.60	1.00	Major
11	1.5	2	0.5	8	0.0073	0.73	0.15	Minor
12	1.5	3	0.5	8	0.0427	4.27	1.00	Major
13	1.5	1	0.5	10	0.0240	2.40	1.00	Major
14	1.5	2	0.5	10	0.0094	0.94	0.29	Minor
15	1.5	3	0.5	10	0.0358	3.58	1.00	Major
16	1.5	1	0.5	12	0.0229	2.29	1.00	Major
17	1.5	2	0.5	12	0.0146	1.46	0.64	Substantial
18	1.5	3	0.5	12	0.0319	3.19	1.00	Major

Table C- 63. Analysis Result: Centro Earthquake (0.6-1 g) of Two-Story Concrete Frame models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	R_i	DI(%)	DS	DS
11	1.5	2	0.6	8	0.0094	0.94	0.29	Minor
14	1.5	2	0.6	10	0.0135	1.35	0.57	Substantial
17	1.5	2	0.6	12	0.0208	2.08	1.00	Major
11	1.5	2	0.7	8	0.0135	1.35	0.57	Substantial
14	1.5	2	0.7	10	0.0177	1.77	0.85	Major
17	1.5	2	0.7	12	0.0260	2.60	1.00	Major
11	1.5	2	0.8	8	0.0156	1.56	0.71	Substantial
14	1.5	2	0.8	10	0.0250	2.50	1.00	Major
17	1.5	2	0.8	12	0.0302	3.02	1.00	Major
11	1.5	2	0.9	8	0.0208	2.08	1.00	Major
14	1.5	2	0.9	10	0.0323	3.23	1.00	Major
17	1.5	2	0.9	12	0.0333	3.33	1.00	Major
11	1.5	2	1	8	0.0240	2.40	1.00	Major
14	1.5	2	1	10	0.0396	3.96	1.00	Major
17	1.5	2	1	12	0.0375	3.75	1.00	Major

Table C- 64. Analysis Result: San Salvador Earthquake (0.1g) of Two-Story Concrete Frame models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	R_i	DI(%)	DS	DS
1	1	1	0.1	8	0.0052	0.52	0.01	none
2	1	2	0.1	8	0.0031	0.31	0.00	none
3	1	3	0.1	8	0.0094	0.94	0.29	Minor
4	1	1	0.1	10	0.0052	0.52	0.01	none
5	1	2	0.1	10	0.0050	0.50	0.00	none
6	1	3	0.1	10	0.0104	1.04	0.36	Moderate
7	1	1	0.1	12	0.0042	0.42	0.00	none
8	1	2	0.1	12	0.0035	0.35	0.00	none
9	1	3	0.1	12	0.0063	0.63	0.08	Minor
10	1.5	1	0.1	8	0.0031	0.31	0.00	none
11	1.5	2	0.1	8	0.0010	0.10	0.00	none
12	1.5	3	0.1	8	0.0052	0.52	0.01	none
13	1.5	1	0.1	10	0.0042	0.42	0.00	none
14	1.5	2	0.1	10	0.0010	0.10	0.00	none
15	1.5	3	0.1	10	0.0050	0.50	0.00	none
16	1.5	1	0.1	12	0.0042	0.42	0.00	none
17	1.5	2	0.1	12	0.0021	0.21	0.00	none
18	1.5	3	0.1	12	0.0042	0.42	0.00	none

Table C- 65. Analysis Result: San Salvador Earthquake (0.2g) of Two-Story Concrete Frame models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	R_i	DI(%)	DS	DS
1	1	1	0.2	8	0.0125	1.25	0.50	Moderate
2	1	2	0.2	8	0.0104	1.04	0.36	Moderate
3	1	3	0.2	8	0.0260	2.60	1.00	Major
4	1	1	0.2	10	0.0115	1.15	0.43	Moderate
5	1	2	0.2	10	0.0075	0.75	0.17	Minor
6	1	3	0.2	10	0.0219	2.19	1.00	Major
7	1	1	0.2	12	0.0083	0.83	0.22	Minor
8	1	2	0.2	12	0.0083	0.83	0.22	Minor
9	1	3	0.2	12	0.0260	2.60	1.00	Major
10	1.5	1	0.2	8	0.0229	2.29	1.00	Major
11	1.5	2	0.2	8	0.0146	1.46	0.64	Substantial
12	1.5	3	0.2	8	0.0406	4.06	1.00	Major
13	1.5	1	0.2	10	0.0240	2.40	1.00	Major
14	1.5	2	0.2	10	0.0146	1.46	0.64	Substantial
15	1.5	3	0.2	10	0.0267	2.67	1.00	Major
16	1.5	1	0.2	12	0.0198	1.98	0.99	Major
17	1.5	2	0.2	12	0.0146	1.46	0.64	Substantial
18	1.5	3	0.2	12	0.0236	2.36	1.00	Major

Table C- 66. Analysis Result: San Salvador Earthquake (0.3g) of Two-Story Concrete Frame models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	R_i	DI(%)	DS	DS
1	1	1	0.3	8	0.0208	2.08	1.00	Major
2	1	2	0.3	8	0.0156	1.56	0.71	Substantial
3	1	3	0.3	8	0.0323	3.23	1.00	Major
4	1	1	0.3	10	0.0177	1.77	0.85	Major
5	1	2	0.3	10	0.0117	1.17	0.44	Moderate
6	1	3	0.3	10	0.0260	2.60	1.00	Major
7	1	1	0.3	12	0.0125	1.25	0.50	Moderate
8	1	2	0.3	12	0.0139	1.39	0.59	Substantial
9	1	3	0.3	12	0.0156	1.56	0.71	Substantial
10	1.5	1	0.3	8	0.0115	1.15	0.43	Moderate
11	1.5	2	0.3	8	0.0052	0.52	0.01	none
12	1.5	3	0.3	8	0.0271	2.71	1.00	Major
13	1.5	1	0.3	10	0.0125	1.25	0.50	Moderate
14	1.5	2	0.3	10	0.0083	0.83	0.22	Minor
15	1.5	3	0.3	10	0.0167	1.67	0.78	Major
16	1.5	1	0.3	12	0.0125	1.25	0.50	Moderate
17	1.5	2	0.3	12	0.0090	0.90	0.27	Minor
18	1.5	3	0.3	12	0.0132	1.32	0.55	Moderate

Table C- 67. Analysis Result: San Salvador Earthquake (0.4g) of Two-Story Concrete Frame models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	R_i	DI(%)	DS	DS
1	1	1	0.4	8	0.0313	3.13	1.00	Major
2	1	2	0.4	8	0.0167	1.67	0.78	Major
3	1	3	0.4	8	0.0365	3.65	1.00	Major
4	1	1	0.4	10	0.0219	2.19	1.00	Major
5	1	2	0.4	10	0.0177	1.77	0.85	Major
6	1	3	0.4	10	0.0333	3.33	1.00	Major
7	1	1	0.4	12	0.0188	1.88	0.92	Major
8	1	2	0.4	12	0.0181	1.81	0.87	Major
9	1	3	0.4	12	0.0208	2.08	1.00	Major
10	1.5	1	0.4	8	0.0156	1.56	0.71	Substantial
11	1.5	2	0.4	8	0.0094	0.94	0.29	Minor
12	1.5	3	0.4	8	0.0365	3.65	1.00	Major
13	1.5	1	0.4	10	0.0188	1.88	0.92	Major
14	1.5	2	0.4	10	0.0135	1.35	0.57	Substantial
15	1.5	3	0.4	10	0.0219	2.19	1.00	Major
16	1.5	1	0.4	12	0.0167	1.67	0.78	Major
17	1.5	2	0.4	12	0.0104	1.04	0.36	Moderate
18	1.5	3	0.4	12	0.0188	1.88	0.92	Major

Table C- 68. Analysis Result: San Salvador Earthquake (0.5g) of Two-Story Concrete Frame models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	R_i	DI(%)	DS	DS
1	1	1	0.5	8	0.0375	3.75	1.00	Major
2	1	2	0.5	8	0.0219	2.19	1.00	Major
3	1	3	0.5	8	0.0469	4.69	1.00	Major
4	1	1	0.5	10	0.0260	2.60	1.00	Major
5	1	2	0.5	10	0.0250	2.50	1.00	Major
6	1	3	0.5	10	0.0385	3.85	1.00	Major
7	1	1	0.5	12	0.0240	2.40	1.00	Major
8	1	2	0.5	12	0.0208	2.08	1.00	Major
9	1	3	0.5	12	0.0260	2.60	1.00	Major
10	1.5	1	0.5	8	0.0229	2.29	1.00	Major
11	1.5	2	0.5	8	0.0146	1.46	0.64	Substantial
12	1.5	3	0.5	8	0.0406	4.06	1.00	Major
13	1.5	1	0.5	10	0.0240	2.40	1.00	Major
14	1.5	2	0.5	10	0.0146	1.46	0.64	Substantial
15	1.5	3	0.5	10	0.0267	2.67	1.00	Major
16	1.5	1	0.5	12	0.0198	1.98	0.99	Major
17	1.5	2	0.5	12	0.0146	1.46	0.64	Substantial
18	1.5	3	0.5	12	0.0236	2.36	1.00	Major

Table C- 69. Analysis Result: San Salvador Earthquake (0.6-1 g) of Two-Story Concrete Frame models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	R_i	DI(%)	DS	DS
11	1.5	2	0.6	8	0.0208	2.08	1.00	Major
14	1.5	2	0.6	10	0.0156	1.56	0.71	Substantial
17	1.5	2	0.6	12	0.0194	1.94	0.96	Major
11	1.5	2	0.7	8	0.0250	2.50	1.00	Major
14	1.5	2	0.7	10	0.0198	1.98	0.99	Major
17	1.5	2	0.7	12	0.0236	2.36	1.00	Major
11	1.5	2	0.8	8	0.0271	2.71	1.00	Major
14	1.5	2	0.8	10	0.0250	2.50	1.00	Major
17	1.5	2	0.8	12	0.0285	2.85	1.00	Major
11	1.5	2	0.9	8	0.0292	2.92	1.00	Major
14	1.5	2	0.9	10	0.0313	3.13	1.00	Major
17	1.5	2	0.9	12	0.0323	3.23	1.00	Major
11	1.5	2	1	8	0.0323	3.23	1.00	Major
14	1.5	2	1	10	0.0365	3.65	1.00	Major
17	1.5	2	1	12	0.0365	3.65	1.00	Major

C.3 ONE-STORY CONCRETE SHEAR WALL MODELS

Table C- 70. Analysis Result: Mayagüez Earthquake (0.1g) of One-Story Concrete Shear Wall models of One-Story Concrete Shear Wall models of One-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.1	8	0.0083	0.83	0.22	Minor
2	1.67	2	0.1	8	0.0001	0.01	0.00	None
3	1.67	3	0.1	8	0.0260	2.60	1.00	Major
4	1.67	1	0.1	8	0.0122	1.22	0.48	Moderate
5	1.67	2	0.1	10	0.0002	0.02	0.00	None
6	1.67	3	0.1	10	0.0417	4.17	1.00	Major
7	1.67	1	0.1	12	0.0132	1.32	0.55	Moderate
8	1.67	2	0.1	12	0.0002	0.02	0.00	None
9	1.67	3	0.1	12	0.0222	2.22	1.00	Major
10	3	1	0.1	8	0.0000	0.00	0.00	None
11	3	2	0.1	8	0.0000	0.00	0.00	None
12	3	3	0.1	8	0.0333	3.33	1.00	Major
13	3	1	0.1	10	0.0001	0.01	0.00	None
14	3	2	0.1	10	0.0000	0.00	0.00	None
15	3	3	0.1	10	0.0233	2.33	1.00	Major
16	3	1	0.1	12	0.0001	0.01	0.00	None
17	3	2	0.1	12	0.0000	0.00	0.00	None
18	3	3	0.1	12	0.0340	3.40	1.00	Major

Table C- 71. Analysis Result: Mayagüez Earthquake (0.2g) of One-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.2	8	0.0208	2.08	1.00	Major
2	1.67	2	0.2	8	0.0002	0.02	0.00	None
3	1.67	3	0.2	8	0.5240	52.40	1.00	Major
4	1.67	1	0.2	8	0.0169	1.69	0.79	Major
5	1.67	2	0.2	10	0.0125	1.25	0.50	Moderate
6	1.67	3	0.2	10	0.3717	37.17	1.00	Major
7	1.67	1	0.2	12	0.0194	1.94	0.96	Major
8	1.67	2	0.2	12	0.0188	1.88	0.92	Major
9	1.67	3	0.2	12	0.0438	4.38	1.00	Major
10	3	1	0.2	8	0.0001	0.01	0.00	None
11	3	2	0.2	8	0.0000	0.00	0.00	None
12	3	3	0.2	8	0.5844	58.44	1.00	Major
13	3	1	0.2	10	0.0001	0.01	0.00	None
14	3	2	0.2	10	0.0000	0.00	0.00	None
15	3	3	0.2	10	0.0458	4.58	1.00	Major
16	3	1	0.2	12	0.0111	1.11	0.41	Moderate
17	3	2	0.2	12	0.0001	0.01	0.00	None
18	3	3	0.2	12	0.1326	13.26	1.00	Major

Table C- 72. Analysis Result: Mayagüez Earthquake (0.3g) of One-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.3	8	0.0250	2.50	1.00	Major
2	1.67	2	0.3	8	0.0146	1.46	0.64	Substantial
3	1.67	3	0.3	8	0.6792	67.92	1.00	Major
4	1.67	1	0.3	8	0.0297	2.97	1.00	Major
5	1.67	2	0.3	10	0.0225	2.25	1.00	Major
6	1.67	3	0.3	10	0.3367	33.67	1.00	Major
7	1.67	1	0.3	12	0.0292	2.92	1.00	Major
8	1.67	2	0.3	12	0.0215	2.15	1.00	Major
9	1.67	3	0.3	12	0.1736	17.36	1.00	Major
10	3	1	0.3	8	0.0001	0.01	0.00	None
11	3	2	0.3	8	0.0000	0.00	0.00	None
12	3	3	0.3	8	1.6458	164.58	1.00	Major
13	3	1	0.3	10	0.0002	0.02	0.00	None
14	3	2	0.3	10	0.0001	0.01	0.00	None
15	3	3	0.3	10	1.2717	127.17	1.00	Major
16	3	1	0.3	12	0.0118	1.18	0.45	Moderate
17	3	2	0.3	12	0.0001	0.01	0.00	None
18	3	3	0.3	12	0.5222	52.22	1.00	Major

Table C- 73. Analysis Result: Mayagüez Earthquake (0.4g) of One-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.4	8	0.0406	4.06	1.00	Major
2	1.67	2	0.4	8	0.0229	2.29	1.00	Major
3	1.67	3	0.4	8	0.5167	51.67	1.00	Major
4	1.67	1	0.4	8	0.0325	3.25	1.00	Major
5	1.67	2	0.4	10	0.0292	2.92	1.00	Major
6	1.67	3	0.4	10	0.2475	24.75	1.00	Major
7	1.67	1	0.4	12	0.0306	3.06	1.00	Major
8	1.67	2	0.4	12	0.0292	2.92	1.00	Major
9	1.67	3	0.4	12	0.2944	29.44	1.00	Major
10	3	1	0.4	8	0.0000	0.00	0.00	None
11	3	2	0.4	8	0.0000	0.00	0.00	None
12	3	3	0.4	8	1.9271	192.71	1.00	Major
13	3	1	0.4	10	0.0158	1.58	0.72	Substantial
14	3	2	0.4	10	0.0000	0.00	0.00	None
15	3	3	0.4	10	1.5700	157.00	1.00	Major
16	3	1	0.4	12	0.0194	1.94	0.96	Major
17	3	2	0.4	12	0.0000	0.00	0.00	None
18	3	3	0.4	12	1.0000	100.00	1.00	Major

Table C- 74. Analysis Result: Mayagüez Earthquake (0.5g) of One-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.5	8	0.0573	5.73	1.00	Major
2	1.67	2	0.5	8	0.0344	3.44	1.00	Major
3	1.67	3	0.5	8	0.7781	77.81	1.00	Major
4	1.67	1	0.5	8	0.0458	4.58	1.00	Major
5	1.67	2	0.5	10	0.0408	4.08	1.00	Major
6	1.67	3	0.5	10	0.2900	29.00	1.00	Major
7	1.67	1	0.5	12	0.0472	4.72	1.00	Major
8	1.67	2	0.5	12	0.0431	4.31	1.00	Major
9	1.67	3	0.5	12	0.5701	57.01	1.00	Major
10	3	1	0.5	8	0.0000	0.00	0.00	None
11	3	2	0.5	8	0.0000	0.00	0.00	None
12	3	3	0.5	8	1.6354	163.54	1.00	Major
13	3	1	0.5	10	0.0208	2.08	1.00	Major
14	3	2	0.5	10	0.0000	0.00	0.00	None
15	3	3	0.5	10	1.6925	169.25	1.00	Major
16	3	1	0.5	12	0.0257	2.57	1.00	Major
17	3	2	0.5	12	0.0000	0.00	0.00	None
18	3	3	0.5	12	1.2792	127.92	1.00	Major

Table C- 75. Analysis Result: Mayagüez Earthquake (0.6-g)

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.6	8	0.0677	6.77	1.00	Major
2	1.67	2	0.6	8	0.0479	4.79	1.00	Major
3	1.67	3	0.6	8	0.9583	95.83	1.00	Major
4	1.67	1	0.6	8	0.0542	5.42	1.00	Major
5	1.67	2	0.6	10	0.0508	5.08	1.00	Major
6	1.67	3	0.6	10	0.4058	40.58	1.00	Major
7	1.67	1	0.6	12	0.0507	5.07	1.00	Major
8	1.67	2	0.6	12	0.0451	4.51	1.00	Major
9	1.67	3	0.6	12	0.5458	54.58	1.00	Major
10	3	1	0.6	8	0.0219	2.19	1.00	Major
11	3	2	0.6	8	0.0001	0.01	0.00	None
12	3	3	0.6	8	1.2375	123.75	1.00	Major
13	3	1	0.6	10	0.0333	3.33	1.00	Major
14	3	2	0.6	10	0.0001	0.01	0.00	None
15	3	3	0.6	10	2.0208	202.08	1.00	Major
16	3	1	0.6	12	0.0340	3.40	1.00	Major
17	3	2	0.6	12	0.0181	1.81	0.87	Major
18	3	3	0.6	12	1.3903	139.03	1.00	Major

Table C- 76. Analysis Result: Mayagüez Earthquake (0.7g) of One-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.7	8	0.0750	7.50	1.00	Major
2	1.67	2	0.7	8	0.0531	5.31	1.00	Major
3	1.67	3	0.7	8	0.8052	80.52	1.00	Major
4	1.67	1	0.7	8	0.0600	6.00	1.00	Major
5	1.67	2	0.7	10	0.0575	5.75	1.00	Major
6	1.67	3	0.7	10	0.4108	41.08	1.00	Major
7	1.67	1	0.7	12	0.0701	7.01	1.00	Major
8	1.67	2	0.7	12	0.0507	5.07	1.00	Major
9	1.67	3	0.7	12	0.5451	54.51	1.00	Major
10	3	1	0.7	8	0.0333	3.33	1.00	Major
11	3	2	0.7	8	0.0001	0.01	0.00	None
12	3	3	0.7	8	1.9573	195.73	1.00	Major
13	3	1	0.7	10	0.0400	4.00	1.00	Major
14	3	2	0.7	10	0.0002	0.02	0.00	None
15	3	3	0.7	10	1.5808	158.08	1.00	Major
16	3	1	0.7	12	0.0431	4.31	1.00	Major
17	3	2	0.7	12	0.0208	2.08	1.00	Major
18	3	3	0.7	12	1.4889	148.89	1.00	Major

Table C- 77. Analysis Result: Mayagüez Earthquake (0.8g) of One-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.8	8	0.0844	8.44	1.00	Major
2	1.67	2	0.8	8	0.0729	7.29	1.00	Major
3	1.67	3	0.8	8	0.8615	86.15	1.00	Major
4	1.67	1	0.8	8	0.0675	6.75	1.00	Major
5	1.67	2	0.8	10	0.0583	5.83	1.00	Major
6	1.67	3	0.8	10	0.4317	43.17	1.00	Major
7	1.67	1	0.8	12	0.0806	8.06	1.00	Major
8	1.67	2	0.8	12	0.0597	5.97	1.00	Major
9	1.67	3	0.8	12	0.2243	22.43	1.00	Major
10	3	1	0.8	8	0.0385	3.85	1.00	Major
11	3	2	0.8	8	0.0001	0.01	0.00	None
12	3	3	0.8	8	2.8063	280.63	1.00	Major
13	3	1	0.8	10	0.0483	4.83	1.00	Major
14	3	2	0.8	10	0.0167	1.67	0.78	Major
15	3	3	0.8	10	1.7450	174.50	1.00	Major
16	3	1	0.8	12	0.0479	4.79	1.00	Major
17	3	2	0.8	12	0.0243	2.43	1.00	Major
18	3	3	0.8	12	0.9014	90.14	1.00	Major

Table C- 78. Analysis Result: Mayagüez Earthquake (0.9g) of One-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.9	8	0.0885	8.85	1.00	Major
2	1.67	2	0.9	8	0.0865	8.65	1.00	Major
3	1.67	3	0.9	8	0.6396	63.96	1.00	Major
4	1.67	1	0.9	8	0.0708	7.08	1.00	Major
5	1.67	2	0.9	10	0.0633	6.33	1.00	Major
6	1.67	3	0.9	10	0.5033	50.33	1.00	Major
7	1.67	1	0.9	12	0.1035	10.35	1.00	Major
8	1.67	2	0.9	12	0.0667	6.67	1.00	Major
9	1.67	3	0.9	12	0.2729	27.29	1.00	Major
10	3	1	0.9	8	0.0635	6.35	1.00	Major
11	3	2	0.9	8	0.0001	0.01	0.00	None
12	3	3	0.9	8	3.0052	300.52	1.00	Major
13	3	1	0.9	10	0.0517	5.17	1.00	Major
14	3	2	0.9	10	0.0258	2.58	1.00	Major
15	3	3	0.9	10	1.7892	178.92	1.00	Major
16	3	1	0.9	12	0.0549	5.49	1.00	Major
17	3	2	0.9	12	0.0326	3.26	1.00	Major
18	3	3	0.9	12	1.2069	120.69	1.00	Major

Table C- 79. Analysis Result: Mayagüez Earthquake (1 g)

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	1	8	0.0979	9.79	1.00	Major
2	1.67	2	1	8	0.0833	8.33	1.00	Major
3	1.67	3	1	8	0.7927	79.27	1.00	Major
4	1.67	1	1	8	0.0783	7.83	1.00	Major
5	1.67	2	1	10	0.0617	6.17	1.00	Major
6	1.67	3	1	10	0.1875	18.75	1.00	Major
7	1.67	1	1	12	0.1361	13.61	1.00	Major
8	1.67	2	1	12	0.0736	7.36	1.00	Major
9	1.67	3	1	12	0.1465	14.65	1.00	Major
10	3	1	1	8	0.0792	7.92	1.00	Major
11	3	2	1	8	0.0001	0.01	0.00	None
12	3	3	1	8	2.8938	289.38	1.00	Major
13	3	1	1	10	0.0633	6.33	1.00	Major
14	3	2	1	10	0.0342	3.42	1.00	Major
15	3	3	1	10	1.9133	191.33	1.00	Major
16	3	1	1	12	0.0625	6.25	1.00	Major
17	3	2	1	12	0.0410	4.10	1.00	Major
18	3	3	1	12	1.3083	130.83	1.00	Major

Table C- 80. Analysis Result: San Juan Earthquake (0.1g) of One-Story Concrete Shear Wall models of One-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.1	8	0.0042	0.42	0.00	None
2	1.67	2	0.1	8	0.0002	0.02	0.00	None
3	1.67	3	0.1	8	0.0219	2.19	1.00	Major
4	1.67	1	0.1	8	0.0062	0.62	0.08	Minor
5	1.67	2	0.1	10	0.0002	0.02	0.00	None
6	1.67	3	0.1	10	0.0350	3.50	1.00	Major
7	1.67	1	0.1	12	0.0090	0.90	0.27	Minor
8	1.67	2	0.1	12	0.0049	0.49	0.00	None
9	1.67	3	0.1	12	0.0556	5.56	1.00	Major
10	3	1	0.1	8	0.0001	0.01	0.00	None
11	3	2	0.1	8	0.0000	0.00	0.00	None
12	3	3	0.1	8	0.0156	1.56	0.71	Substantial
13	3	1	0.1	10	0.0001	0.01	0.00	None
14	3	2	0.1	10	0.0000	0.00	0.00	None
15	3	3	0.1	10	0.0158	1.58	0.72	Substantial
16	3	1	0.1	12	0.0001	0.01	0.00	None
17	3	2	0.1	12	0.0001	0.01	0.00	None
18	3	3	0.1	12	0.0382	3.82	1.00	Major

Table C- 81. Analysis Result: San Juan Earthquake (0.2g) of One-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.2	8	0.0083	0.83	0.22	Minor
2	1.67	2	0.2	8	0.0094	0.94	0.29	Minor
3	1.67	3	0.2	8	0.1417	14.17	1.00	Major
4	1.67	1	0.2	8	0.0100	1.00	0.34	Minor
5	1.67	2	0.2	10	0.0075	0.75	0.17	Minor
6	1.67	3	0.2	10	0.2308	23.08	1.00	Major
7	1.67	1	0.2	12	0.0146	1.46	0.64	Substantial
8	1.67	2	0.2	12	0.0090	0.90	0.27	Minor
9	1.67	3	0.2	12	0.4694	46.94	1.00	Major
10	3	1	0.2	8	0.0001	0.01	0.00	None
11	3	2	0.2	8	0.0000	0.00	0.00	None
12	3	3	0.2	8	0.0302	3.02	1.00	Major
13	3	1	0.2	10	0.0067	0.67	0.11	Minor
14	3	2	0.2	10	0.0001	0.01	0.00	None
15	3	3	0.2	10	0.0308	3.08	1.00	Major
16	3	1	0.2	12	0.0076	0.76	0.18	Minor
17	3	2	0.2	12	0.0001	0.01	0.00	None
18	3	3	0.2	12	0.4556	45.56	1.00	Major

Table C- 82. Analysis Result: San Juan Earthquake (0.3g) of One-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.3	8	0.0156	1.56	0.71	Substantial
2	1.67	2	0.3	8	0.0104	1.04	0.36	Moderate
3	1.67	3	0.3	8	0.3479	34.79	1.00	Major
4	1.67	1	0.3	8	0.0182	1.82	0.88	Major
5	1.67	2	0.3	10	0.0092	0.92	0.28	Minor
6	1.67	3	0.3	10	0.6967	69.67	1.00	Major
7	1.67	1	0.3	12	0.0153	1.53	0.69	Substantial
8	1.67	2	0.3	12	0.0118	1.18	0.45	Moderate
9	1.67	3	0.3	12	0.2528	25.28	1.00	Major
10	3	1	0.3	8	0.0002	0.02	0.00	None
11	3	2	0.3	8	0.0001	0.01	0.00	None
12	3	3	0.3	8	0.7698	76.98	1.00	Major
13	3	1	0.3	10	0.0100	1.00	0.33	Minor
14	3	2	0.3	10	0.0001	0.01	0.00	None
15	3	3	0.3	10	0.5958	59.58	1.00	Major
16	3	1	0.3	12	0.0104	1.04	0.36	Moderate
17	3	2	0.3	12	0.0002	0.02	0.00	None
18	3	3	0.3	12	0.9146	91.46	1.00	Major

Table C- 83. Analysis Result: San Juan Earthquake (0.4g) of One-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.4	8	0.0240	2.40	1.00	Major
2	1.67	2	0.4	8	0.0135	1.35	0.57	Substantial
3	1.67	3	0.4	8	0.7833	78.33	1.00	Major
4	1.67	1	0.4	8	0.0192	1.92	0.94	Major
5	1.67	2	0.4	10	0.0142	1.42	0.61	Substantial
6	1.67	3	0.4	10	0.5025	50.25	1.00	Major
7	1.67	1	0.4	12	0.0181	1.81	0.87	Major
8	1.67	2	0.4	12	0.0146	1.46	0.64	Substantial
9	1.67	3	0.4	12	0.4153	41.53	1.00	Major
10	3	1	0.4	8	0.0001	0.01	0.00	None
11	3	2	0.4	8	0.0001	0.01	0.00	None
12	3	3	0.4	8	1.0063	100.63	1.00	Major
13	3	1	0.4	10	0.0100	1.00	0.33	Minor
14	3	2	0.4	10	0.0001	0.01	0.00	None
15	3	3	0.4	10	1.3475	134.75	1.00	Major
16	3	1	0.4	12	0.0132	1.32	0.55	Moderate
17	3	2	0.4	12	0.0001	0.01	0.00	None
18	3	3	0.4	12	0.3618	36.18	1.00	Major

Table C- 84. Analysis Result: San Juan Earthquake (0.5g) of One-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.5	8	0.0365	3.65	1.00	Major
2	1.67	2	0.5	8	0.0167	1.67	0.78	Major
3	1.67	3	0.5	8	0.5500	55.00	1.00	Major
4	1.67	1	0.5	8	0.0292	2.92	1.00	Major
5	1.67	2	0.5	10	0.0208	2.08	1.00	Major
6	1.67	3	0.5	10	0.6525	65.25	1.00	Major
7	1.67	1	0.5	12	0.0215	2.15	1.00	Major
8	1.67	2	0.5	12	0.0236	2.36	1.00	Major
9	1.67	3	0.5	12	0.2625	26.25	1.00	Major
10	3	1	0.5	8	0.0000	0.00	0.00	None
11	3	2	0.5	8	0.0001	0.01	0.00	None
12	3	3	0.5	8	1.6885	168.85	1.00	Major
13	3	1	0.5	10	0.0125	1.25	0.50	Moderate
14	3	2	0.5	10	0.0002	0.02	0.00	None
15	3	3	0.5	10	1.5975	159.75	1.00	Major
16	3	1	0.5	12	0.0118	1.18	0.45	Moderate
17	3	2	0.5	12	0.0002	0.02	0.00	None
18	3	3	0.5	12	0.8701	87.01	1.00	Major

Table C- 85. Analysis Result: San Juan Earthquake (0.6g) of One-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.6	8	0.0406	4.06	1.00	Major
2	1.67	2	0.6	8	0.0229	2.29	1.00	Major
3	1.67	3	0.6	8	1.1125	111.25	1.00	Major
4	1.67	1	0.6	8	0.0325	3.25	1.00	Major
5	1.67	2	0.6	10	0.0292	2.92	1.00	Major
6	1.67	3	0.6	10	0.9558	95.58	1.00	Major
7	1.67	1	0.6	12	0.0347	3.47	1.00	Major
8	1.67	2	0.6	12	0.0264	2.64	1.00	Major
9	1.67	3	0.6	12	0.5215	52.15	1.00	Major
10	3	1	0.6	8	0.0001	0.01	0.00	None
11	3	2	0.6	8	0.0001	0.01	0.00	None
12	3	3	0.6	8	2.5510	255.10	1.00	Major
13	3	1	0.6	10	0.0159	1.59	0.73	Substantial
14	3	2	0.6	10	0.0001	0.01	0.00	None
15	3	3	0.6	10	1.5775	157.75	1.00	Major
16	3	1	0.6	12	0.0132	1.32	0.55	Moderate
17	3	2	0.6	12	0.0001	0.01	0.00	None
18	3	3	0.6	12	1.3181	131.81	1.00	Major

Table C- 86. Analysis Result: San Juan Earthquake (0.7g) of One-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.7	8	0.0375	3.75	1.00	Major
2	1.67	2	0.7	8	0.0271	2.71	1.00	Major
3	1.67	3	0.7	8	1.4708	147.08	1.00	Major
4	1.67	1	0.7	8	0.0300	3.00	1.00	Major
5	1.67	2	0.7	10	0.0383	3.83	1.00	Major
6	1.67	3	0.7	10	1.1367	113.67	1.00	Major
7	1.67	1	0.7	12	0.0340	3.40	1.00	Major
8	1.67	2	0.7	12	0.0278	2.78	1.00	Major
9	1.67	3	0.7	12	0.6111	61.11	1.00	Major
10	3	1	0.7	8	0.0001	0.01	0.00	None
11	3	2	0.7	8	0.0001	0.01	0.00	None
12	3	3	0.7	8	2.0896	208.96	1.00	Major
13	3	1	0.7	10	0.0200	2.00	1.00	Major
14	3	2	0.7	10	0.0001	0.01	0.00	None
15	3	3	0.7	10	0.0475	4.75	1.00	Major
16	3	1	0.7	12	0.0167	1.67	0.78	Major
17	3	2	0.7	12	0.0001	0.01	0.00	None
18	3	3	0.7	12	1.9063	190.63	1.00	Major

Table C- 87. Analysis Result: San Juan Earthquake (0.8g) of One-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.8	8	0.0406	4.06	1.00	Major
2	1.67	2	0.8	8	0.0417	4.17	1.00	Major
3	1.67	3	0.8	8	1.5750	157.50	1.00	Major
4	1.67	1	0.8	8	0.0325	3.25	1.00	Major
5	1.67	2	0.8	10	0.0433	4.33	1.00	Major
6	1.67	3	0.8	10	1.3158	131.58	1.00	Major
7	1.67	1	0.8	12	0.0521	5.21	1.00	Major
8	1.67	2	0.8	12	0.0319	3.19	1.00	Major
9	1.67	3	0.8	12	0.9049	90.49	1.00	Major
10	3	1	0.8	8	0.0002	0.02	0.00	None
11	3	2	0.8	8	0.0001	0.01	0.00	None
12	3	3	0.8	8	3.7510	375.10	1.00	Major
13	3	1	0.8	10	0.0250	2.50	1.00	Major
14	3	2	0.8	10	0.0001	0.01	0.00	None
15	3	3	0.8	10	2.8825	288.25	1.00	Major
16	3	1	0.8	12	0.0306	3.06	1.00	Major
17	3	2	0.8	12	0.0002	0.02	0.00	None
18	3	3	0.8	12	1.9056	190.56	1.00	Major

Table C- 88. Analysis Result: San Juan Earthquake (0.9g) of One-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.9	8	0.0542	5.42	1.00	Major
2	1.67	2	0.9	8	0.0521	5.21	1.00	Major
3	1.67	3	0.9	8	0.4135	41.35	1.00	Major
4	1.67	1	0.9	8	0.0433	4.33	1.00	Major
5	1.67	2	0.9	10	0.0500	5.00	1.00	Major
6	1.67	3	0.9	10	1.5592	155.92	1.00	Major
7	1.67	1	0.9	12	0.0736	7.36	1.00	Major
8	1.67	2	0.9	12	0.0340	3.40	1.00	Major
9	1.67	3	0.9	12	1.1042	110.42	1.00	Major
10	3	1	0.9	8	0.0002	0.02	0.00	None
11	3	2	0.9	8	0.0001	0.01	0.00	None
12	3	3	0.9	8	3.5417	354.17	1.00	Major
13	3	1	0.9	10	0.0308	3.08	1.00	Major
14	3	2	0.9	10	0.0001	0.01	0.00	None
15	3	3	0.9	10	2.6650	266.50	1.00	Major
16	3	1	0.9	12	0.0396	3.96	1.00	Major
17	3	2	0.9	12	0.0002	0.02	0.00	None
18	3	3	0.9	12	2.6799	267.99	1.00	Major

Table C- 89. Analysis Result: San Juan Earthquake (1 g)

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	1	8	0.0573	5.73	1.00	Major
2	1.67	2	1	8	0.0667	6.67	1.00	Major
3	1.67	3	1	8	1.5646	156.46	1.00	Major
4	1.67	1	1	8	0.0458	4.58	1.00	Major
5	1.67	2	1	10	0.0550	5.50	1.00	Major
6	1.67	3	1	10	1.4975	149.75	1.00	Major
7	1.67	1	1	12	0.1104	11.04	1.00	Major
8	1.67	2	1	12	0.0361	3.61	1.00	Major
9	1.67	3	1	12	0.9944	99.44	1.00	Major
10	3	1	1	8	0.0281	2.81	1.00	Major
11	3	2	1	8	0.0001	0.01	0.00	None
12	3	3	1	8	0.0552	5.52	1.00	Major
13	3	1	1	10	0.0375	3.75	1.00	Major
14	3	2	1	10	0.0001	0.01	0.00	None
15	3	3	1	10	3.0967	309.67	1.00	Major
16	3	1	1	12	0.0458	4.58	1.00	Major
17	3	2	1	12	0.0215	2.15	1.00	Major
18	3	3	1	12	2.7049	270.49	1.00	Major

Table C- 90. Analysis Result: Northridge Earthquake (0.1g) of One-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.1	8	0.0001	0.01	0.00	None
2	1.67	2	0.1	8	0.0001	0.01	0.00	None
3	1.67	3	0.1	8	0.0177	1.77	0.85	Major
4	1.67	1	0.1	8	0.0083	0.83	0.22	Minor
5	1.67	2	0.1	10	0.0001	0.01	0.00	None
6	1.67	3	0.1	10	0.0167	1.67	0.78	Major
7	1.67	1	0.1	12	0.0003	0.03	0.00	None
8	1.67	2	0.1	12	0.0001	0.01	0.00	None
9	1.67	3	0.1	12	0.0111	1.11	0.41	Moderate
10	3	1	0.1	8	0.0000	0.00	0.00	None
11	3	2	0.1	8	0.0000	0.00	0.00	None
12	3	3	0.1	8	0.0292	2.92	1.00	Major
13	3	1	0.1	10	0.0000	0.00	0.00	None
14	3	2	0.1	10	0.0000	0.00	0.00	None
15	3	3	0.1	10	0.0117	1.17	0.44	Moderate
16	3	1	0.1	12	0.0000	0.00	0.00	None
17	3	2	0.1	12	0.0000	0.00	0.00	None
18	3	3	0.1	12	0.0146	1.46	0.64	Substantial

Table C- 91. Analysis Result: Northridge Earthquake (0.2g) of One-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.2	8	0.0115	1.15	0.43	Moderate
2	1.67	2	0.2	8	0.0000	0.00	0.00	None
3	1.67	3	0.2	8	0.1781	17.81	1.00	Major
4	1.67	1	0.2	8	0.0129	1.29	0.53	Moderate
5	1.67	2	0.2	10	0.0000	0.00	0.00	None
6	1.67	3	0.2	10	0.0333	3.33	1.00	Major
7	1.67	1	0.2	12	0.0160	1.60	0.73	Substantial
8	1.67	2	0.2	12	0.0000	0.00	0.00	None
9	1.67	3	0.2	12	0.0215	2.15	1.00	Major
10	3	1	0.2	8	0.0000	0.00	0.00	None
11	3	2	0.2	8	0.0000	0.00	0.00	None
12	3	3	0.2	8	0.5083	50.83	1.00	Major
13	3	1	0.2	10	0.0000	0.00	0.00	None
14	3	2	0.2	10	0.0000	0.00	0.00	None
15	3	3	0.2	10	0.0242	2.42	1.00	Major
16	3	1	0.2	12	0.0000	0.00	0.00	None
17	3	2	0.2	12	0.0000	0.00	0.00	None
18	3	3	0.2	12	0.0292	2.92	1.00	Major

Table C- 92. Analysis Result: Northridge Earthquake (0.3g) of One-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.3	8	0.0188	1.88	0.92	Major
2	1.67	2	0.3	8	0.0000	0.00	0.00	None
3	1.67	3	0.3	8	0.2802	28.02	1.00	Major
4	1.67	1	0.3	8	0.0255	2.55	1.00	Major
5	1.67	2	0.3	10	0.0133	1.33	0.56	Substantial
6	1.67	3	0.3	10	0.0508	5.08	1.00	Major
7	1.67	1	0.3	12	0.0236	2.36	1.00	Major
8	1.67	2	0.3	12	0.0181	1.81	0.87	Major
9	1.67	3	0.3	12	0.0326	3.26	1.00	Major
10	3	1	0.3	8	0.0000	0.00	0.00	None
11	3	2	0.3	8	0.0000	0.00	0.00	None
12	3	3	0.3	8	6.6344	663.44	1.00	Major
13	3	1	0.3	10	0.0000	0.00	0.00	None
14	3	2	0.3	10	0.0000	0.00	0.00	None
15	3	3	0.3	10	0.0358	3.58	1.00	Major
16	3	1	0.3	12	0.0000	0.00	0.00	None
17	3	2	0.3	12	0.0000	0.00	0.00	None
18	3	3	0.3	12	0.0444	4.44	1.00	Major

Table C- 93. Analysis Result: Northridge Earthquake (0.4g) of One-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.4	8	0.0302	3.02	1.00	Major
2	1.67	2	0.4	8	0.0188	1.88	0.92	Major
3	1.67	3	0.4	8	0.3927	39.27	1.00	Major
4	1.67	1	0.4	8	0.0242	2.42	1.00	Major
5	1.67	2	0.4	10	0.0250	2.50	1.00	Major
6	1.67	3	0.4	10	0.4692	46.92	1.00	Major
7	1.67	1	0.4	12	0.0250	2.50	1.00	Major
8	1.67	2	0.4	12	0.0292	2.92	1.00	Major
9	1.67	3	0.4	12	0.0438	4.38	1.00	Major
10	3	1	0.4	8	0.0000	0.00	0.00	None
11	3	2	0.4	8	0.0000	0.00	0.00	None
12	3	3	0.4	8	3.3740	337.40	1.00	Major
13	3	1	0.4	10	0.0000	0.00	0.00	None
14	3	2	0.4	10	0.0000	0.00	0.00	None
15	3	3	0.4	10	2.3208	232.08	1.00	Major
16	3	1	0.4	12	0.0000	0.00	0.00	None
17	3	2	0.4	12	0.0000	0.00	0.00	None
18	3	3	0.4	12	1.3875	138.75	1.00	Major

Table C- 94. Analysis Result: Northridge Earthquake (0.5g) of One-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.5	8	0.0385	3.85	1.00	Major
2	1.67	2	0.5	8	0.0281	2.81	1.00	Major
3	1.67	3	0.5	8	0.3365	33.65	1.00	Major
4	1.67	1	0.5	8	0.0308	3.08	1.00	Major
5	1.67	2	0.5	10	0.0300	3.00	1.00	Major
6	1.67	3	0.5	10	0.6575	65.75	1.00	Major
7	1.67	1	0.5	12	0.0264	2.64	1.00	Major
8	1.67	2	0.5	12	0.0368	3.68	1.00	Major
9	1.67	3	0.5	12	0.0604	6.04	1.00	Major
10	3	1	0.5	8	0.0000	0.00	0.00	None
11	3	2	0.5	8	0.0000	0.00	0.00	None
12	3	3	0.5	8	2.0875	208.75	1.00	Major
13	3	1	0.5	10	0.0000	0.00	0.00	None
14	3	2	0.5	10	0.0000	0.00	0.00	None
15	3	3	0.5	10	4.4108	441.08	1.00	Major
16	3	1	0.5	12	0.0000	0.00	0.00	None
17	3	2	0.5	12	0.0000	0.00	0.00	None
18	3	3	0.5	12	1.3694	136.94	1.00	Major

Table C- 95. Analysis Result: Northridge Earthquake (0.6g) of One-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.6	8	0.0573	5.73	1.00	Major
2	1.67	2	0.6	8	0.0344	3.44	1.00	Major
3	1.67	3	0.6	8	0.7740	77.40	1.00	Major
4	1.67	1	0.6	8	0.0458	4.58	1.00	Major
5	1.67	2	0.6	10	0.0375	3.75	1.00	Major
6	1.67	3	0.6	10	0.5900	59.00	1.00	Major
7	1.67	1	0.6	12	0.0361	3.61	1.00	Major
8	1.67	2	0.6	12	0.0479	4.79	1.00	Major
9	1.67	3	0.6	12	0.3986	39.86	1.00	Major
10	3	1	0.6	8	0.0198	1.98	0.99	Major
11	3	2	0.6	8	0.0042	0.42	0.00	None
12	3	3	0.6	8	3.8208	382.08	1.00	Major
13	3	1	0.6	10	0.0242	2.42	1.00	Major
14	3	2	0.6	10	0.0125	1.25	0.50	Moderate
15	3	3	0.6	10	4.3258	432.58	1.00	Major
16	3	1	0.6	12	0.0257	2.57	1.00	Major
17	3	2	0.6	12	0.0146	1.46	0.64	Substantial
18	3	3	0.6	12	2.7938	279.38	1.00	Major

Table C- 96. Analysis Results: Northridge Earthquake (0.7g) of One-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.7	8	0.0792	7.92	1.00	Major
2	1.67	2	0.7	8	0.0385	3.85	1.00	Major
3	1.67	3	0.7	8	0.4958	49.58	1.00	Major
4	1.67	1	0.7	8	0.0633	6.33	1.00	Major
5	1.67	2	0.7	10	0.0425	4.25	1.00	Major
6	1.67	3	0.7	10	0.5183	51.83	1.00	Major
7	1.67	1	0.7	12	0.0556	5.56	1.00	Major
8	1.67	2	0.7	12	0.0542	5.42	1.00	Major
9	1.67	3	0.7	12	0.6757	67.57	1.00	Major
10	3	1	0.7	8	0.0260	2.60	1.00	Major
11	3	2	0.7	8	0.0104	1.04	0.36	Moderate
12	3	3	0.7	8	2.2781	227.81	1.00	Major
13	3	1	0.7	10	0.0333	3.33	1.00	Major
14	3	2	0.7	10	0.0150	1.50	0.67	Substantial
15	3	3	0.7	10	2.3483	234.83	1.00	Major
16	3	1	0.7	12	0.0340	3.40	1.00	Major
17	3	2	0.7	12	0.0181	1.81	0.87	Major
18	3	3	0.7	12	5.5292	552.92	1.00	Major

Table C- 97. Analysis Result: Northridge Earthquake (0.8g) of One-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.8	8	0.0792	7.92	1.00	Major
2	1.67	2	0.8	8	0.0385	3.85	1.00	Major
3	1.67	3	0.8	8	0.4958	49.58	1.00	Major
4	1.67	1	0.8	8	0.0633	6.33	1.00	Major
5	1.67	2	0.8	10	0.0425	4.25	1.00	Major
6	1.67	3	0.8	10	0.5183	51.83	1.00	Major
7	1.67	1	0.8	12	0.0556	5.56	1.00	Major
8	1.67	2	0.8	12	0.0542	5.42	1.00	Major
9	1.67	3	0.8	12	0.6757	67.57	1.00	Major
10	3	1	0.8	8	0.0260	2.60	1.00	Major
11	3	2	0.8	8	0.0104	1.04	0.36	Moderate
12	3	3	0.8	8	2.2781	227.81	1.00	Major
13	3	1	0.8	10	0.0333	3.33	1.00	Major
14	3	2	0.8	10	0.0150	1.50	0.67	Substantial
15	3	3	0.8	10	2.3483	234.83	1.00	Major
16	3	1	0.8	12	0.0340	3.40	1.00	Major
17	3	2	0.8	12	0.0181	1.81	0.87	Major
18	3	3	0.8	12	5.5292	552.92	1.00	Major

Table C- 98. Analysis Result: Northridge Earthquake (0.9g) of One-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.9	8	0.1021	10.21	1.00	Major
2	1.67	2	0.9	8	0.0500	5.00	1.00	Major
3	1.67	3	0.9	8	0.4333	43.33	1.00	Major
4	1.67	1	0.9	8	0.0817	8.17	1.00	Major
5	1.67	2	0.9	10	0.0508	5.08	1.00	Major
6	1.67	3	0.9	10	0.6250	62.50	1.00	Major
7	1.67	1	0.9	12	0.0660	6.60	1.00	Major
8	1.67	2	0.9	12	0.0618	6.18	1.00	Major
9	1.67	3	0.9	12	0.6097	60.97	1.00	Major
10	3	1	0.9	8	0.0281	2.81	1.00	Major
11	3	2	0.9	8	0.0167	1.67	0.78	Major
12	3	3	0.9	8	2.2333	223.33	1.00	Major
13	3	1	0.9	10	0.0350	3.50	1.00	Major
14	3	2	0.9	10	0.0217	2.17	1.00	Major
15	3	3	0.9	10	0.6050	60.50	1.00	Major
16	3	1	0.9	12	0.0403	4.03	1.00	Major
17	3	2	0.9	12	0.0174	1.74	0.82	Major
18	3	3	0.9	12	1.8333	183.33	1.00	Major

Table C- 99. Analysis Result: Northridge Earthquake (1 g)

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	1	8	0.1313	13.13	1.00	Major
2	1.67	2	1	8	0.0719	7.19	1.00	Major
3	1.67	3	1	8	0.6083	60.83	1.00	Major
4	1.67	1	1	8	0.1050	10.50	1.00	Major
5	1.67	2	1	10	0.0892	8.92	1.00	Major
6	1.67	3	1	10	0.7467	74.67	1.00	Major
7	1.67	1	1	12	0.0792	7.92	1.00	Major
8	1.67	2	1	12	0.0813	8.13	1.00	Major
9	1.67	3	1	12	0.4257	42.57	1.00	Major
10	3	1	1	8	0.0448	4.48	1.00	Major
11	3	2	1	8	0.0281	2.81	1.00	Major
12	3	3	1	8	1.6365	163.65	1.00	Major
13	3	1	1	10	0.0517	5.17	1.00	Major
14	3	2	1	10	0.0250	2.50	1.00	Major
15	3	3	1	10	4.9383	493.83	1.00	Major
16	3	1	1	12	0.0521	5.21	1.00	Major
17	3	2	1	12	0.0361	3.61	1.00	Major
18	3	3	1	12	5.7257	572.57	1.00	Major

Table C- 100. Analysis Result: Centro Earthquake (0.1g) of One-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.1	8	0.0002	0.02	0.00	None
2	1.67	2	0.1	8	0.0001	0.01	0.00	None
3	1.67	3	0.1	8	0.4021	40.21	1.00	Major
4	1.67	1	0.1	8	0.0087	0.87	0.25	Minor
5	1.67	2	0.1	10	0.0001	0.01	0.00	None
6	1.67	3	0.1	10	0.0342	3.42	1.00	Major
7	1.67	1	0.1	12	0.0132	1.32	0.55	Moderate
8	1.67	2	0.1	12	0.0001	0.01	0.00	None
9	1.67	3	0.1	12	0.0188	1.88	0.92	Major
10	3	1	0.1	8	0.0000	0.00	0.00	None
11	3	2	0.1	8	0.0000	0.00	0.00	None
12	3	3	0.1	8	0.0323	3.23	1.00	Major
13	3	1	0.1	10	0.0000	0.00	0.00	None
14	3	2	0.1	10	0.0000	0.00	0.00	None
15	3	3	0.1	10	0.0450	4.50	1.00	Major
16	3	1	0.1	12	0.0001	0.01	0.00	None
17	3	2	0.1	12	0.0000	0.00	0.00	None
18	3	3	0.1	12	0.0201	2.01	1.00	Major

Table C- 101. Analysis Result: Centro Earthquake (0.2g) of One-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.2	8	0.0177	1.77	0.85	Major
2	1.67	2	0.2	8	0.0001	0.01	0.00	None
3	1.67	3	0.2	8	0.2094	20.94	1.00	Major
4	1.67	1	0.2	8	0.0186	1.86	0.90	Major
5	1.67	2	0.2	10	0.0003	0.03	0.00	None
6	1.67	3	0.2	10	0.4625	46.25	1.00	Major
7	1.67	1	0.2	12	0.0188	1.88	0.92	Major
8	1.67	2	0.2	12	0.0153	1.53	0.69	Substantial
9	1.67	3	0.2	12	0.0375	3.75	1.00	Major
10	3	1	0.2	8	0.0000	0.00	0.00	None
11	3	2	0.2	8	0.0000	0.00	0.00	None
12	3	3	0.2	8	2.3333	233.33	1.00	Major
13	3	1	0.2	10	0.0001	0.01	0.00	None
14	3	2	0.2	10	0.0000	0.00	0.00	None
15	3	3	0.2	10	0.3883	38.83	1.00	Major
16	3	1	0.2	12	0.0001	0.01	0.00	None
17	3	2	0.2	12	0.0001	0.01	0.00	None
18	3	3	0.2	12	0.0410	4.10	1.00	Major

Table C- 102. Analysis Result: Centro Earthquake (0.3g) of One-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.3	8	0.0250	2.50	1.00	Major
2	1.67	2	0.3	8	0.0002	0.02	0.00	None
3	1.67	3	0.3	8	0.6594	65.94	1.00	Major
4	1.67	1	0.3	8	0.0200	2.00	1.00	Major
5	1.67	2	0.3	10	0.0208	2.08	1.00	Major
6	1.67	3	0.3	10	0.5600	56.00	1.00	Major
7	1.67	1	0.3	12	0.0250	2.50	1.00	Major
8	1.67	2	0.3	12	0.0194	1.94	0.96	Major
9	1.67	3	0.3	12	0.2507	25.07	1.00	Major
10	3	1	0.3	8	0.0001	0.01	0.00	None
11	3	2	0.3	8	0.0000	0.00	0.00	None
12	3	3	0.3	8	2.4208	242.08	1.00	Major
13	3	1	0.3	10	0.0001	0.01	0.00	None
14	3	2	0.3	10	0.0001	0.01	0.00	None
15	3	3	0.3	10	1.1500	115.00	1.00	Major
16	3	1	0.3	12	0.0001	0.01	0.00	None
17	3	2	0.3	12	0.0001	0.01	0.00	None
18	3	3	0.3	12	2.6778	267.78	1.00	Major

Table C- 103. Analysis Result: Centro Earthquake (0.4g) of One-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.4	8	0.0448	4.48	1.00	Major
2	1.67	2	0.4	8	0.0208	2.08	1.00	Major
3	1.67	3	0.4	8	0.2844	28.44	1.00	Major
4	1.67	1	0.4	8	0.0358	3.58	1.00	Major
5	1.67	2	0.4	10	0.0275	2.75	1.00	Major
6	1.67	3	0.4	10	0.6017	60.17	1.00	Major
7	1.67	1	0.4	12	0.0333	3.33	1.00	Major
8	1.67	2	0.4	12	0.0292	2.92	1.00	Major
9	1.67	3	0.4	12	0.2847	28.47	1.00	Major
10	3	1	0.4	8	0.0001	0.01	0.00	None
11	3	2	0.4	8	0.0000	0.00	0.00	None
12	3	3	0.4	8	3.1604	316.04	1.00	Major
13	3	1	0.4	10	0.0002	0.02	0.00	None
14	3	2	0.4	10	0.0001	0.01	0.00	None
15	3	3	0.4	10	3.1483	314.83	1.00	Major
16	3	1	0.4	12	0.0002	0.02	0.00	None
17	3	2	0.4	12	0.0001	0.01	0.00	None
18	3	3	0.4	12	1.0785	107.85	1.00	Major

Table C- 104. Analysis Result: Centro Earthquake (0.5g) of One-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.5	8	0.0448	4.48	1.00	Major
2	1.67	2	0.5	8	0.0198	1.98	0.99	Major
3	1.67	3	0.5	8	0.9604	96.04	1.00	Major
4	1.67	1	0.5	8	0.0358	3.58	1.00	Major
5	1.67	2	0.5	10	0.0342	3.42	1.00	Major
6	1.67	3	0.5	10	0.8117	81.17	1.00	Major
7	1.67	1	0.5	12	0.0424	4.24	1.00	Major
8	1.67	2	0.5	12	0.0417	4.17	1.00	Major
9	1.67	3	0.5	12	0.4833	48.33	1.00	Major
10	3	1	0.5	8	0.0001	0.01	0.00	None
11	3	2	0.5	8	0.0000	0.00	0.00	None
12	3	3	0.5	8	5.0563	505.63	1.00	Major
13	3	1	0.5	10	0.0167	1.67	0.78	Major
14	3	2	0.5	10	0.0001	0.01	0.00	None
15	3	3	0.5	10	3.9150	391.50	1.00	Major
16	3	1	0.5	12	0.0243	2.43	1.00	Major
17	3	2	0.5	12	0.0001	0.01	0.00	None
18	3	3	0.5	12	1.3451	134.51	1.00	Major

Table C- 105. Analysis Result: Centro Earthquake (0.6g) of One-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.6	8	0.0510	5.10	1.00	Major
2	1.67	2	0.6	8	0.0396	3.96	1.00	Major
3	1.67	3	0.6	8	1.1563	115.63	1.00	Major
4	1.67	1	0.6	8	0.0408	4.08	1.00	Major
5	1.67	2	0.6	10	0.0550	5.50	1.00	Major
6	1.67	3	0.6	10	0.7250	72.50	1.00	Major
7	1.67	1	0.6	12	0.0556	5.56	1.00	Major
8	1.67	2	0.6	12	0.0465	4.65	1.00	Major
9	1.67	3	0.6	12	0.2611	26.11	1.00	Major
10	3	1	0.6	8	0.0001	0.01	0.00	None
11	3	2	0.6	8	0.0001	0.01	0.00	None
12	3	3	0.6	8	3.0771	307.71	1.00	Major
13	3	1	0.6	10	0.0208	2.08	1.00	Major
14	3	2	0.6	10	0.0001	0.01	0.00	None
15	3	3	0.6	10	4.9792	497.92	1.00	Major
16	3	1	0.6	12	0.0333	3.33	1.00	Major
17	3	2	0.6	12	0.0002	0.02	0.00	None
18	3	3	0.6	12	3.3861	338.61	1.00	Major

Table C- 106. Analysis Result: Centro Earthquake (0.7g) of One-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.7	8	0.0656	6.56	1.00	Major
2	1.67	2	0.7	8	0.0510	5.10	1.00	Major
3	1.67	3	0.7	8	0.5198	51.98	1.00	Major
4	1.67	1	0.7	8	0.0525	5.25	1.00	Major
5	1.67	2	0.7	10	0.0600	6.00	1.00	Major
6	1.67	3	0.7	10	0.7992	79.92	1.00	Major
7	1.67	1	0.7	12	0.0618	6.18	1.00	Major
8	1.67	2	0.7	12	0.0590	5.90	1.00	Major
9	1.67	3	0.7	12	0.5729	57.29	1.00	Major
10	3	1	0.7	8	0.0002	0.02	0.00	None
11	3	2	0.7	8	0.0001	0.01	0.00	None
12	3	3	0.7	8	4.3938	439.38	1.00	Major
13	3	1	0.7	10	0.0300	3.00	1.00	Major
14	3	2	0.7	10	0.0001	0.01	0.00	None
15	3	3	0.7	10	5.7292	572.92	1.00	Major
16	3	1	0.7	12	0.0410	4.10	1.00	Major
17	3	2	0.7	12	0.0002	0.02	0.00	None
18	3	3	0.7	12	0.1799	17.99	1.00	Major

Table C- 107. Analysis Result: Centro Earthquake (0.8g) of One-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.8	8	0.0656	6.56	1.00	Major
2	1.67	2	0.8	8	0.0510	5.10	1.00	Major
3	1.67	3	0.8	8	0.5198	51.98	1.00	Major
4	1.67	1	0.8	8	0.0525	5.25	1.00	Major
5	1.67	2	0.8	10	0.0600	6.00	1.00	Major
6	1.67	3	0.8	10	0.7992	79.92	1.00	Major
7	1.67	1	0.8	12	0.0618	6.18	1.00	Major
8	1.67	2	0.8	12	0.0590	5.90	1.00	Major
9	1.67	3	0.8	12	0.5729	57.29	1.00	Major
10	3	1	0.8	8	0.0002	0.02	0.00	None
11	3	2	0.8	8	0.0001	0.01	0.00	None
12	3	3	0.8	8	4.3938	439.38	1.00	Major
13	3	1	0.8	10	0.0300	3.00	1.00	Major
14	3	2	0.8	10	0.0001	0.01	0.00	None
15	3	3	0.8	10	5.7292	572.92	1.00	Major
16	3	1	0.8	12	0.0410	4.10	1.00	Major
17	3	2	0.8	12	0.0002	0.02	0.00	None
18	3	3	0.8	12	0.1799	17.99	1.00	Major

Centro Earthquake (0.9g) of One-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.9	8	0.1104	11.04	1.00	Major
2	1.67	2	0.9	8	0.0885	8.85	1.00	Major
3	1.67	3	0.9	8	1.0979	109.79	1.00	Major
4	1.67	1	0.9	8	0.0883	8.83	1.00	Major
5	1.67	2	0.9	10	0.0667	6.67	1.00	Major
6	1.67	3	0.9	10	0.9417	94.17	1.00	Major
7	1.67	1	0.9	12	0.0903	9.03	1.00	Major
8	1.67	2	0.9	12	0.0660	6.60	1.00	Major
9	1.67	3	0.9	12	1.1340	113.40	1.00	Major
10	3	1	0.9	8	0.0344	3.44	1.00	Major
11	3	2	0.9	8	0.0003	0.03	0.00	None
12	3	3	0.9	8	3.8531	385.31	1.00	Major
13	3	1	0.9	10	0.0492	4.92	1.00	Major
14	3	2	0.9	10	0.0001	0.01	0.00	None
15	3	3	0.9	10	2.0292	202.92	1.00	Major
16	3	1	0.9	12	0.0542	5.42	1.00	Major
17	3	2	0.9	12	0.0292	2.92	1.00	Major
18	3	3	0.9	12	5.9250	592.50	1.00	Major

Table C- 108. Analysis Result: Centro Earthquake (1g) of One-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	1	8	0.1031	10.31	1.00	Major
2	1.67	2	1	8	0.1021	10.21	1.00	Major
3	1.67	3	1	8	1.6313	163.13	1.00	Major
4	1.67	1	1	8	0.0825	8.25	1.00	Major
5	1.67	2	1	10	0.0700	7.00	1.00	Major
6	1.67	3	1	10	1.1867	118.67	1.00	Major
7	1.67	1	1	12	0.1076	10.76	1.00	Major
8	1.67	2	1	12	0.0799	7.99	1.00	Major
9	1.67	3	1	12	1.2208	122.08	1.00	Major
10	3	1	1	8	0.0438	4.38	1.00	Major
11	3	2	1	8	0.0001	0.01	0.00	None
12	3	3	1	8	4.4094	440.94	1.00	Major
13	3	1	1	10	0.0633	6.33	1.00	Major
14	3	2	1	10	0.0002	0.02	0.00	None
15	3	3	1	10	7.6750	767.50	1.00	Major
16	3	1	1	12	0.0694	6.94	1.00	Major
17	3	2	1	12	0.0925	9.25	1.00	Major
18	3	3	1	12	8.2667	826.67	1.00	Major

Table C- 109. Analysis Result: San Salvador Earthquake (0.1g) of One-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.1	8	0.0000	0.00	0.00	None
2	1.67	2	0.1	8	0.0000	0.00	0.00	None
3	1.67	3	0.1	8	0.0119	1.19	0.46	Moderate
4	1.67	1	0.1	8	0.0080	0.80	0.20	Minor
5	1.67	2	0.1	10	0.0000	0.00	0.00	None
6	1.67	3	0.1	10	0.0091	0.91	0.28	Minor
7	1.67	1	0.1	12	0.0000	0.00	0.00	None
8	1.67	2	0.1	12	0.0000	0.00	0.00	None
9	1.67	3	0.1	12	0.0043	0.43	0.00	None
10	3	1	0.1	8	0.0000	0.00	0.00	None
11	3	2	0.1	8	0.0000	0.00	0.00	None
12	3	3	0.1	8	0.0083	0.83	0.22	Minor
13	3	1	0.1	10	0.0000	0.00	0.00	None
14	3	2	0.1	10	0.0000	0.00	0.00	None
15	3	3	0.1	10	0.0117	1.17	0.45	Moderate
16	3	1	0.1	12	0.0000	0.00	0.00	None
17	3	2	0.1	12	0.0000	0.00	0.00	None
18	3	3	0.1	12	0.0070	0.70	0.14	Minor

Table C- 110. Analysis Result: San Salvador Earthquake (0.2g) of One-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.2	8	0.0191	1.91	0.94	Major
2	1.67	2	0.2	8	0.0000	0.00	0.00	None
3	1.67	3	0.2	8	0.0239	2.39	1.00	Major
4	1.67	1	0.2	8	0.0169	1.69	0.79	Major
5	1.67	2	0.2	10	0.0002	0.02	0.00	None
6	1.67	3	0.2	10	0.0182	1.82	0.88	Major
7	1.67	1	0.2	12	0.0155	1.55	0.70	Substantial
8	1.67	2	0.2	12	0.0136	1.36	0.57	Substantial
9	1.67	3	0.2	12	0.0086	0.86	0.24	Minor
10	3	1	0.2	8	0.0000	0.00	0.00	None
11	3	2	0.2	8	0.0000	0.00	0.00	None
12	3	3	0.2	8	0.0166	1.66	0.77	Major
13	3	1	0.2	10	0.0000	0.00	0.00	None
14	3	2	0.2	10	0.0000	0.00	0.00	None
15	3	3	0.2	10	0.0235	2.35	1.00	Major
16	3	1	0.2	12	0.0000	0.00	0.00	None
17	3	2	0.2	12	0.0000	0.00	0.00	None
18	3	3	0.2	12	0.0141	1.41	0.60	Substantial

Table C- 111. Analysis Result: San Salvador Earthquake (0.3g) of One-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.3	8	0.0263	2.63	1.00	Major
2	1.67	2	0.3	8	0.0000	0.00	0.00	None
3	1.67	3	0.3	8	0.2953	29.53	1.00	Major
4	1.67	1	0.3	8	0.0210	2.10	1.00	Major
5	1.67	2	0.3	10	0.0000	0.00	0.00	None
6	1.67	3	0.3	10	0.0273	2.73	1.00	Major
7	1.67	1	0.3	12	0.0218	2.18	1.00	Major
8	1.67	2	0.3	12	0.0218	2.18	1.00	Major
9	1.67	3	0.3	12	0.0129	1.29	0.53	Moderate
10	3	1	0.3	8	0.0000	0.00	0.00	None
11	3	2	0.3	8	0.0000	0.00	0.00	None
12	3	3	0.3	8	0.0248	2.48	1.00	Major
13	3	1	0.3	10	0.0000	0.00	0.00	None
14	3	2	0.3	10	0.0000	0.00	0.00	None
15	3	3	0.3	10	0.0351	3.51	1.00	Major
16	3	1	0.3	12	0.0000	0.00	0.00	None
17	3	2	0.3	12	0.0000	0.00	0.00	None
18	3	3	0.3	12	0.0211	2.11	1.00	Major

Table C- 112. Analysis Result: San Salvador Earthquake (0.4g) of One-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.4	8	0.0287	2.87	1.00	Major
2	1.67	2	0.4	8	0.0000	0.00	0.00	None
3	1.67	3	0.4	8	0.1779	17.79	1.00	Major
4	1.67	1	0.4	8	0.0230	2.30	1.00	Major
5	1.67	2	0.4	10	0.0289	2.89	1.00	Major
6	1.67	3	0.4	10	0.0366	3.66	1.00	Major
7	1.67	1	0.4	12	0.0269	2.69	1.00	Major
8	1.67	2	0.4	12	0.0243	2.43	1.00	Major
9	1.67	3	0.4	12	0.0174	1.74	0.82	Major
10	3	1	0.4	8	0.0000	0.00	0.00	None
11	3	2	0.4	8	0.0000	0.00	0.00	None
12	3	3	0.4	8	0.0331	3.31	1.00	Major
13	3	1	0.4	10	0.0000	0.00	0.00	None
14	3	2	0.4	10	0.0000	0.00	0.00	None
15	3	3	0.4	10	1.0728	107.28	1.00	Major
16	3	1	0.4	12	0.0000	0.00	0.00	None
17	3	2	0.4	12	0.0000	0.00	0.00	None
18	3	3	0.4	12	0.0284	2.84	1.00	Major

Table C- 113. Analysis Result: San Salvador Earthquake (0.5g) of One-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.5	8	0.0319	3.19	1.00	Major
2	1.67	2	0.5	8	0.0000	0.00	0.00	None
3	1.67	3	0.5	8	0.1021	10.21	1.00	Major
4	1.67	1	0.5	8	0.0255	2.55	1.00	Major
5	1.67	2	0.5	10	0.0332	3.32	1.00	Major
6	1.67	3	0.5	10	0.2473	24.73	1.00	Major
7	1.67	1	0.5	12	0.0263	2.63	1.00	Major
8	1.67	2	0.5	12	0.0274	2.74	1.00	Major
9	1.67	3	0.5	12	0.0216	2.16	1.00	Major
10	3	1	0.5	8	0.0000	0.00	0.00	None
11	3	2	0.5	8	0.0000	0.00	0.00	None
12	3	3	0.5	8	2.2206	222.06	1.00	Major
13	3	1	0.5	10	0.0000	0.00	0.00	None
14	3	2	0.5	10	0.0000	0.00	0.00	None
15	3	3	0.5	10	2.6026	260.26	1.00	Major
16	3	1	0.5	12	0.0000	0.00	0.00	None
17	3	2	0.5	12	0.0000	0.00	0.00	None
18	3	3	0.5	12	0.0353	3.53	1.00	Major

Table C- 114. Analysis Result: San Salvador Earthquake (0.6g) of One-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.6	8	0.0418	4.18	1.00	Major
2	1.67	2	0.6	8	0.0442	4.42	1.00	Major
3	1.67	3	0.6	8	0.0839	8.39	1.00	Major
4	1.67	1	0.6	8	0.0334	3.34	1.00	Major
5	1.67	2	0.6	10	0.0339	3.39	1.00	Major
6	1.67	3	0.6	10	0.1582	15.82	1.00	Major
7	1.67	1	0.6	12	0.0307	3.07	1.00	Major
8	1.67	2	0.6	12	0.0272	2.72	1.00	Major
9	1.67	3	0.6	12	0.0258	2.58	1.00	Major
10	3	1	0.6	8	0.0000	0.00	0.00	None
11	3	2	0.6	8	0.0000	0.00	0.00	None
12	3	3	0.6	8	1.4489	144.89	1.00	Major
13	3	1	0.6	10	0.0000	0.00	0.00	None
14	3	2	0.6	10	0.0000	0.00	0.00	None
15	3	3	0.6	10	2.6164	261.64	1.00	Major
16	3	1	0.6	12	0.0302	3.02	1.00	Major
17	3	2	0.6	12	0.0000	0.00	0.00	None
18	3	3	0.6	12	0.0424	4.24	1.00	Major

Table C- 115. Analysis Result: San Salvador Earthquake (0.7g) of One-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.7	8	0.0578	5.78	1.00	Major
2	1.67	2	0.7	8	0.0471	4.71	1.00	Major
3	1.67	3	0.7	8	0.8543	85.43	1.00	Major
4	1.67	1	0.7	8	0.0463	4.63	1.00	Major
5	1.67	2	0.7	10	0.0353	3.53	1.00	Major
6	1.67	3	0.7	10	0.6444	64.44	1.00	Major
7	1.67	1	0.7	12	0.0370	3.70	1.00	Major
8	1.67	2	0.7	12	0.0422	4.22	1.00	Major
9	1.67	3	0.7	12	0.0302	3.02	1.00	Major
10	3	1	0.7	8	0.0000	0.00	0.00	None
11	3	2	0.7	8	0.0000	0.00	0.00	None
12	3	3	0.7	8	6.6376	663.76	1.00	Major
13	3	1	0.7	10	0.0000	0.00	0.00	None
14	3	2	0.7	10	0.0000	0.00	0.00	None
15	3	3	0.7	10	3.9887	398.87	1.00	Major
16	3	1	0.7	12	0.0354	3.54	1.00	Major
17	3	2	0.7	12	0.0000	0.00	0.00	None
18	3	3	0.7	12	0.0495	4.95	1.00	Major

Table C- 116. Analysis Result: San Salvador Earthquake (0.8g) of One-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.8	8	0.0624	6.24	1.00	Major
2	1.67	2	0.8	8	0.0540	5.40	1.00	Major
3	1.67	3	0.8	8	0.7317	73.17	1.00	Major
4	1.67	1	0.8	8	0.0499	4.99	1.00	Major
5	1.67	2	0.8	10	0.0425	4.25	1.00	Major
6	1.67	3	0.8	10	0.1176	11.76	1.00	Major
7	1.67	1	0.8	12	0.0436	4.36	1.00	Major
8	1.67	2	0.8	12	0.0521	5.21	1.00	Major
9	1.67	3	0.8	12	0.0345	3.45	1.00	Major
10	3	1	0.8	8	0.0000	0.00	0.00	None
11	3	2	0.8	8	0.0000	0.00	0.00	None
12	3	3	0.8	8	3.7633	376.33	1.00	Major
13	3	1	0.8	10	0.0419	4.19	1.00	Major
14	3	2	0.8	10	0.0000	0.00	0.00	None
15	3	3	0.8	10	4.2917	429.17	1.00	Major
16	3	1	0.8	12	0.0346	3.46	1.00	Major
17	3	2	0.8	12	0.0000	0.00	0.00	None
18	3	3	0.8	12	0.0675	6.75	1.00	Major

Table C- 117. Analysis Result: San Salvador Earthquake (0.9g) of One-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.9	8	0.0719	7.19	1.00	Major
2	1.67	2	0.9	8	0.0533	5.33	1.00	Major
3	1.67	3	0.9	8	1.4820	148.20	1.00	Major
4	1.67	1	0.9	8	0.0575	5.75	1.00	Major
5	1.67	2	0.9	10	0.0596	5.96	1.00	Major
6	1.67	3	0.9	10	0.2816	28.16	1.00	Major
7	1.67	1	0.9	12	0.0504	5.04	1.00	Major
8	1.67	2	0.9	12	0.0539	5.39	1.00	Major
9	1.67	3	0.9	12	0.0390	3.90	1.00	Major
10	3	1	0.9	8	0.0000	0.00	0.00	None
11	3	2	0.9	8	0.0000	0.00	0.00	None
12	3	3	0.9	8	5.1191	511.91	1.00	Major
13	3	1	0.9	10	0.0518	5.18	1.00	Major
14	3	2	0.9	10	0.0000	0.00	0.00	None
15	3	3	0.9	10	1.2292	122.92	1.00	Major
16	3	1	0.9	12	0.0377	3.77	1.00	Major
17	3	2	0.9	12	0.0000	0.00	0.00	None
18	3	3	0.9	12	0.8218	82.18	1.00	Major

Table C- 118. Analysis Result: San Salvador Earthquake (1g)

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	1	8	0.0810	8.10	1.00	Major
2	1.67	2	1	8	0.0606	6.06	1.00	Major
3	1.67	3	1	8	0.7074	70.74	1.00	Major
4	1.67	1	1	8	0.0648	6.48	1.00	Major
5	1.67	2	1	10	0.0761	7.61	1.00	Major
6	1.67	3	1	10	0.6549	65.49	1.00	Major
7	1.67	1	1	12	0.0572	5.72	1.00	Major
8	1.67	2	1	12	0.0570	5.70	1.00	Major
9	1.67	3	1	12	0.0432	4.32	1.00	Major
10	3	1	1	8	0.0000	0.00	0.00	None
11	3	2	1	8	0.0000	0.00	0.00	None
12	3	3	1	8	9.0559	905.59	1.00	Major
13	3	1	1	10	0.0541	5.41	1.00	Major
14	3	2	1	10	0.0000	0.00	0.00	None
15	3	3	1	10	4.2640	426.40	1.00	Major
16	3	1	1	12	0.0444	4.44	1.00	Major
17	3	2	1	12	0.0000	0.00	0.00	None
18	3	3	1	12	3.3108	331.08	1.00	Major

C.4 TWO-STORY CONCRETE SHEAR WALL MODELS

Table C- 119. Analysis Result: Mayagüez Earthquake (0.1g) of Two-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.1	8	0.0042	0.42	0.00	None
2	1.67	2	0.1	8	0.0038	0.38	0.00	None
3	1.67	3	0.1	8	0.0151	1.51	0.67	Substantial
4	1.67	1	0.1	8	0.0073	0.73	0.15	Minor
5	1.67	2	0.1	10	0.0033	0.33	0.00	None
6	1.67	3	0.1	10	0.0100	1.00	0.33	Minor
7	1.67	1	0.1	12	0.0063	0.63	0.08	Minor
8	1.67	2	0.1	12	0.0042	0.42	0.00	None
9	1.67	3	0.1	12	0.0128	1.28	0.52	Moderate
10	3	1	0.1	8	0.0000	0.00	0.00	None
11	3	2	0.1	8	0.0000	0.00	0.00	None
12	3	3	0.1	8	0.0146	1.46	0.64	Substantial
13	3	1	0.1	10	0.0033	0.33	0.00	None
14	3	2	0.1	10	0.0000	0.00	0.00	None
15	3	3	0.1	10	0.0075	0.75	0.17	Minor
16	3	1	0.1	12	0.0021	0.21	0.00	None
17	3	2	0.1	12	0.0000	0.00	0.00	None
18	3	3	0.1	12	0.0135	1.35	0.57	Substantial

Table C- 120. Analysis Result: Mayagüez Earthquake (0.2g) of Two-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.2	8	0.0156	1.56	0.71	Substantial
2	1.67	2	0.2	8	0.0115	1.15	0.43	Moderate
3	1.67	3	0.2	8	0.3094	30.94	1.00	Major
4	1.67	1	0.2	8	0.0208	2.08	1.00	Major
5	1.67	2	0.2	10	0.0075	0.75	0.17	Minor
6	1.67	3	0.2	10	0.0200	2.00	1.00	Major
7	1.67	1	0.2	12	0.0167	1.67	0.78	Major
8	1.67	2	0.2	12	0.0111	1.11	0.41	Moderate
9	1.67	3	0.2	12	0.0260	2.60	1.00	Major
10	3	1	0.2	8	0.0083	0.83	0.22	Minor
11	3	2	0.2	8	0.0000	0.00	0.00	None
12	3	3	0.2	8	0.3104	31.04	1.00	Major
13	3	1	0.2	10	0.0075	0.75	0.17	Minor
14	3	2	0.2	10	0.0042	0.42	0.00	None
15	3	3	0.2	10	0.0150	1.50	0.67	Substantial
16	3	1	0.2	12	0.0049	0.49	0.00	None
17	3	2	0.2	12	0.0049	0.49	0.00	None
18	3	3	0.2	12	0.0267	2.67	1.00	Major

Table C- 121. Analysis Result: Mayagüez Earthquake (0.3g) of Two-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.3	8	0.0260	2.60	1.00	Major
2	1.67	2	0.3	8	0.0125	1.25	0.50	Moderate
3	1.67	3	0.3	8	0.3620	36.20	1.00	Major
4	1.67	1	0.3	8	0.0302	3.02	1.00	Major
5	1.67	2	0.3	10	0.0183	1.83	0.89	Major
6	1.67	3	0.3	10	0.1913	19.13	1.00	Major
7	1.67	1	0.3	12	0.0326	3.26	1.00	Major
8	1.67	2	0.3	12	0.0160	1.60	0.73	Substantial
9	1.67	3	0.3	12	0.0736	7.36	1.00	Major
10	3	1	0.3	8	0.0146	1.46	0.64	Substantial
11	3	2	0.3	8	0.0052	0.52	0.01	None
12	3	3	0.3	8	4.3917	439.17	1.00	Major
13	3	1	0.3	10	0.0092	0.92	0.28	Minor
14	3	2	0.3	10	0.0100	1.00	0.33	Minor
15	3	3	0.3	10	0.0225	2.25	1.00	Major
16	3	1	0.3	12	0.0090	0.90	0.27	Minor
17	3	2	0.3	12	0.0083	0.83	0.22	Minor
18	3	3	0.3	12	0.0406	4.06	1.00	Major

Table C- 122. Analysis Result: Mayagüez Earthquake (0.4g) of Two-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.4	8	0.0313	3.13	1.00	Major
2	1.67	2	0.4	8	0.0229	2.29	1.00	Major
3	1.67	3	0.4	8	0.4760	47.60	1.00	Major
4	1.67	1	0.4	8	0.0396	3.96	1.00	Major
5	1.67	2	0.4	10	0.0283	2.83	1.00	Major
6	1.67	3	0.4	10	0.1942	19.42	1.00	Major
7	1.67	1	0.4	12	0.0278	2.78	1.00	Major
8	1.67	2	0.4	12	0.0250	2.50	1.00	Major
9	1.67	3	0.4	12	0.2069	20.69	1.00	Major
10	3	1	0.4	8	0.0156	1.56	0.71	Substantial
11	3	2	0.4	8	0.0188	1.88	0.92	Major
12	3	3	0.4	8	2.8339	283.39	1.00	Major
13	3	1	0.4	10	0.0125	1.25	0.50	Moderate
14	3	2	0.4	10	0.0183	1.83	0.89	Major
15	3	3	0.4	10	0.0292	2.92	1.00	Major
16	3	1	0.4	12	0.0160	1.60	0.73	Substantial
17	3	2	0.4	12	0.0146	1.46	0.64	Substantial
18	3	3	0.4	12	0.0333	3.33	1.00	Major

Table C- 123. Analysis Result: Mayagüez Earthquake (0.5g) of Two-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.5	8	0.0542	5.42	1.00	Major
2	1.67	2	0.5	8	0.0271	2.71	1.00	Major
3	1.67	3	0.5	8	0.4479	44.79	1.00	Major
4	1.67	1	0.5	8	0.0729	7.29	1.00	Major
5	1.67	2	0.5	10	0.0358	3.58	1.00	Major
6	1.67	3	0.5	10	0.2658	26.58	1.00	Major
7	1.67	1	0.5	12	0.0361	3.61	1.00	Major
8	1.67	2	0.5	12	0.0410	4.10	1.00	Major
9	1.67	3	0.5	12	0.5215	52.15	1.00	Major
10	3	1	0.5	8	0.0229	2.29	1.00	Major
11	3	2	0.5	8	0.0104	1.04	0.36	Moderate
12	3	3	0.5	8	2.3823	238.23	1.00	Major
13	3	1	0.5	10	0.0367	3.67	1.00	Major
14	3	2	0.5	10	0.0233	2.33	1.00	Major
15	3	3	0.5	10	0.6658	66.58	1.00	Major
16	3	1	0.5	12	0.0243	2.43	1.00	Major
17	3	2	0.5	12	0.0181	1.81	0.87	Major
18	3	3	0.5	12	0.0372	3.72	1.00	Major

Table C- 124. Analysis Result: Mayagüez Earthquake (0.6g) of Two-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.6	8	0.0688	6.88	1.00	Major
2	1.67	2	0.6	8	0.0479	4.79	1.00	Major
3	1.67	3	0.6	8	0.5411	54.11	1.00	Major
4	1.67	1	0.6	8	0.0594	5.94	1.00	Major
5	1.67	2	0.6	10	0.0442	4.42	1.00	Major
6	1.67	3	0.6	10	0.2858	28.58	1.00	Major
7	1.67	1	0.6	12	0.0389	3.89	1.00	Major
8	1.67	2	0.6	12	0.0486	4.86	1.00	Major
9	1.67	3	0.6	12	0.3215	32.15	1.00	Major
10	3	1	0.6	8	0.0375	3.75	1.00	Major
11	3	2	0.6	8	0.0271	2.71	1.00	Major
12	3	3	0.6	8	1.1396	113.96	1.00	Major
13	3	1	0.6	10	0.0433	4.33	1.00	Major
14	3	2	0.6	10	0.0250	2.50	1.00	Major
15	3	3	0.6	10	1.7167	171.67	1.00	Major
16	3	1	0.6	12	0.0271	2.71	1.00	Major
17	3	2	0.6	12	0.0236	2.36	1.00	Major
18	3	3	0.6	12	0.0410	4.10	1.00	Major

Table C- 125. Analysis Result: Mayagüez Earthquake (0.7g) of Two-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.7	8	0.0760	7.60	1.00	Major
2	1.67	2	0.7	8	0.0615	6.15	1.00	Major
3	1.67	3	0.7	8	0.4536	45.36	1.00	Major
4	1.67	1	0.7	8	0.0750	7.50	1.00	Major
5	1.67	2	0.7	10	0.0475	4.75	1.00	Major
6	1.67	3	0.7	10	0.3300	33.00	1.00	Major
7	1.67	1	0.7	12	0.0556	5.56	1.00	Major
8	1.67	2	0.7	12	0.0771	7.71	1.00	Major
9	1.67	3	0.7	12	0.2069	20.69	1.00	Major
10	3	1	0.7	8	0.0292	2.92	1.00	Major
11	3	2	0.7	8	0.0354	3.54	1.00	Major
12	3	3	0.7	8	1.0396	103.96	1.00	Major
13	3	1	0.7	10	0.0542	5.42	1.00	Major
14	3	2	0.7	10	0.0192	1.92	0.94	Major
15	3	3	0.7	10	0.4758	47.58	1.00	Major
16	3	1	0.7	12	0.0354	3.54	1.00	Major
17	3	2	0.7	12	0.0194	1.94	0.96	Major
18	3	3	0.7	12	0.0396	3.96	1.00	Major

Table C- 126. **Analysis Result: Mayagüez Earthquake (0.8g) of Two-Story Concrete Shear Wall models**

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.8	8	0.0885	8.85	1.00	Major
2	1.67	2	0.8	8	0.0719	7.19	1.00	Major
3	1.67	3	0.8	8	0.4885	48.85	1.00	Major
4	1.67	1	0.8	8	0.0594	5.94	1.00	Major
5	1.67	2	0.8	10	0.0625	6.25	1.00	Major
6	1.67	3	0.8	10	0.2850	28.50	1.00	Major
7	1.67	1	0.8	12	0.0715	7.15	1.00	Major
8	1.67	2	0.8	12	0.0729	7.29	1.00	Major
9	1.67	3	0.8	12	0.1806	18.06	1.00	Major
10	3	1	0.8	8	0.0813	8.13	1.00	Major
11	3	2	0.8	8	0.0333	3.33	1.00	Major
12	3	3	0.8	8	1.2417	124.17	1.00	Major
13	3	1	0.8	10	0.0617	6.17	1.00	Major
14	3	2	0.8	10	0.0258	2.58	1.00	Major
15	3	3	0.8	10	1.0863	108.63	1.00	Major
16	3	1	0.8	12	0.0458	4.58	1.00	Major
17	3	2	0.8	12	0.0229	2.29	1.00	Major
18	3	3	0.8	12	0.0396	3.96	1.00	Major

Table C- 127. Analysis Result: Mayagüez Earthquake (0.9g) of Two-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.9	8	0.0885	8.85	1.00	Major
2	1.67	2	0.9	8	0.0854	8.54	1.00	Major
3	1.67	3	0.9	8	0.4635	46.35	1.00	Major
4	1.67	1	0.9	8	0.0906	9.06	1.00	Major
5	1.67	2	0.9	10	0.0750	7.50	1.00	Major
6	1.67	3	0.9	10	0.6008	60.08	1.00	Major
7	1.67	1	0.9	12	0.0771	7.71	1.00	Major
8	1.67	2	0.9	12	0.0590	5.90	1.00	Major
9	1.67	3	0.9	12	0.2750	27.50	1.00	Major
10	3	1	0.9	8	0.0927	9.27	1.00	Major
11	3	2	0.9	8	0.0344	3.44	1.00	Major
12	3	3	0.9	8	1.0521	105.21	1.00	Major
13	3	1	0.9	10	0.0742	7.42	1.00	Major
14	3	2	0.9	10	0.0400	4.00	1.00	Major
15	3	3	0.9	10	1.2371	123.71	1.00	Major
16	3	1	0.9	12	0.0458	4.58	1.00	Major
17	3	2	0.9	12	0.0333	3.33	1.00	Major
18	3	3	0.9	12	0.0389	3.89	1.00	Major

Table C- 128. Analysis Result: Mayagüez Earthquake (1 g)

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	1	8	0.0667	6.67	1.00	Major
2	1.67	2	1	8	0.0833	8.33	1.00	Major
3	1.67	3	1	8	0.5646	56.46	1.00	Major
4	1.67	1	1	8	0.0948	9.48	1.00	Major
5	1.67	2	1	10	0.0808	8.08	1.00	Major
6	1.67	3	1	10	0.3300	33.00	1.00	Major
7	1.67	1	1	12	0.0882	8.82	1.00	Major
8	1.67	2	1	12	0.0507	5.07	1.00	Major
9	1.67	3	1	12	0.1868	18.68	1.00	Major
10	3	1	1	8	0.0792	7.92	1.00	Major
11	3	2	1	8	0.0479	4.79	1.00	Major
12	3	3	1	8	1.1094	110.94	1.00	Major
13	3	1	1	10	0.0750	7.50	1.00	Major
14	3	2	1	10	0.0492	4.92	1.00	Major
15	3	3	1	10	2.0767	207.67	1.00	Major
16	3	1	1	12	0.0479	4.79	1.00	Major
17	3	2	1	12	0.0278	2.78	1.00	Major
18	3	3	1	12	0.0389	3.89	1.00	Major

Table C- 129. Analysis Result: San Juan Earthquake (0.1g) of Two-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.1	8	0.0042	0.42	0.00	None
2	1.67	2	0.1	8	0.0031	0.31	0.00	None
3	1.67	3	0.1	8	0.0177	1.77	0.85	Major
4	1.67	1	0.1	8	0.0063	0.63	0.08	Minor
5	1.67	2	0.1	10	0.0033	0.33	0.00	None
6	1.67	3	0.1	10	0.0183	1.83	0.89	Major
7	1.67	1	0.1	12	0.0069	0.69	0.13	Minor
8	1.67	2	0.1	12	0.0028	0.28	0.00	None
9	1.67	3	0.1	12	0.0132	1.32	0.55	Moderate
10	3	1	0.1	8	0.0010	0.10	0.00	None
11	3	2	0.1	8	0.0000	0.00	0.00	None
12	3	3	0.1	8	0.0188	1.88	0.92	Major
13	3	1	0.1	10	0.0017	0.17	0.00	None
14	3	2	0.1	10	0.0000	0.00	0.00	None
15	3	3	0.1	10	0.0100	1.00	0.33	Minor
16	3	1	0.1	12	0.0021	0.21	0.00	None
17	3	2	0.1	12	0.0014	0.14	0.00	None
18	3	3	0.1	12	0.0118	1.18	0.45	Moderate

Table C- 130. Analysis Result: San Juan Earthquake (0.2g) of Two-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.2	8	0.0094	0.94	0.29	Minor
2	1.67	2	0.2	8	0.0052	0.52	0.01	None
3	1.67	3	0.2	8	0.0609	6.09	1.00	Major
4	1.67	1	0.2	8	0.0188	1.88	0.92	Major
5	1.67	2	0.2	10	0.0058	0.58	0.06	Minor
6	1.67	3	0.2	10	0.0358	3.58	1.00	Major
7	1.67	1	0.2	12	0.0194	1.94	0.96	Major
8	1.67	2	0.2	12	0.0056	0.56	0.04	None
9	1.67	3	0.2	12	0.0264	2.64	1.00	Major
10	3	1	0.2	8	0.0031	0.31	0.00	None
11	3	2	0.2	8	0.0021	0.21	0.00	None
12	3	3	0.2	8	0.1198	11.98	1.00	Major
13	3	1	0.2	10	0.0033	0.33	0.00	None
14	3	2	0.2	10	0.0025	0.25	0.00	None
15	3	3	0.2	10	0.0200	2.00	1.00	Major
16	3	1	0.2	12	0.0035	0.35	0.00	None
17	3	2	0.2	12	0.0028	0.28	0.00	None
18	3	3	0.2	12	0.0243	2.43	1.00	Major

Table C- 131. Analysis Result: San Juan Earthquake (0.3g) of Two-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.3	8	0.0177	1.77	0.85	Major
2	1.67	2	0.3	8	0.0083	0.83	0.22	Minor
3	1.67	3	0.3	8	0.1813	18.13	1.00	Major
4	1.67	1	0.3	8	0.0240	2.40	1.00	Major
5	1.67	2	0.3	10	0.0125	1.25	0.50	Moderate
6	1.67	3	0.3	10	0.1325	13.25	1.00	Major
7	1.67	1	0.3	12	0.0306	3.06	1.00	Major
8	1.67	2	0.3	12	0.0139	1.39	0.59	Substantial
9	1.67	3	0.3	12	0.0396	3.96	1.00	Major
10	3	1	0.3	8	0.0052	0.52	0.01	None
11	3	2	0.3	8	0.0031	0.31	0.00	None
12	3	3	0.3	8	0.4792	47.92	1.00	Major
13	3	1	0.3	10	0.0058	0.58	0.06	Minor
14	3	2	0.3	10	0.0033	0.33	0.00	None
15	3	3	0.3	10	0.0308	3.08	1.00	Major
16	3	1	0.3	12	0.0056	0.56	0.04	None
17	3	2	0.3	12	0.0042	0.42	0.00	None
18	3	3	0.3	12	0.0361	3.61	1.00	Major

Table C- 132. Analysis Result: San Juan Earthquake (0.4g) of Two-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.4	8	0.0292	2.92	1.00	Major
2	1.67	2	0.4	8	0.0156	1.56	0.71	Substantial
3	1.67	3	0.4	8	0.2688	26.88	1.00	Major
4	1.67	1	0.4	8	0.0094	0.94	0.29	Minor
5	1.67	2	0.4	10	0.0167	1.67	0.78	Major
6	1.67	3	0.4	10	0.1983	19.83	1.00	Major
7	1.67	1	0.4	12	0.0556	5.56	1.00	Major
8	1.67	2	0.4	12	0.0375	3.75	1.00	Major
9	1.67	3	0.4	12	0.0545	5.45	1.00	Major
10	3	1	0.4	8	0.0115	1.15	0.43	Moderate
11	3	2	0.4	8	0.0042	0.42	0.00	None
12	3	3	0.4	8	0.5417	54.17	1.00	Major
13	3	1	0.4	10	0.0083	0.83	0.22	Minor
14	3	2	0.4	10	0.0050	0.50	0.00	None
15	3	3	0.4	10	0.0408	4.08	1.00	Major
16	3	1	0.4	12	0.0090	0.90	0.27	Minor
17	3	2	0.4	12	0.0056	0.56	0.04	None
18	3	3	0.4	12	0.0479	4.79	1.00	Major

Table C- 133. Analysis Result: San Juan Earthquake (0.5g) of Two-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.5	8	0.0365	3.65	1.00	Major
2	1.67	2	0.5	8	0.0302	3.02	1.00	Major
3	1.67	3	0.5	8	0.4365	43.65	1.00	Major
4	1.67	1	0.5	8	0.0667	6.67	1.00	Major
5	1.67	2	0.5	10	0.0317	3.17	1.00	Major
6	1.67	3	0.5	10	0.3271	32.71	1.00	Major
7	1.67	1	0.5	12	0.0701	7.01	1.00	Major
8	1.67	2	0.5	12	0.0403	4.03	1.00	Major
9	1.67	3	0.5	12	0.4281	42.81	1.00	Major
10	3	1	0.5	8	0.0115	1.15	0.43	Moderate
11	3	2	0.5	8	0.0063	0.63	0.08	Minor
12	3	3	0.5	8	0.7229	72.29	1.00	Major
13	3	1	0.5	10	0.0183	1.83	0.89	Major
14	3	2	0.5	10	0.0067	0.67	0.11	Minor
15	3	3	0.5	10	0.6529	65.29	1.00	Major
16	3	1	0.5	12	0.0118	1.18	0.45	Moderate
17	3	2	0.5	12	0.0090	0.90	0.27	Minor
18	3	3	0.5	12	0.0507	5.07	1.00	Major

Table C- 134. Analysis Result: San Juan Earthquake (0.6g) of Two-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.6	8	0.0594	5.94	1.00	Major
2	1.67	2	0.6	8	0.0313	3.13	1.00	Major
3	1.67	3	0.6	8	1.0313	103.13	1.00	Major
4	1.67	1	0.6	8	0.0917	9.17	1.00	Major
5	1.67	2	0.6	10	0.0375	3.75	1.00	Major
6	1.67	3	0.6	10	0.5108	51.08	1.00	Major
7	1.67	1	0.6	12	0.0125	1.25	0.50	Moderate
8	1.67	2	0.6	12	0.0389	3.89	1.00	Major
9	1.67	3	0.6	12	0.3785	37.85	1.00	Major
10	3	1	0.6	8	0.0177	1.77	0.85	Major
11	3	2	0.6	8	0.0083	0.83	0.22	Minor
12	3	3	0.6	8	1.9182	191.82	1.00	Major
13	3	1	0.6	10	0.0125	1.25	0.50	Moderate
14	3	2	0.6	10	0.0100	1.00	0.33	Minor
15	3	3	0.6	10	0.8067	80.67	1.00	Major
16	3	1	0.6	12	0.0146	1.46	0.64	Substantial
17	3	2	0.6	12	0.0111	1.11	0.41	Moderate
18	3	3	0.6	12	0.0438	4.38	1.00	Major

Table C- 135. Analysis Result: San Juan Earthquake (0.7g) of Two-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.7	8	0.0656	6.56	1.00	Major
2	1.67	2	0.7	8	0.0458	4.58	1.00	Major
3	1.67	3	0.7	8	0.5578	55.78	1.00	Major
4	1.67	1	0.7	8	0.1094	10.94	1.00	Major
5	1.67	2	0.7	10	0.0408	4.08	1.00	Major
6	1.67	3	0.7	10	0.5908	59.08	1.00	Major
7	1.67	1	0.7	12	0.0889	8.89	1.00	Major
8	1.67	2	0.7	12	0.0479	4.79	1.00	Major
9	1.67	3	0.7	12	0.5101	51.01	1.00	Major
10	3	1	0.7	8	0.0167	1.67	0.78	Major
11	3	2	0.7	8	0.0115	1.15	0.43	Moderate
12	3	3	0.7	8	1.2208	122.08	1.00	Major
13	3	1	0.7	10	0.0275	2.75	1.00	Major
14	3	2	0.7	10	0.0158	1.58	0.72	Substantial
15	3	3	0.7	10	4.2175	421.75	1.00	Major
16	3	1	0.7	12	0.0194	1.94	0.96	Major
17	3	2	0.7	12	0.0111	1.11	0.41	Moderate
18	3	3	0.7	12	0.0493	4.93	1.00	Major

Table C- 136. Analysis Result: San Juan Earthquake (0.8g) of Two-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.8	8	0.0750	7.50	1.00	Major
2	1.67	2	0.8	8	0.0542	5.42	1.00	Major
3	1.67	3	0.8	8	1.7281	172.81	1.00	Major
4	1.67	1	0.8	8	0.1240	12.40	1.00	Major
5	1.67	2	0.8	10	0.0558	5.58	1.00	Major
6	1.67	3	0.8	10	0.7567	75.67	1.00	Major
7	1.67	1	0.8	12	0.0688	6.88	1.00	Major
8	1.67	2	0.8	12	0.0681	6.81	1.00	Major
9	1.67	3	0.8	12	0.4712	47.12	1.00	Major
10	3	1	0.8	8	0.0219	2.19	1.00	Major
11	3	2	0.8	8	0.0135	1.35	0.57	Substantial
12	3	3	0.8	8	1.0880	108.80	1.00	Major
13	3	1	0.8	10	0.0292	2.92	1.00	Major
14	3	2	0.8	10	0.0142	1.42	0.61	Substantial
15	3	3	0.8	10	1.2050	120.50	1.00	Major
16	3	1	0.8	12	0.0347	3.47	1.00	Major
17	3	2	0.8	12	0.0125	1.25	0.50	Moderate
18	3	3	0.8	12	0.0521	5.21	1.00	Major

Table C- 137. Analysis Result: San Juan Earthquake (0.9g) of Two-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.9	8	0.0885	8.85	1.00	Major
2	1.67	2	0.9	8	0.0740	7.40	1.00	Major
3	1.67	3	0.9	8	1.8573	185.73	1.00	Major
4	1.67	1	0.9	8	0.1281	12.81	1.00	Major
5	1.67	2	0.9	10	0.0783	7.83	1.00	Major
6	1.67	3	0.9	10	0.4683	46.83	1.00	Major
7	1.67	1	0.9	12	0.0840	8.40	1.00	Major
8	1.67	2	0.9	12	0.0819	8.19	1.00	Major
9	1.67	3	0.9	12	0.4535	45.35	1.00	Major
10	3	1	0.9	8	0.0271	2.71	1.00	Major
11	3	2	0.9	8	0.0156	1.56	0.71	Substantial
12	3	3	0.9	8	1.2958	129.58	1.00	Major
13	3	1	0.9	10	0.0383	3.83	1.00	Major
14	3	2	0.9	10	0.0200	2.00	1.00	Major
15	3	3	0.9	10	0.8892	88.92	1.00	Major
16	3	1	0.9	12	0.0479	4.79	1.00	Major
17	3	2	0.9	12	0.0201	2.01	1.00	Major
18	3	3	0.9	12	0.0549	5.49	1.00	Major

Table C- 138. Analysis Result: San Juan Earthquake (1g) of Two-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	1	8	0.1177	11.77	1.00	Major
2	1.67	2	1	8	0.0469	4.69	1.00	Major
3	1.67	3	1	8	1.7604	176.04	1.00	Major
4	1.67	1	1	8	0.1260	12.60	1.00	Major
5	1.67	2	1	10	0.0950	9.50	1.00	Major
6	1.67	3	1	10	0.5583	55.83	1.00	Major
7	1.67	1	1	12	0.1000	10.00	1.00	Major
8	1.67	2	1	12	0.0917	9.17	1.00	Major
9	1.67	3	1	12	0.5132	51.32	1.00	Major
10	3	1	1	8	0.0375	3.75	1.00	Major
11	3	2	1	8	0.0219	2.19	1.00	Major
12	3	3	1	8	1.1380	113.80	1.00	Major
13	3	1	1	10	0.0500	5.00	1.00	Major
14	3	2	1	10	0.0208	2.08	1.00	Major
15	3	3	1	10	0.9742	97.42	1.00	Major
16	3	1	1	12	0.0479	4.79	1.00	Major
17	3	2	1	12	0.0250	2.50	1.00	Major
18	3	3	1	12	0.0580	5.80	1.00	Major

Table C- 139. Analysis Result: Northridge Earthquake (0.1g) of Two-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.1	8	0.0052	0.52	0.01	None
2	1.67	2	0.1	8	0.0031	0.31	0.00	None
3	1.67	3	0.1	8	0.0083	0.83	0.22	Minor
4	1.67	1	0.1	8	0.0063	0.63	0.08	Minor
5	1.67	2	0.1	10	0.0042	0.42	0.00	None
6	1.67	3	0.1	10	0.0092	0.92	0.28	Minor
7	1.67	1	0.1	12	0.0049	0.49	0.00	None
8	1.67	2	0.1	12	0.0035	0.35	0.00	None
9	1.67	3	0.1	12	0.0111	1.11	0.41	Moderate
10	3	1	0.1	8	0.0000	0.00	0.00	None
11	3	2	0.1	8	0.0000	0.00	0.00	None
12	3	3	0.1	8	0.0125	1.25	0.50	Moderate
13	3	1	0.1	10	0.0000	0.00	0.00	None
14	3	2	0.1	10	0.0000	0.00	0.00	None
15	3	3	0.1	10	0.0067	0.67	0.11	Minor
16	3	1	0.1	12	0.0021	0.21	0.00	None
17	3	2	0.1	12	0.0000	0.00	0.00	None
18	3	3	0.1	12	0.0111	1.11	0.41	Moderate

Table C- 140. Analysis Result: Northridge Earthquake (0.2g) of Two-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.2	8	0.0094	0.94	0.29	Minor
2	1.67	2	0.2	8	0.0063	0.63	0.08	Minor
3	1.67	3	0.2	8	0.0177	1.77	0.85	Major
4	1.67	1	0.2	8	0.0167	1.67	0.78	Major
5	1.67	2	0.2	10	0.0075	0.75	0.17	Minor
6	1.67	3	0.2	10	0.0192	1.92	0.94	Major
7	1.67	1	0.2	12	0.0104	1.04	0.36	Moderate
8	1.67	2	0.2	12	0.0069	0.69	0.13	Minor
9	1.67	3	0.2	12	0.0219	2.19	1.00	Major
10	3	1	0.2	8	0.0042	0.42	0.00	None
11	3	2	0.2	8	0.0000	0.00	0.00	None
12	3	3	0.2	8	3.8250	382.50	1.00	Major
13	3	1	0.2	10	0.0050	0.50	0.00	None
14	3	2	0.2	10	0.0000	0.00	0.00	None
15	3	3	0.2	10	0.0133	1.33	0.56	Substantial
16	3	1	0.2	12	0.0042	0.42	0.00	None
17	3	2	0.2	12	0.0003	0.03	0.00	None
18	3	3	0.2	12	0.0222	2.22	1.00	Major

Table C- 141. Analysis Result: Northridge Earthquake (0.3g) of Two-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.3	8	0.0208	2.08	1.00	Major
2	1.67	2	0.3	8	0.0104	1.04	0.36	Moderate
3	1.67	3	0.3	8	0.5167	51.67	1.00	Major
4	1.67	1	0.3	8	0.0323	3.23	1.00	Major
5	1.67	2	0.3	10	0.0125	1.25	0.50	Moderate
6	1.67	3	0.3	10	0.6533	65.33	1.00	Major
7	1.67	1	0.3	12	0.0132	1.32	0.55	Moderate
8	1.67	2	0.3	12	0.0139	1.39	0.59	Substantial
9	1.67	3	0.3	12	0.4215	42.15	1.00	Major
10	3	1	0.3	8	0.0104	1.04	0.36	Moderate
11	3	2	0.3	8	0.0000	0.00	0.00	None
12	3	3	0.3	8	1.7490	174.90	1.00	Major
13	3	1	0.3	10	0.0108	1.08	0.39	Moderate
14	3	2	0.3	10	0.0000	0.00	0.00	None
15	3	3	0.3	10	0.0192	1.92	0.94	Major
16	3	1	0.3	12	0.0069	0.69	0.13	Minor
17	3	2	0.3	12	0.0063	0.63	0.08	Minor
18	3	3	0.3	12	0.0333	3.33	1.00	Major

Table C- 142. Analysis Result: Northridge Earthquake (0.4g) of Two-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.4	8	0.0271	2.71	1.00	Major
2	1.67	2	0.4	8	0.0469	4.69	1.00	Major
3	1.67	3	0.4	8	0.9240	92.40	1.00	Major
4	1.67	1	0.4	8	0.0313	3.13	1.00	Major
5	1.67	2	0.4	10	0.0208	2.08	1.00	Major
6	1.67	3	0.4	10	0.8917	89.17	1.00	Major
7	1.67	1	0.4	12	0.0264	2.64	1.00	Major
8	1.67	2	0.4	12	0.0201	2.01	1.00	Major
9	1.67	3	0.4	12	0.7493	74.93	1.00	Major
10	3	1	0.4	8	0.0271	2.71	1.00	Major
11	3	2	0.4	8	0.0073	0.73	0.15	Minor
12	3	3	0.4	8	4.5792	457.92	1.00	Major
13	3	1	0.4	10	0.0117	1.17	0.44	Moderate
14	3	2	0.4	10	0.0117	1.17	0.44	Moderate
15	3	3	0.4	10	0.0258	2.58	1.00	Major
16	3	1	0.4	12	0.0111	1.11	0.41	Moderate
17	3	2	0.4	12	0.0090	0.90	0.27	Minor
18	3	3	0.4	12	0.0299	2.99	1.00	Major

Table C- 143. Analysis Result: Northridge Earthquake (0.5g) of Two-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.5	8	0.0406	4.06	1.00	Major
2	1.67	2	0.5	8	0.0354	3.54	1.00	Major
3	1.67	3	0.5	8	0.7740	77.40	1.00	Major
4	1.67	1	0.5	8	0.0375	3.75	1.00	Major
5	1.67	2	0.5	10	0.0258	2.58	1.00	Major
6	1.67	3	0.5	10	0.4558	45.58	1.00	Major
7	1.67	1	0.5	12	0.0354	3.54	1.00	Major
8	1.67	2	0.5	12	0.0319	3.19	1.00	Major
9	1.67	3	0.5	12	1.2292	122.92	1.00	Major
10	3	1	0.5	8	0.0271	2.71	1.00	Major
11	3	2	0.5	8	0.0083	0.83	0.22	Minor
12	3	3	0.5	8	2.0271	202.71	1.00	Major
13	3	1	0.5	10	0.0175	1.75	0.83	Major
14	3	2	0.5	10	0.0150	1.50	0.67	Substantial
15	3	3	0.5	10	2.6633	266.33	1.00	Major
16	3	1	0.5	12	0.0132	1.32	0.55	Moderate
17	3	2	0.5	12	0.0104	1.04	0.36	Moderate
18	3	3	0.5	12	0.0326	3.26	1.00	Major

Table C- 144. Analysis Result: Northridge Earthquake (0.6g) of Two-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.6	8	0.0469	4.69	1.00	Major
2	1.67	2	0.6	8	0.0250	2.50	1.00	Major
3	1.67	3	0.6	8	0.7135	71.35	1.00	Major
4	1.67	1	0.6	8	0.0469	4.69	1.00	Major
5	1.67	2	0.6	10	0.0408	4.08	1.00	Major
6	+	3	0.6	10	1.0225	102.25	1.00	Major
7	1.67	1	0.6	12	0.0361	3.61	1.00	Major
8	1.67	2	0.6	12	0.0368	3.68	1.00	Major
9	1.67	3	0.6	12	0.6146	61.46	1.00	Major
10	3	1	0.6	8	0.0365	3.65	1.00	Major
11	3	2	0.6	8	0.0198	1.98	0.99	Major
12	3	3	0.6	8	4.5552	455.52	1.00	Major
13	3	1	0.6	10	0.0200	2.00	1.00	Major
14	3	2	0.6	10	0.0208	2.08	1.00	Major
15	3	3	0.6	10	2.1975	219.75	1.00	Major
16	3	1	0.6	12	0.0160	1.60	0.73	Substantial
17	3	2	0.6	12	0.0229	2.29	1.00	Major
18	3	3	0.6	12	0.0326	3.26	1.00	Major

Table C- 145. Analysis Result: Northridge Earthquake (0.7g) of Two-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.7	8	0.0552	5.52	1.00	Major
2	1.67	2	0.7	8	0.0333	3.33	1.00	Major
3	1.67	3	0.7	8	0.6771	67.71	1.00	Major
4	1.67	1	0.7	8	0.0510	5.10	1.00	Major
5	1.67	2	0.7	10	0.0475	4.75	1.00	Major
6	1.67	3	0.7	10	0.6425	64.25	1.00	Major
7	1.67	1	0.7	12	0.0368	3.68	1.00	Major
8	1.67	2	0.7	12	0.0382	3.82	1.00	Major
9	1.67	3	0.7	12	1.3813	138.13	1.00	Major
10	3	1	0.7	8	0.0427	4.27	1.00	Major
11	3	2	0.7	8	0.0167	1.67	0.78	Major
12	3	3	0.7	8	5.3661	536.61	1.00	Major
13	3	1	0.7	10	0.0242	2.42	1.00	Major
14	3	2	0.7	10	0.0200	2.00	1.00	Major
15	3	3	0.7	10	2.8342	283.42	1.00	Major
16	3	1	0.7	12	0.0236	2.36	1.00	Major
17	3	2	0.7	12	0.0375	3.75	1.00	Major
18	3	3	0.7	12	0.0313	3.13	1.00	Major

Table C- 146. Analysis Result: Northridge Earthquake (0.8g) of Two-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.8	8	0.0615	6.15	1.00	Major
2	1.67	2	0.8	8	0.0448	4.48	1.00	Major
3	1.67	3	0.8	8	0.7667	76.67	1.00	Major
4	1.67	1	0.8	8	0.0708	7.08	1.00	Major
5	1.67	2	0.8	10	0.0375	3.75	1.00	Major
6	1.67	3	0.8	10	1.1617	116.17	1.00	Major
7	1.67	1	0.8	12	0.0472	4.72	1.00	Major
8	1.67	2	0.8	12	0.0368	3.68	1.00	Major
9	1.67	3	0.8	12	0.8729	87.29	1.00	Major
10	3	1	0.8	8	0.0469	4.69	1.00	Major
11	3	2	0.8	8	0.0177	1.77	0.85	Major
12	3	3	0.8	8	1.1615	116.15	1.00	Major
13	3	1	0.8	10	0.0267	2.67	1.00	Major
14	3	2	0.8	10	0.0358	3.58	1.00	Major
15	3	3	0.8	10	5.0633	506.33	1.00	Major
16	3	1	0.8	12	0.0257	2.57	1.00	Major
17	3	2	0.8	12	0.0243	2.43	1.00	Major
18	3	3	0.8	12	0.0333	3.33	1.00	Major

Table C- 147. Analysis Result: Northridge Earthquake (0.9g) of Two-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.9	8	0.0615	6.15	1.00	Major
2	1.67	2	0.9	8	0.0448	4.48	1.00	Major
3	1.67	3	0.9	8	0.7667	76.67	1.00	Major
4	1.67	1	0.9	8	0.0708	7.08	1.00	Major
5	1.67	2	0.9	10	0.0375	3.75	1.00	Major
6	1.67	3	0.9	10	1.1617	116.17	1.00	Major
7	1.67	1	0.9	12	0.0472	4.72	1.00	Major
8	1.67	2	0.9	12	0.0368	3.68	1.00	Major
9	1.67	3	0.9	12	0.8729	87.29	1.00	Major
10	3	1	0.9	8	0.0469	4.69	1.00	Major
11	3	2	0.9	8	0.0177	1.77	0.85	Major
12	3	3	0.9	8	1.1615	116.15	1.00	Major
13	3	1	0.9	10	0.0267	2.67	1.00	Major
14	3	2	0.9	10	0.0358	3.58	1.00	Major
15	3	3	0.9	10	5.0633	506.33	1.00	Major
16	3	1	0.9	12	0.0257	2.57	1.00	Major
17	3	2	0.9	12	0.0243	2.43	1.00	Major
18	3	3	0.9	12	0.0333	3.33	1.00	Major

Table C- 148. Analysis Result: Northridge Earthquake (1 g)

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	1	8	0.0604	6.04	1.00	Major
2	1.67	2	1	8	0.0615	6.15	1.00	Major
3	1.67	3	1	8	0.8823	88.23	1.00	Major
4	1.67	1	1	8	0.0802	8.02	1.00	Major
5	1.67	2	1	10	0.0533	5.33	1.00	Major
6	1.67	3	1	10	0.9300	93.00	1.00	Major
7	1.67	1	1	12	0.0528	5.28	1.00	Major
8	1.67	2	1	12	0.0389	3.89	1.00	Major
9	1.67	3	1	12	0.8757	87.57	1.00	Major
10	3	1	1	8	0.0521	5.21	1.00	Major
11	3	2	1	8	0.0573	5.73	1.00	Major
12	3	3	1	8	2.4188	241.88	1.00	Major
13	3	1	1	10	0.0400	4.00	1.00	Major
14	3	2	1	10	0.0500	5.00	1.00	Major
15	3	3	1	10	5.9675	596.75	1.00	Major
16	3	1	1	12	0.0403	4.03	1.00	Major
17	3	2	1	12	0.0313	3.13	1.00	Major
18	3	3	1	12	0.0417	4.17	1.00	Major

Table C- 149. Analysis Result: Centro Earthquake (0.1g) of Two-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.1	8	0.0042	0.42	0.00	None
2	1.67	2	0.1	8	0.0042	0.42	0.00	None
3	1.67	3	0.1	8	0.0125	1.25	0.50	Moderate
4	1.67	1	0.1	8	0.0083	0.83	0.22	Minor
5	1.67	2	0.1	10	0.0033	0.33	0.00	None
6	1.67	3	0.1	10	0.0133	1.33	0.56	Substantial
7	1.67	1	0.1	12	0.0069	0.69	0.13	Minor
8	1.67	2	0.1	12	0.0042	0.42	0.00	None
9	1.67	3	0.1	12	0.0160	1.60	0.73	Substantial
10	3	1	0.1	8	0.0000	0.00	0.00	None
11	3	2	0.1	8	0.0000	0.00	0.00	None
12	3	3	0.1	8	0.0125	1.25	0.50	Moderate
13	3	1	0.1	10	0.0000	0.00	0.00	None
14	3	2	0.1	10	0.0000	0.00	0.00	None
15	3	3	0.1	10	0.0125	1.25	0.50	Moderate
16	3	1	0.1	12	0.0028	0.28	0.00	None
17	3	2	0.1	12	0.0000	0.00	0.00	None
18	3	3	0.1	12	0.0111	1.11	0.41	Moderate

Table C- 150. Analysis Result: Centro Earthquake (0.2g) of Two-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.2	8	0.0115	1.15	0.43	Moderate
2	1.67	2	0.2	8	0.0115	1.15	0.43	Moderate
3	1.67	3	0.2	8	0.6917	69.17	1.00	Major
4	1.67	1	0.2	8	0.0177	1.77	0.85	Major
5	1.67	2	0.2	10	0.0067	0.67	0.11	Minor
6	1.67	3	0.2	10	0.0275	2.75	1.00	Major
7	1.67	1	0.2	12	0.0160	1.60	0.73	Substantial
8	1.67	2	0.2	12	0.0083	0.83	0.22	Minor
9	1.67	3	0.2	12	0.0319	3.19	1.00	Major
10	3	1	0.2	8	0.0125	1.25	0.50	Moderate
11	3	2	0.2	8	0.0000	0.00	0.00	None
12	3	3	0.2	8	0.9500	95.00	1.00	Major
13	3	1	0.2	10	0.0067	0.67	0.11	Minor
14	3	2	0.2	10	0.0000	0.00	0.00	None
15	3	3	0.2	10	0.0258	2.58	1.00	Major
16	3	1	0.2	12	0.0049	0.49	0.00	None
17	3	2	0.2	12	0.0049	0.49	0.00	None
18	3	3	0.2	12	0.0222	2.22	1.00	Major

Table C- 151. Analysis Result: Centro Earthquake (0.3g) of Two-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.3	8	0.0188	1.88	0.92	Major
2	1.67	2	0.3	8	0.0198	1.98	0.99	Major
3	1.67	3	0.3	8	0.6813	68.13	1.00	Major
4	1.67	1	0.3	8	0.0281	2.81	1.00	Major
5	1.67	2	0.3	10	0.0117	1.17	0.44	Moderate
6	1.67	3	0.3	10	0.7033	70.33	1.00	Major
7	1.67	1	0.3	12	0.0299	2.99	1.00	Major
8	1.67	2	0.3	12	0.0188	1.88	0.92	Major
9	1.67	3	0.3	12	0.5965	59.65	1.00	Major
10	3	1	0.3	8	0.0271	2.71	1.00	Major
11	3	2	0.3	8	0.0000	0.00	0.00	None
12	3	3	0.3	8	2.6188	261.88	1.00	Major
13	3	1	0.3	10	0.0125	1.25	0.50	Moderate
14	3	2	0.3	10	0.0108	1.08	0.39	Moderate
15	3	3	0.3	10	3.5621	356.21	1.00	Major
16	3	1	0.3	12	0.0083	0.83	0.22	Minor
17	3	2	0.3	12	0.0069	0.69	0.13	Minor
18	3	3	0.3	12	0.0340	3.40	1.00	Major

Table C- 152. Analysis Result: Centro Earthquake (0.4g) of Two-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.4	8	0.0344	3.44	1.00	Major
2	1.67	2	0.4	8	0.0167	1.67	0.78	Major
3	1.67	3	0.4	8	0.8125	81.25	1.00	Major
4	1.67	1	0.4	8	0.0406	4.06	1.00	Major
5	1.67	2	0.4	10	0.0208	2.08	1.00	Major
6	1.67	3	0.4	10	0.5683	56.83	1.00	Major
7	1.67	1	0.4	12	0.0368	3.68	1.00	Major
8	1.67	2	0.4	12	0.0215	2.15	1.00	Major
9	1.67	3	0.4	12	0.6660	66.60	1.00	Major
10	3	1	0.4	8	0.0135	1.35	0.57	Substantial
11	3	2	0.4	8	0.0104	1.04	0.36	Moderate
12	3	3	0.4	8	3.0146	301.46	1.00	Major
13	3	1	0.4	10	0.0183	1.83	0.89	Major
14	3	2	0.4	10	0.0167	1.67	0.78	Major
15	3	3	0.4	10	3.1558	315.58	1.00	Major
16	3	1	0.4	12	0.0160	1.60	0.73	Substantial
17	3	2	0.4	12	0.0125	1.25	0.50	Moderate
18	3	3	0.4	12	0.0389	3.89	1.00	Major

Table C- 153. Analysis Result: Centro Earthquake (0.5g) of Two-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.5	8	0.0542	5.42	1.00	Major
2	1.67	2	0.5	8	0.0365	3.65	1.00	Major
3	1.67	3	0.5	8	1.1073	110.73	1.00	Major
4	1.67	1	0.5	8	0.0458	4.58	1.00	Major
5	1.67	2	0.5	10	0.0417	4.17	1.00	Major
6	1.67	3	0.5	10	0.6417	64.17	1.00	Major
7	1.67	1	0.5	12	0.0507	5.07	1.00	Major
8	1.67	2	0.5	12	0.0299	2.99	1.00	Major
9	1.67	3	0.5	12	1.3451	134.51	1.00	Major
10	3	1	0.5	8	0.0313	3.13	1.00	Major
11	3	2	0.5	8	0.0177	1.77	0.85	Major
12	3	3	0.5	8	1.8302	183.02	1.00	Major
13	3	1	0.5	10	0.0183	1.83	0.89	Major
14	3	2	0.5	10	0.0358	3.58	1.00	Major
15	3	3	0.5	10	2.6900	269.00	1.00	Major
16	3	1	0.5	12	0.0229	2.29	1.00	Major
17	3	2	0.5	12	0.0167	1.67	0.78	Major
18	3	3	0.5	12	0.0306	3.06	1.00	Major

Table C- 154. Analysis Result: Centro Earthquake (0.6g) of Two-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.6	8	0.0521	5.21	1.00	Major
2	1.67	2	0.6	8	0.0510	5.10	1.00	Major
3	1.67	3	0.6	8	1.2677	126.77	1.00	Major
4	1.67	1	0.6	8	0.0563	5.63	1.00	Major
5	1.67	2	0.6	10	0.0508	5.08	1.00	Major
6	1.67	3	0.6	10	1.4692	146.92	1.00	Major
7	1.67	1	0.6	12	0.0569	5.69	1.00	Major
8	1.67	2	0.6	12	0.0292	2.92	1.00	Major
9	1.67	3	0.6	12	0.7896	78.96	1.00	Major
10	3	1	0.6	8	0.0260	2.60	1.00	Major
11	3	2	0.6	8	0.0281	2.81	1.00	Major
12	3	3	0.6	8	4.6714	467.14	1.00	Major
13	3	1	0.6	10	0.0242	2.42	1.00	Major
14	3	2	0.6	10	0.0142	1.42	0.61	Substantial
15	3	3	0.6	10	3.3383	333.83	1.00	Major
16	3	1	0.6	12	0.0333	3.33	1.00	Major
17	3	2	0.6	12	0.0174	1.74	0.82	Major
18	3	3	0.6	12	0.0354	3.54	1.00	Major

Table C- 155. Analysis Result: Centro Earthquake (0.7g) of Two-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.7	8	0.0458	4.58	1.00	Major
2	1.67	2	0.7	8	0.0594	5.94	1.00	Major
3	1.67	3	0.7	8	1.1031	110.31	1.00	Major
4	1.67	1	0.7	8	0.0719	7.19	1.00	Major
5	1.67	2	0.7	10	0.0425	4.25	1.00	Major
6	1.67	3	0.7	10	0.6975	69.75	1.00	Major
7	1.67	1	0.7	12	0.1139	11.39	1.00	Major
8	1.67	2	0.7	12	0.0375	3.75	1.00	Major
9	1.67	3	0.7	12	1.1354	113.54	1.00	Major
10	3	1	0.7	8	0.0333	3.33	1.00	Major
11	3	2	0.7	8	0.0323	3.23	1.00	Major
12	3	3	0.7	8	5.8776	587.76	1.00	Major
13	3	1	0.7	10	0.0400	4.00	1.00	Major
14	3	2	0.7	10	0.0217	2.17	1.00	Major
15	3	3	0.7	10	5.4121	541.21	1.00	Major
16	3	1	0.7	12	0.0361	3.61	1.00	Major
17	3	2	0.7	12	0.0250	2.50	1.00	Major
18	3	3	0.7	12	0.0417	4.17	1.00	Major

Table C- 156. Analysis Result: Centro Earthquake (0.8g) of Two-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.8	8	0.0521	5.21	1.00	Major
2	1.67	2	0.8	8	0.0594	5.94	1.00	Major
3	1.67	3	0.8	8	1.3260	132.60	1.00	Major
4	1.67	1	0.8	8	0.0948	9.48	1.00	Major
5	1.67	2	0.8	10	0.0592	5.92	1.00	Major
6	1.67	3	0.8	10	0.9783	97.83	1.00	Major
7	1.67	1	0.8	12	0.1222	12.22	1.00	Major
8	1.67	2	0.8	12	0.0444	4.44	1.00	Major
9	1.67	3	0.8	12	1.2667	126.67	1.00	Major
10	3	1	0.8	8	0.0396	3.96	1.00	Major
11	3	2	0.8	8	0.0271	2.71	1.00	Major
12	3	3	0.8	8	4.5010	450.10	1.00	Major
13	3	1	0.8	10	0.0492	4.92	1.00	Major
14	3	2	0.8	10	0.0208	2.08	1.00	Major
15	3	3	0.8	10	6.9238	692.38	1.00	Major
16	3	1	0.8	12	0.0333	3.33	1.00	Major
17	3	2	0.8	12	0.0222	2.22	1.00	Major
18	3	3	0.8	12	0.0472	4.72	1.00	Major

Table C- 157. Analysis Result: Centro Earthquake (0.9g) of Two-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.9	8	0.1010	10.10	1.00	Major
2	1.67	2	0.9	8	0.0438	4.38	1.00	Major
3	1.67	3	0.9	8	1.0250	102.50	1.00	Major
4	1.67	1	0.9	8	0.1219	12.19	1.00	Major
5	1.67	2	0.9	10	0.0592	5.92	1.00	Major
6	1.67	3	0.9	10	1.1692	116.92	1.00	Major
7	1.67	1	0.9	12	0.1410	14.10	1.00	Major
8	1.67	2	0.9	12	0.0549	5.49	1.00	Major
9	1.67	3	0.9	12	1.1458	114.58	1.00	Major
10	3	1	0.9	8	0.0490	4.90	1.00	Major
11	3	2	0.9	8	0.0292	2.92	1.00	Major
12	3	3	0.9	8	6.2630	626.30	1.00	Major
13	3	1	0.9	10	0.0508	5.08	1.00	Major
14	3	2	0.9	10	0.0317	3.17	1.00	Major
15	3	3	0.9	10	7.3517	735.17	1.00	Major
16	3	1	0.9	12	0.0472	4.72	1.00	Major
17	3	2	0.9	12	0.0292	2.92	1.00	Major
18	3	3	0.9	12	0.0354	3.54	1.00	Major

Table C- 158. Analysis Result: Centro Earthquake (1g) of Two-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	1	8	0.1198	11.98	1.00	Major
2	1.67	2	1	8	0.0573	5.73	1.00	Major
3	1.67	3	1	8	0.8667	86.67	1.00	Major
4	1.67	1	1	8	0.1646	16.46	1.00	Major
5	1.67	2	1	10	0.0550	5.50	1.00	Major
6	1.67	3	1	10	1.5875	158.75	1.00	Major
7	1.67	1	1	12	0.1479	14.79	1.00	Major
8	1.67	2	1	12	0.0583	5.83	1.00	Major
9	1.67	3	1	12	1.7833	178.33	1.00	Major
10	3	1	1	8	0.0417	4.17	1.00	Major
11	3	2	1	8	0.0344	3.44	1.00	Major
12	3	3	1	8	1.7313	173.13	1.00	Major
13	3	1	1	10	0.0417	4.17	1.00	Major
14	3	2	1	10	0.0317	3.17	1.00	Major
15	3	3	1	10	6.8867	688.67	1.00	Major
16	3	1	1	12	0.0451	4.51	1.00	Major
17	3	2	1	12	0.0444	4.44	1.00	Major
18	3	3	1	12	0.0340	3.40	1.00	Major

Table C- 159. Analysis Result: San Salvador Earthquake (0.1g) of Two-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.1	8	0.0031	0.31	0.00	None
2	1.67	2	0.1	8	0.0000	0.00	0.00	None
3	1.67	3	0.1	8	0.0083	0.83	0.22	Minor
4	1.67	1	0.1	8	0.0042	0.42	0.00	None
5	1.67	2	0.1	10	0.0025	0.25	0.00	None
6	1.67	3	0.1	10	0.0054	0.54	0.03	None
7	1.67	1	0.1	12	0.0042	0.42	0.00	None
8	1.67	2	0.1	12	0.0024	0.24	0.00	None
9	1.67	3	0.1	12	0.0042	0.42	0.00	None
10	3	1	0.1	8	0.0000	0.00	0.00	None
11	3	2	0.1	8	0.0000	0.00	0.00	None
12	3	3	0.1	8	0.0094	0.94	0.29	Minor
13	3	1	0.1	10	0.0000	0.00	0.00	None
14	3	2	0.1	10	0.0000	0.00	0.00	None
15	3	3	0.1	10	0.0050	0.50	0.00	None
16	3	1	0.1	12	0.0000	0.00	0.00	None
17	3	2	0.1	12	0.0000	0.00	0.00	None
18	3	3	0.1	12	0.0052	0.52	0.01	None

Table C- 160. Analysis Result: San Salvador Earthquake (0.2g) of Two-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.2	8	0.0052	0.52	0.01	None
2	1.67	2	0.2	8	0.0063	0.63	0.08	Minor
3	1.67	3	0.2	8	0.0156	1.56	0.71	Substantial
4	1.67	1	0.2	8	0.0068	0.68	0.12	Minor
5	1.67	2	0.2	10	0.0042	0.42	0.00	None
6	1.67	3	0.2	10	0.0108	1.08	0.39	Moderate
7	1.67	1	0.2	12	0.0201	2.01	1.00	Major
8	1.67	2	0.2	12	0.0045	0.45	0.00	None
9	1.67	3	0.2	12	0.0083	0.83	0.22	Minor
10	3	1	0.2	8	0.0125	1.25	0.50	Moderate
11	3	2	0.2	8	0.0104	1.04	0.36	Moderate
12	3	3	0.2	8	0.0177	1.77	0.85	Major
13	3	1	0.2	10	0.0042	0.42	0.00	None
14	3	2	0.2	10	0.0042	0.42	0.00	None
15	3	3	0.2	10	0.0108	1.08	0.39	Moderate
16	3	1	0.2	12	0.0035	0.35	0.00	None
17	3	2	0.2	12	0.0035	0.35	0.00	None
18	3	3	0.2	12	0.0115	1.15	0.43	Moderate

Table C- 161. Analysis Result: San Salvador Earthquake (0.3g) of Two-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.3	8	0.0083	0.83	0.22	Minor
2	1.67	2	0.3	8	0.0135	1.35	0.57	Substantial
3	1.67	3	0.3	8	0.3448	34.48	1.00	Major
4	1.67	1	0.3	8	0.0125	1.25	0.50	Moderate
5	1.67	2	0.3	10	0.0067	0.67	0.11	Minor
6	1.67	3	0.3	10	0.0158	1.58	0.72	Substantial
7	1.67	1	0.3	12	0.0208	2.08	1.00	Major
8	1.67	2	0.3	12	0.0069	0.69	0.13	Minor
9	1.67	3	0.3	12	0.0125	1.25	0.50	Moderate
10	3	1	0.3	8	0.0188	1.88	0.92	Major
11	3	2	0.3	8	0.0000	0.00	0.00	None
12	3	3	0.3	8	2.0552	205.52	1.00	Major
13	3	1	0.3	10	0.0108	1.08	0.39	Moderate
14	3	2	0.3	10	0.0000	0.00	0.00	None
15	3	3	0.3	10	0.0158	1.58	0.72	Substantial
16	3	1	0.3	12	0.0056	0.56	0.04	None
17	3	2	0.3	12	0.0056	0.56	0.04	None
18	3	3	0.3	12	0.0167	1.67	0.78	Major

Table C- 162. Analysis Result: San Salvador Earthquake (0.4g) of Two-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.4	8	0.0156	1.56	0.71	Substantial
2	1.67	2	0.4	8	0.0146	1.46	0.64	Substantial
3	1.67	3	0.4	8	0.5906	59.06	1.00	Major
4	1.67	1	0.4	8	0.0229	2.29	1.00	Major
5	1.67	2	0.4	10	0.0092	0.92	0.28	Minor
6	1.67	3	0.4	10	0.0208	2.08	1.00	Major
7	1.67	1	0.4	12	0.0285	2.85	1.00	Major
8	1.67	2	0.4	12	0.0104	1.04	0.36	Moderate
9	1.67	3	0.4	12	0.0160	1.60	0.73	Substantial
10	3	1	0.4	8	0.0229	2.29	1.00	Major
11	3	2	0.4	8	0.0000	0.00	0.00	None
12	3	3	0.4	8	2.6104	261.04	1.00	Major
13	3	1	0.4	10	0.0125	1.25	0.50	Moderate
14	3	2	0.4	10	0.0117	1.17	0.44	Moderate
15	3	3	0.4	10	0.0208	2.08	1.00	Major
16	3	1	0.4	12	0.0076	0.76	0.18	Minor
17	3	2	0.4	12	0.0097	0.97	0.31	Minor
18	3	3	0.4	12	0.0226	2.26	1.00	Major

Table C- 163. **Analysis Result: San Salvador Earthquake (0.5g) of Two-Story Concrete Shear Wall models**

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.5	8	0.0177	1.77	0.85	Major
2	1.67	2	0.5	8	0.0427	4.27	1.00	Major
3	1.67	3	0.5	8	0.6135	61.35	1.00	Major
4	1.67	1	0.5	8	0.0260	2.60	1.00	Major
5	1.67	2	0.5	10	0.0125	1.25	0.50	Moderate
6	1.67	3	0.5	10	0.5833	58.33	1.00	Major
7	1.67	1	0.5	12	0.0285	2.85	1.00	Major
8	1.67	2	0.5	12	0.0115	1.15	0.43	Moderate
9	1.67	3	0.5	12	0.0201	2.01	1.00	Major
10	3	1	0.5	8	0.0365	3.65	1.00	Major
11	3	2	0.5	8	0.0167	1.67	0.78	Major
12	3	3	0.5	8	1.2896	128.96	1.00	Major
13	3	1	0.5	10	0.0283	2.83	1.00	Major
14	3	2	0.5	10	0.0183	1.83	0.89	Major
15	3	3	0.5	10	0.0258	2.58	1.00	Major
16	3	1	0.5	12	0.0097	0.97	0.31	Minor
17	3	2	0.5	12	0.0278	2.78	1.00	Major
18	3	3	0.5	12	0.0278	2.78	1.00	Major

Table C- 164. **Analysis Result: San Salvador Earthquake (0.6g) of Two-Story Concrete Shear Wall models**

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.6	8	0.0302	3.02	1.00	Major
2	1.67	2	0.6	8	0.0521	5.21	1.00	Major
3	1.67	3	0.6	8	0.6219	62.19	1.00	Major
4	1.67	1	0.6	8	0.0490	4.90	1.00	Major
5	1.67	2	0.6	10	0.0192	1.92	0.94	Major
6	1.67	3	0.6	10	0.8783	87.83	1.00	Major
7	1.67	1	0.6	12	0.0347	3.47	1.00	Major
8	1.67	2	0.6	12	0.0208	2.08	1.00	Major
9	1.67	3	0.6	12	0.0243	2.43	1.00	Major
10	3	1	0.6	8	0.0448	4.48	1.00	Major
11	3	2	0.6	8	0.0240	2.40	1.00	Major
12	3	3	0.6	8	2.1917	219.17	1.00	Major
13	3	1	0.6	10	0.0142	1.42	0.61	Substantial
14	3	2	0.6	10	0.0283	2.83	1.00	Major
15	3	3	0.6	10	2.1933	219.33	1.00	Major
16	3	1	0.6	12	0.0160	1.60	0.73	Substantial
17	3	2	0.6	12	0.0146	1.46	0.64	Substantial
18	3	3	0.6	12	0.0340	3.40	1.00	Major

Table C- 165. Analysis Result: San Salvador Earthquake (0.7g) of Two-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.7	8	0.0438	4.38	1.00	Major
2	1.67	2	0.7	8	0.0531	5.31	1.00	Major
3	1.67	3	0.7	8	0.6677	66.77	1.00	Major
4	1.67	1	0.7	8	0.0448	4.48	1.00	Major
5	1.67	2	0.7	10	0.0242	2.42	1.00	Major
6	1.67	3	0.7	10	0.9717	97.17	1.00	Major
7	1.67	1	0.7	12	0.0438	4.38	1.00	Major
8	1.67	2	0.7	12	0.0340	3.40	1.00	Major
9	1.67	3	0.7	12	0.0285	2.85	1.00	Major
10	3	1	0.7	8	0.0188	1.88	0.92	Major
11	3	2	0.7	8	0.0375	3.75	1.00	Major
12	3	3	0.7	8	2.5531	255.31	1.00	Major
13	3	1	0.7	10	0.0217	2.17	1.00	Major
14	3	2	0.7	10	0.0333	3.33	1.00	Major
15	3	3	0.7	10	3.5754	357.54	1.00	Major
16	3	1	0.7	12	0.0278	2.78	1.00	Major
17	3	2	0.7	12	0.0347	3.47	1.00	Major
18	3	3	0.7	12	0.0392	3.92	1.00	Major

Table C- 166. Analysis Result: San Salvador Earthquake (0.8g) of Two-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.8	8	0.0510	5.10	1.00	Major
2	1.67	2	0.8	8	0.0583	5.83	1.00	Major
3	1.67	3	0.8	8	0.6229	62.29	1.00	Major
4	1.67	1	0.8	8	0.0604	6.04	1.00	Major
5	1.67	2	0.8	10	0.0242	2.42	1.00	Major
6	1.67	3	0.8	10	0.8933	89.33	1.00	Major
7	1.67	1	0.8	12	0.0410	4.10	1.00	Major
8	1.67	2	0.8	12	0.0347	3.47	1.00	Major
9	1.67	3	0.8	12	0.7299	72.99	1.00	Major
10	3	1	0.8	8	0.0323	3.23	1.00	Major
11	3	2	0.8	8	0.0448	4.48	1.00	Major
12	3	3	0.8	8	3.0031	300.31	1.00	Major
13	3	1	0.8	10	0.0183	1.83	0.89	Major
14	3	2	0.8	10	0.0458	4.58	1.00	Major
15	3	3	0.8	10	2.1392	213.92	1.00	Major
16	3	1	0.8	12	0.0326	3.26	1.00	Major
17	3	2	0.8	12	0.0486	4.86	1.00	Major
18	3	3	0.8	12	0.0333	3.33	1.00	Major

Table C- 167. Analysis Result: San Salvador Earthquake (0.9g) of Two-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	0.9	8	0.0438	4.38	1.00	Major
2	1.67	2	0.9	8	0.0625	6.25	1.00	Major
3	1.67	3	0.9	8	2.0156	201.56	1.00	Major
4	1.67	1	0.9	8	0.0510	5.10	1.00	Major
5	1.67	2	0.9	10	0.0350	3.50	1.00	Major
6	1.67	3	0.9	10	1.0117	101.17	1.00	Major
7	1.67	1	0.9	12	0.0354	3.54	1.00	Major
8	1.67	2	0.9	12	0.0326	3.26	1.00	Major
9	1.67	3	0.9	12	0.8132	81.32	1.00	Major
10	3	1	0.9	8	0.0396	3.96	1.00	Major
11	3	2	0.9	8	0.0521	5.21	1.00	Major
12	3	3	0.9	8	1.6531	165.31	1.00	Major
13	3	1	0.9	10	0.0217	2.17	1.00	Major
14	3	2	0.9	10	0.0517	5.17	1.00	Major
15	3	3	0.9	10	2.0942	209.42	1.00	Major
16	3	1	0.9	12	0.0375	3.75	1.00	Major
17	3	2	0.9	12	0.0201	2.01	1.00	Major
18	3	3	0.9	12	0.0368	3.68	1.00	Major

Table C- 168. Analysis Result: San Salvador Earthquake (1g) of Two-Story Concrete Shear Wall models

MODEL	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	1.67	1	1	8	0.0448	4.48	1.00	Major
2	1.67	2	1	8	0.0635	6.35	1.00	Major
3	1.67	3	1	8	0.7365	73.65	1.00	Major
4	1.67	1	1	8	0.0458	4.58	1.00	Major
5	1.67	2	1	10	0.0583	5.83	1.00	Major
6	1.67	3	1	10	1.4342	143.42	1.00	Major
7	1.67	1	1	12	0.0410	4.10	1.00	Major
8	1.67	2	1	12	0.0590	5.90	1.00	Major
9	1.67	3	1	12	0.5597	55.97	1.00	Major
10	3	1	1	8	0.0406	4.06	1.00	Major
11	3	2	1	8	0.0635	6.35	1.00	Major
12	3	3	1	8	3.5125	351.25	1.00	Major
13	3	1	1	10	0.0458	4.58	1.00	Major
14	3	2	1	10	0.0608	6.08	1.00	Major
15	3	3	1	10	2.7108	271.08	1.00	Major
16	3	1	1	12	0.0389	3.89	1.00	Major
17	3	2	1	12	0.0410	4.10	1.00	Major
18	3	3	1	12	0.3722	37.22	1.00	Major

C.5 MULTISTORY SHEAR WALL MODELS

Table C- 169. Analysis Result: Mayagüez Earthquake (0.1g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	0.1	9.42	0.0002	0.02	0.00	None
2	8	1.03	2	0.1	9.42	0.0007	0.07	0.00	None
3	8	5.35	1	0.1	8.75	0.0003	0.03	0.00	None
4	8	1.66	2	0.1	8.75	0.0005	0.05	0.00	None
5	4	2.81	1	0.1	8.50	0.0002	0.02	0.00	None
6	4	0.33	2	0.1	8.50	0.0011	0.11	0.00	None
7	7	5.55	1	0.1	8.00	0.0003	0.03	0.00	None
8	7	1.08	2	0.1	8.00	0.0003	0.03	0.00	None
9	6	2.18	1	0.1	8.00	0.0001	0.01	0.00	None
10	6	0.69	2	0.1	8.00	0.0151	1.51	0.67	Substantial
11	10	4.31	1	0.1	8.42	0.0001	0.01	0.00	None
12	10	1.17	2	0.1	8.42	0.0006	0.06	0.00	None
13	5	3.08	1	0.1	8.83	0.0001	0.01	0.00	None
14	5	0.5	2	0.1	8.83	0.0017	0.17	0.00	None
15	3	5.3	1	0.1	8.00	0.0001	0.01	0.00	None
16	3	1.33	2	0.1	8.00	0.0002	0.02	0.00	None
17	3	5.61	1	0.1	8.00	0.0000	0	0.00	None
18	3	1.2	2	0.1	8.00	0.0002	0.02	0.00	None
19	4	20.56	1	0.1	8.67	0.0000	0	0.00	None
20	4	6.73	2	0.1	8.67	0.0000	0	0.00	None
21	4	27.84	1	0.1	8.67	0.0000	0	0.00	None
22	4	2.54	2	0.1	8.67	0.0022	0.22	0.00	None
23	3	3.88	1	0.1	8.42	0.0002	0.02	0.00	None
24	3	1.37	2	0.1	8.42	0.0007	0.07	0.00	None
25	4	2.69	1	0.1	8.42	0.0001	0.01	0.00	None
26	4	0.74	2	0.1	8.42	0.0005	0.05	0.00	None

Table C- 170. Analysis Result: Mayagüez Earthquake (0.2g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	0.2	9.42	0.0005	0.05	0.00	None
2	8	1.03	2	0.2	9.42	0.0013	0.13	0.00	None
3	8	5.35	1	0.2	8.75	0.0009	0.09	0.00	None
4	8	1.66	2	0.2	8.75	0.0016	0.16	0.00	None
5	4	2.81	1	0.2	8.50	0.0004	0.04	0.00	None
6	4	0.33	2	0.2	8.50	0.0046	0.46	0.00	None
7	7	5.55	1	0.2	8.00	0.0008	0.08	0.00	None
8	7	1.08	2	0.2	8.00	0.0049	0.49	0.00	None
9	6	2.18	1	0.2	8.00	0.0002	0.02	0.00	None
10	6	0.69	2	0.2	8.00	0.0302	3.02	1.00	Major
11	10	4.31	1	0.2	8.42	0.0004	0.04	0.00	None
12	10	1.17	2	0.2	8.42	0.0014	0.14	0.00	None
13	5	3.08	1	0.2	8.83	0.0002	0.02	0.00	None
14	5	0.5	2	0.2	8.83	0.0030	0.3	0.00	None
15	3	5.3	1	0.2	8.00	0.0001	0.01	0.00	None
16	3	1.33	2	0.2	8.00	0.0009	0.09	0.00	None
17	3	5.61	1	0.2	8.00	0.0000	0	0.00	None
18	3	1.2	2	0.2	8.00	0.0012	0.12	0.00	None
19	4	20.56	1	0.2	8.67	0.0000	0	0.00	None
20	4	6.73	2	0.2	8.67	0.0000	0	0.00	None
21	4	27.84	1	0.2	8.67	0.0001	0.01	0.00	None
22	4	2.54	2	0.2	8.67	0.0035	0.35	0.00	None
23	3	3.88	1	0.2	8.42	0.0003	0.03	0.00	None
24	3	1.37	2	0.2	8.42	0.0019	0.19	0.00	None
25	4	2.69	1	0.2	8.42	0.0001	0.01	0.00	None
26	4	0.74	2	0.2	8.42	0.0021	0.21	0.00	None

Table C- 171. Analysis Result: Mayagüez Earthquake (0.3g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	0.3	9.42	0.0010	0.1	0.00	None
2	8	1.03	2	0.3	9.42	0.0026	0.26	0.00	None
3	8	5.35	1	0.3	8.75	0.0020	0.2	0.00	None
4	8	1.66	2	0.3	8.75	0.0022	0.22	0.00	None
5	4	2.81	1	0.3	8.50	0.0102	1.02	0.35	Minor
6	4	0.33	2	0.3	8.50	0.0071	0.71	0.14	Minor
7	7	5.55	1	0.3	8.00	0.0008	0.08	0.00	None
8	7	1.08	2	0.3	8.00	0.0133	1.33	0.55	Substantial
9	6	2.18	1	0.3	8.00	0.0003	0.03	0.00	None
10	6	0.69	2	0.3	8.00	0.0454	4.54	1.00	Major
11	10	4.31	1	0.3	8.42	0.0008	0.08	0.00	None
12	10	1.17	2	0.3	8.42	0.0017	0.17	0.00	None
13	5	3.08	1	0.3	8.83	0.0007	0.07	0.00	None
14	5	0.5	2	0.3	8.83	0.0051	0.51	0.01	None
15	3	5.3	1	0.3	8.00	0.0002	0.02	0.00	None
16	3	1.33	2	0.3	8.00	0.0022	0.22	0.00	None
17	3	5.61	1	0.3	8.00	0.0001	0.01	0.00	None
18	3	1.2	2	0.3	8.00	0.0034	0.34	0.00	None
19	4	20.56	1	0.3	8.67	0.0001	0.01	0.00	None
20	4	6.73	2	0.3	8.67	0.0000	0	0.00	None
21	4	27.84	1	0.3	8.67	0.0001	0.01	0.00	None
22	4	2.54	2	0.3	8.67	0.0056	0.56	0.04	None
23	3	3.88	1	0.3	8.42	0.0005	0.05	0.00	None
24	3	1.37	2	0.3	8.42	0.0035	0.35	0.00	None
25	4	2.69	1	0.3	8.42	0.0002	0.02	0.00	None
26	4	0.74	2	0.3	8.42	0.0043	0.43	0.00	None

Table C- 172. Analysis Result: Mayagüez Earthquake (0.4g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	0.4	9.42	0.0016	0.16	0.00	None
2	8	1.03	2	0.4	9.42	0.0036	0.36	0.00	None
3	8	5.35	1	0.4	8.75	0.0028	0.28	0.00	None
4	8	1.66	2	0.4	8.75	0.0025	0.25	0.00	None
5	4	2.81	1	0.4	8.50	0.0108	1.08	0.39	Moderate
6	4	0.33	2	0.4	8.50	0.0070	0.7	0.13	Minor
7	7	5.55	1	0.4	8.00	0.0008	0.08	0.00	None
8	7	1.08	2	0.4	8.00	0.0286	2.86	1.00	Major
9	6	2.18	1	0.4	8.00	0.0009	0.09	0.00	None
10	6	0.69	2	0.4	8.00	0.0604	6.04	1.00	Major
11	10	4.31	1	0.4	8.42	0.0012	0.12	0.00	None
12	10	1.17	2	0.4	8.42	0.0023	0.23	0.00	None
13	5	3.08	1	0.4	8.83	0.0014	0.14	0.00	None
14	5	0.5	2	0.4	8.83	0.0082	0.82	0.21	Minor
15	3	5.3	1	0.4	8.00	0.0002	0.02	0.00	None
16	3	1.33	2	0.4	8.00	0.0049	0.49	0.00	None
17	3	5.61	1	0.4	8.00	0.0001	0.01	0.00	None
18	3	1.2	2	0.4	8.00	0.0063	0.63	0.09	Minor
19	4	20.56	1	0.4	8.67	0.0001	0.01	0.00	None
20	4	6.73	2	0.4	8.67	0.0000	0	0.00	None
21	4	27.84	1	0.4	8.67	0.0001	0.01	0.00	None
22	4	2.54	2	0.4	8.67	0.0086	0.86	0.24	Minor
23	3	3.88	1	0.4	8.42	0.0007	0.07	0.00	None
24	3	1.37	2	0.4	8.42	0.0063	0.63	0.09	Minor
25	4	2.69	1	0.4	8.42	0.0004	0.04	0.00	None
26	4	0.74	2	0.4	8.42	0.0068	0.68	0.12	Minor

Table C- 173. Analysis Result: Mayagüez Earthquake (0.5g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	0.5	9.42	0.0021	0.21	0.00	None
2	8	1.03	2	0.5	9.42	0.0050	0.5	0.00	None
3	8	5.35	1	0.5	8.75	0.0034	0.34	0.00	None
4	8	1.66	2	0.5	8.75	0.0029	0.29	0.00	None
5	4	2.81	1	0.5	8.50	0.0201	2.01	1.00	Major
6	4	0.33	2	0.5	8.50	0.0100	1	0.33	Minor
7	7	5.55	1	0.5	8.00	0.0007	0.07	0.00	None
8	7	1.08	2	0.5	8.00	0.0319	3.19	1.00	Major
9	6	2.18	1	0.5	8.00	0.0013	0.13	0.00	None
10	6	0.69	2	0.5	8.00	0.0755	7.55	1.00	Major
11	10	4.31	1	0.5	8.42	0.0016	0.16	0.00	None
12	10	1.17	2	0.5	8.42	0.0027	0.27	0.00	None
13	5	3.08	1	0.5	8.83	0.0024	0.24	0.00	None
14	5	0.5	2	0.5	8.83	0.0114	1.14	0.43	Moderate
15	3	5.3	1	0.5	8.00	0.0003	0.03	0.00	None
16	3	1.33	2	0.5	8.00	0.0080	0.8	0.20	Minor
17	3	5.61	1	0.5	8.00	0.0001	0.01	0.00	None
18	3	1.2	2	0.5	8.00	0.0085	0.85	0.23	Minor
19	4	20.56	1	0.5	8.67	0.0001	0.01	0.00	None
20	4	6.73	2	0.5	8.67	0.0001	0.01	0.00	None
21	4	27.84	1	0.5	8.67	0.0002	0.02	0.00	None
22	4	2.54	2	0.5	8.67	0.0094	0.94	0.29	Minor
23	3	3.88	1	0.5	8.42	0.0013	0.13	0.00	None
24	3	1.37	2	0.5	8.42	0.0099	0.99	0.33	Minor
25	4	2.69	1	0.5	8.42	0.0006	0.06	0.00	None
26	4	0.74	2	0.5	8.42	0.0092	0.92	0.28	Minor

Table C- 174. Analysis Result: Mayagüez Earthquake (0.6g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	0.6	9.42	0.0025	0.25	0.00	None
2	8	1.03	2	0.6	9.42	0.0059	0.59	0.06	Minor
3	8	5.35	1	0.6	8.75	0.0041	0.41	0.00	None
4	8	1.66	2	0.6	8.75	0.0034	0.34	0.00	None
5	4	2.81	1	0.6	8.50	0.0225	2.25	1.00	Major
6	4	0.33	2	0.6	8.50	0.0165	1.65	0.77	Major
7	7	5.55	1	0.6	8.00	0.0008	0.08	0.00	None
8	7	1.08	2	0.6	8.00	0.0233	2.33	1.00	Major
9	6	2.18	1	0.6	8.00	0.0015	0.15	0.00	None
10	6	0.69	2	0.6	8.00	0.0905	9.05	1.00	Major
11	10	4.31	1	0.6	8.42	0.0020	0.2	0.00	None
12	10	1.17	2	0.6	8.42	0.0030	0.3	0.00	None
13	5	3.08	1	0.6	8.83	0.0042	0.42	0.00	None
14	5	0.5	2	0.6	8.83	0.0161	1.61	0.74	Substantial
15	3	5.3	1	0.6	8.00	0.0003	0.03	0.00	None
16	3	1.33	2	0.6	8.00	0.0116	1.16	0.44	Moderate
17	3	5.61	1	0.6	8.00	0.0001	0.01	0.00	None
18	3	1.2	2	0.6	8.00	0.0144	1.44	0.63	Substantial
19	4	20.56	1	0.6	8.67	0.0003	0.03	0.00	None
20	4	6.73	2	0.6	8.67	0.0001	0.01	0.00	None
21	4	27.84	1	0.6	8.67	0.0002	0.02	0.00	None
22	4	2.54	2	0.6	8.67	0.0123	1.23	0.49	Moderate
23	3	3.88	1	0.6	8.42	0.0020	0.2	0.00	None
24	3	1.37	2	0.6	8.42	0.0124	1.24	0.49	Moderate
25	4	2.69	1	0.6	8.42	0.0012	0.12	0.00	None
26	4	0.74	2	0.6	8.42	0.0119	1.19	0.46	Moderate

Table C- 175. Analysis Result: Mayagüez Earthquake (0.7g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	0.7	9.42	0.0030	0.3	0.00	None
2	8	1.03	2	0.7	9.42	0.0091	0.91	0.27	Minor
3	8	5.35	1	0.7	8.75	0.0050	0.5	0.00	None
4	8	1.66	2	0.7	8.75	0.0041	0.41	0.00	None
5	4	2.81	1	0.7	8.50	0.0267	2.67	1.00	Major
6	4	0.33	2	0.7	8.50	0.0168	1.68	0.79	Major
7	7	5.55	1	0.7	8.00	0.0012	0.12	0.00	None
8	7	1.08	2	0.7	8.00	0.0401	4.01	1.00	Major
9	6	2.18	1	0.7	8.00	0.0021	0.21	0.00	None
10	6	0.69	2	0.7	8.00	0.1054	10.54	1.00	Major
11	10	4.31	1	0.7	8.42	0.0024	0.24	0.00	None
12	10	1.17	2	0.7	8.42	0.0051	0.51	0.01	None
13	5	3.08	1	0.7	8.83	0.0047	0.47	0.00	None
14	5	0.5	2	0.7	8.83	0.0183	1.83	0.89	Major
15	3	5.3	1	0.7	8.00	0.0004	0.04	0.00	None
16	3	1.33	2	0.7	8.00	0.0172	1.72	0.81	Major
17	3	5.61	1	0.7	8.00	0.0001	0.01	0.00	None
18	3	1.2	2	0.7	8.00	0.0176	1.76	0.84	Major
19	4	20.56	1	0.7	8.67	0.0002	0.02	0.00	None
20	4	6.73	2	0.7	8.67	0.0001	0.01	0.00	None
21	4	27.84	1	0.7	8.67	0.0002	0.02	0.00	None
22	4	2.54	2	0.7	8.67	0.0140	1.4	0.60	Substantial
23	3	3.88	1	0.7	8.42	0.0027	0.27	0.00	None
24	3	1.37	2	0.7	8.42	0.0173	1.73	0.82	Major
25	4	2.69	1	0.7	8.42	0.0019	0.19	0.00	None
26	4	0.74	2	0.7	8.42	0.0135	1.35	0.57	Substantial

Table C- 176. Analysis Result: Mayagüez Earthquake (0.8g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	0.8	9.42	0.0036	0.36	0.00	None
2	8	1.03	2	0.8	9.42	0.0110	1.1	0.40	Moderate
3	8	5.35	1	0.8	8.75	0.0058	0.58	0.05	Minor
4	8	1.66	2	0.8	8.75	0.0047	0.47	0.00	None
5	4	2.81	1	0.8	8.50	0.0334	3.34	1.00	Major
6	4	0.33	2	0.8	8.50	0.0251	2.51	1.00	Major
7	7	5.55	1	0.8	8.00	0.0008	0.08	0.00	None
8	7	1.08	2	0.8	8.00	0.0440	4.4	1.00	Major
9	6	2.18	1	0.8	8.00	0.0028	0.28	0.00	None
10	6	0.69	2	0.8	8.00	0.1203	12.03	1.00	Major
11	10	4.31	1	0.8	8.42	0.0029	0.29	0.00	None
12	10	1.17	2	0.8	8.42	0.0069	0.69	0.13	Minor
13	5	3.08	1	0.8	8.83	0.0062	0.62	0.08	Minor
14	5	0.5	2	0.8	8.83	0.0198	1.98	0.99	Major
15	3	5.3	1	0.8	8.00	0.0005	0.05	0.00	None
16	3	1.33	2	0.8	8.00	0.0188	1.88	0.92	Major
17	3	5.61	1	0.8	8.00	0.0001	0.01	0.00	None
18	3	1.2	2	0.8	8.00	0.0220	2.2	1.00	Major
19	4	20.56	1	0.8	8.67	0.0005	0.05	0.00	None
20	4	6.73	2	0.8	8.67	0.0001	0.01	0.00	None
21	4	27.84	1	0.8	8.67	0.0003	0.03	0.00	None
22	4	2.54	2	0.8	8.67	0.0149	1.49	0.66	Substantial
23	3	3.88	1	0.8	8.42	0.0035	0.35	0.00	None
24	3	1.37	2	0.8	8.42	0.0197	1.97	0.98	Major
25	4	2.69	1	0.8	8.42	0.0028	0.28	0.00	None
26	4	0.74	2	0.8	8.42	0.0147	1.47	0.65	Substantial

Table C- 177. Analysis Result: Mayagüez Earthquake (0.9g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	0.9	9.42	0.0042	0.42	0.00	None
2	8	1.03	2	0.9	9.42	0.0135	1.35	0.57	Substantial
3	8	5.35	1	0.9	8.75	0.0065	0.65	0.10	Minor
4	8	1.66	2	0.9	8.75	0.0056	0.56	0.04	None
5	4	2.81	1	0.9	8.50	0.0248	2.48	1.00	Major
6	4	0.33	2	0.9	8.50	0.0417	4.17	1.00	Major
7	7	5.55	1	0.9	8.00	0.0008	0.08	0.00	None
8	7	1.08	2	0.9	8.00	0.0488	4.88	1.00	Major
9	6	2.18	1	0.9	8.00	0.0034	0.34	0.00	None
10	6	0.69	2	0.9	8.00	0.1352	13.52	1.00	Major
11	10	4.31	1	0.9	8.42	0.0032	0.32	0.00	None
12	10	1.17	2	0.9	8.42	0.0107	1.07	0.38	Moderate
13	5	3.08	1	0.9	8.83	0.0070	0.7	0.13	Minor
14	5	0.5	2	0.9	8.83	0.0201	2.01	1.00	Major
15	3	5.3	1	0.9	8.00	0.0006	0.06	0.00	None
16	3	1.33	2	0.9	8.00	0.0247	2.47	1.00	Major
17	3	5.61	1	0.9	8.00	0.0002	0.02	0.00	None
18	3	1.2	2	0.9	8.00	0.0252	2.52	1.00	Major
19	4	20.56	1	0.9	8.67	0.0004	0.04	0.00	None
20	4	6.73	2	0.9	8.67	0.0001	0.01	0.00	None
21	4	27.84	1	0.9	8.67	0.0003	0.03	0.00	None
22	4	2.54	2	0.9	8.67	0.0154	1.54	0.69	Substantial
23	3	3.88	1	0.9	8.42	0.0043	0.43	0.00	None
24	3	1.37	2	0.9	8.42	0.0216	2.16	1.00	Major
25	4	2.69	1	0.9	8.42	0.0038	0.38	0.00	None
26	4	0.74	2	0.9	8.42	0.0141	1.41	0.61	Substantial

Table C- 178. Analysis Result: Mayagüez Earthquake (1g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	1	9.42	0.0050	0.5	0.00	None
2	8	1.03	2	1	9.42	0.0141	1.41	0.61	Substantial
3	8	5.35	1	1	8.75	0.0064	0.64	0.09	Minor
4	8	1.66	2	1	8.75	0.0074	0.74	0.16	Minor
5	4	2.81	1	1	8.50	0.0252	2.52	1.00	Major
6	4	0.33	2	1	8.50	0.0443	4.43	1.00	Major
7	7	5.55	1	1	8.00	0.0008	0.08	0.00	None
8	7	1.08	2	1	8.00	0.0535	5.35	1.00	Major
9	6	2.18	1	1	8.00	0.0052	0.52	0.01	None
10	6	0.69	2	1	8.00	0.1500	15	1.00	Major
11	10	4.31	1	1	8.42	0.0039	0.39	0.00	None
12	10	1.17	2	1	8.42	0.0112	1.12	0.41	Moderate
13	5	3.08	1	1	8.83	0.0090	0.9	0.27	Minor
14	5	0.5	2	1	8.83	0.0267	2.67	1.00	Major
15	3	5.3	1	1	8.00	0.0008	0.08	0.00	None
16	3	1.33	2	1	8.00	0.0310	3.1	1.00	Major
17	3	5.61	1	1	8.00	0.0016	0.16	0.00	None
18	3	1.2	2	1	8.00	0.0253	2.53	1.00	Major
19	4	20.56	1	1	8.67	0.0007	0.07	0.00	None
20	4	6.73	2	1	8.67	0.0001	0.01	0.00	None
21	4	27.84	1	1	8.67	0.0003	0.03	0.00	None
22	4	2.54	2	1	8.67	0.0169	1.69	0.79	Major
23	3	3.88	1	1	8.42	0.0054	0.54	0.03	None
24	3	1.37	2	1	8.42	0.0234	2.34	1.00	Major
25	4	2.69	1	1	8.42	0.0060	0.6	0.07	Minor
26	4	0.74	2	1	8.42	0.0150	1.5	0.67	Substantial

Table C- 179. Analysis Result: Mayagüez Earthquake (1.1g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	1.1	9.42	0.0055	0.55	0.03	None
2	8	1.03	2	1.1	9.42	0.0151	1.51	0.67	Substantial
3	8	5.35	1	1.1	8.75	0.0064	0.64	0.09	Minor
4	8	1.66	2	1.1	8.75	0.0102	1.02	0.35	Minor
5	4	2.81	1	1.1	8.50	0.0291	2.91	1.00	Major
6	4	0.33	2	1.1	8.50	0.0535	5.35	1.00	Major
7	7	5.55	1	1.1	8.00	0.0010	0.1	0.00	None
8	7	1.08	2	1.1	8.00	0.0561	5.61	1.00	Major
9	6	2.18	1	1.1	8.00	0.0125	1.25	0.50	Moderate
10	6	0.69	2	1.1	8.00	0.1646	16.46	1.00	Major
11	10	4.31	1	1.1	8.42	0.0043	0.43	0.00	None
12	10	1.17	2	1.1	8.42	0.0143	1.43	0.62	Substantial
13	5	3.08	1	1.1	8.83	0.0105	1.05	0.37	Moderate
14	5	0.5	2	1.1	8.83	0.0318	3.18	1.00	Major
15	3	5.3	1	1.1	8.00	0.0010	0.1	0.00	None
16	3	1.33	2	1.1	8.00	0.0346	3.46	1.00	Major
17	3	5.61	1	1.1	8.00	0.0018	0.18	0.00	None
18	3	1.2	2	1.1	8.00	0.0315	3.15	1.00	Major
19	4	20.56	1	1.1	8.67	0.0007	0.07	0.00	None
20	4	6.73	2	1.1	8.67	0.0001	0.01	0.00	None
21	4	27.84	1	1.1	8.67	0.0004	0.04	0.00	None
22	4	2.54	2	1.1	8.67	0.0240	2.4	1.00	Major
23	3	3.88	1	1.1	8.42	0.0065	0.65	0.10	Minor
24	3	1.37	2	1.1	8.42	0.0242	2.42	1.00	Major
25	4	2.69	1	1.1	8.42	0.0142	1.42	0.61	Substantial
26	4	0.74	2	1.1	8.42	0.0178	1.78	0.85	Major

Table C- 180. Analysis Result: Mayagüez Earthquake (1.2g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	1.2	9.42	0.0059	0.59	0.06	Minor
2	8	1.03	2	1.2	9.42	0.0169	1.69	0.79	Major
3	8	5.35	1	1.2	8.75	0.0073	0.73	0.15	Minor
4	8	1.66	2	1.2	8.75	0.0115	1.15	0.43	Moderate
5	4	2.81	1	1.2	8.50	0.0315	3.15	1.00	Major
6	4	0.33	2	1.2	8.50	0.0562	5.62	1.00	Major
7	7	5.55	1	1.2	8.00	0.0010	0.1	0.00	None
8	7	1.08	2	1.2	8.00	0.0648	6.48	1.00	Major
9	6	2.18	1	1.2	8.00	0.0197	1.97	0.98	Major
10	6	0.69	2	1.2	8.00	0.1793	17.93	1.00	Major
11	10	4.31	1	1.2	8.42	0.0045	0.45	0.00	None
12	10	1.17	2	1.2	8.42	0.0183	1.83	0.89	Major
13	5	3.08	1	1.2	8.83	0.0103	1.03	0.35	Moderate
14	5	0.5	2	1.2	8.83	0.0326	3.26	1.00	Major
15	3	5.3	1	1.2	8.00	0.0012	0.12	0.00	None
16	3	1.33	2	1.2	8.00	0.0353	3.53	1.00	Major
17	3	5.61	1	1.2	8.00	0.0039	0.39	0.00	None
18	3	1.2	2	1.2	8.00	0.0297	2.97	1.00	Major
19	4	20.56	1	1.2	8.67	0.0010	0.1	0.00	None
20	4	6.73	2	1.2	8.67	0.0001	0.01	0.00	None
21	4	27.84	1	1.2	8.67	0.0004	0.04	0.00	None
22	4	2.54	2	1.2	8.67	0.0290	2.9	1.00	Major
23	3	3.88	1	1.2	8.42	0.0096	0.96	0.31	Minor
24	3	1.37	2	1.2	8.42	0.0250	2.5	1.00	Major
25	4	2.69	1	1.2	8.42	0.0145	1.45	0.63	Substantial
26	4	0.74	2	1.2	8.42	0.0212	2.12	1.00	Major

Table C- 181. Analysis Result: Mayagüez Earthquake (1.3 g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	1.3	9.42	0.0061	0.61	0.07	Minor
2	8	1.03	2	1.3	9.42	0.0181	1.81	0.87	Major
3	8	5.35	1	1.3	8.75	0.0076	0.76	0.17	Minor
4	8	1.66	2	1.3	8.75	0.0124	1.24	0.49	Moderate
5	4	2.81	1	1.3	8.50	0.0309	3.09	1.00	Major
6	4	0.33	2	1.3	8.50	0.0528	5.28	1.00	Major
7	7	5.55	1	1.3	8.00	0.0007	0.07	0.00	None
8	7	1.08	2	1.3	8.00	0.0698	6.98	1.00	Major
9	6	2.18	1	1.3	8.00	0.0245	2.45	1.00	Major
10	6	0.69	2	1.3	8.00	0.1874	18.74	1.00	Major
11	10	4.31	1	1.3	8.42	0.0048	0.48	0.00	None
12	10	1.17	2	1.3	8.42	0.0207	2.07	1.00	Major
13	5	3.08	1	1.3	8.83	0.0118	1.18	0.45	Moderate
14	5	0.5	2	1.3	8.83	0.0319	3.19	1.00	Major
15	3	5.3	1	1.3	8.00	0.0013	0.13	0.00	None
16	3	1.33	2	1.3	8.00	0.0361	3.61	1.00	Major
17	3	5.61	1	1.3	8.00	0.0063	0.63	0.09	Minor
18	3	1.2	2	1.3	8.00	0.0258	2.58	1.00	Major
19	4	20.56	1	1.3	8.67	0.0013	0.13	0.00	None
20	4	6.73	2	1.3	8.67	0.0001	0.01	0.00	None
21	4	27.84	1	1.3	8.67	0.0004	0.04	0.00	None
22	4	2.54	2	1.3	8.67	0.0297	2.97	1.00	Major
23	3	3.88	1	1.3	8.42	0.0109	1.09	0.39	Moderate
24	3	1.37	2	1.3	8.42	0.0274	2.74	1.00	Major
25	4	2.69	1	1.3	8.42	0.0171	1.71	0.81	Major
26	4	0.74	2	1.3	8.42	0.0235	2.35	1.00	Major

Table C- 182. Analysis Result: Mayagüez Earthquake (1.4 g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	1.4	9.42	0.0063	0.63	0.09	Minor
2	8	1.03	2	1.4	9.42	0.0176	1.76	0.84	Major
3	8	5.35	1	1.4	8.75	0.0084	0.84	0.23	Minor
4	8	1.66	2	1.4	8.75	0.0143	1.43	0.62	Substantial
5	4	2.81	1	1.4	8.50	0.0338	3.38	1.00	Major
6	4	0.33	2	1.4	8.50	0.0427	4.27	1.00	Major
7	7	5.55	1	1.4	8.00	0.0008	0.08	0.00	None
8	7	1.08	2	1.4	8.00	0.0793	7.93	1.00	Major
9	6	2.18	1	1.4	8.00	0.0234	2.34	1.00	Major
10	6	0.69	2	1.4	8.00	0.1880	18.8	1.00	Major
11	10	4.31	1	1.4	8.42	0.0048	0.48	0.00	None
12	10	1.17	2	1.4	8.42	0.0226	2.26	1.00	Major
13	5	3.08	1	1.4	8.83	0.0117	1.17	0.45	Moderate
14	5	0.5	2	1.4	8.83	0.0270	2.7	1.00	Major
15	3	5.3	1	1.4	8.00	0.0015	0.15	0.00	None
16	3	1.33	2	1.4	8.00	0.0294	2.94	1.00	Major
17	3	5.61	1	1.4	8.00	0.0065	0.65	0.10	Minor
18	3	1.2	2	1.4	8.00	0.0312	3.12	1.00	Major
19	4	20.56	1	1.4	8.67	0.0015	0.15	0.00	None
20	4	6.73	2	1.4	8.67	0.0001	0.01	0.00	None
21	4	27.84	1	1.4	8.67	0.0005	0.05	0.00	None
22	4	2.54	2	1.4	8.67	0.0260	2.6	1.00	Major
23	3	3.88	1	1.4	8.42	0.0129	1.29	0.53	Moderate
24	3	1.37	2	1.4	8.42	0.0314	3.14	1.00	Major
25	4	2.69	1	1.4	8.42	0.0118	1.18	0.45	Moderate
26	4	0.74	2	1.4	8.42	0.0237	2.37	1.00	Major

Table C- 183. Analysis Result: Mayagüez Earthquake (1.5 g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	1.5	9.42	0.0065	0.65	0.10	Minor
2	8	1.03	2	1.5	9.42	0.0167	1.67	0.78	Major
3	8	5.35	1	1.5	8.75	0.0086	0.86	0.24	Minor
4	8	1.66	2	1.5	8.75	0.0176	1.76	0.84	Major
5	4	2.81	1	1.5	8.50	0.0464	4.64	1.00	Major
6	4	0.33	2	1.5	8.50	0.0458	4.58	1.00	Major
7	7	5.55	1	1.5	8.00	0.0008	0.08	0.00	None
8	7	1.08	2	1.5	8.00	0.0787	7.87	1.00	Major
9	6	2.18	1	1.5	8.00	0.0254	2.54	1.00	Major
10	6	0.69	2	1.5	8.00	0.1876	18.76	1.00	Major
11	10	4.31	1	1.5	8.42	0.0049	0.49	0.00	None
12	10	1.17	2	1.5	8.42	0.0234	2.34	1.00	Major
13	5	3.08	1	1.5	8.83	0.0136	1.36	0.57	Substantial
14	5	0.5	2	1.5	8.83	0.0281	2.81	1.00	Major
15	3	5.3	1	1.5	8.00	0.0017	0.17	0.00	None
16	3	1.33	2	1.5	8.00	0.0293	2.93	1.00	Major
17	3	5.61	1	1.5	8.00	0.0084	0.84	0.23	Minor
18	3	1.2	2	1.5	8.00	0.0291	2.91	1.00	Major
19	4	20.56	1	1.5	8.67	0.0028	0.28	0.00	None
20	4	6.73	2	1.5	8.67	0.0002	0.02	0.00	None
21	4	27.84	1	1.5	8.67	0.0005	0.05	0.00	None
22	4	2.54	2	1.5	8.67	0.0301	3.01	1.00	Major
23	3	3.88	1	1.5	8.42	0.0144	1.44	0.63	Substantial
24	3	1.37	2	1.5	8.42	0.0349	3.49	1.00	Major
25	4	2.69	1	1.5	8.42	0.0217	2.17	1.00	Major
26	4	0.74	2	1.5	8.42	0.0255	2.55	1.00	Major

Table C- 184. Analysis Result: San Juan Earthquake (0.1g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	0.1	9.42	0.0002	0.02	0.00	None
2	8	1.03	2	0.1	9.42	0.0005	0.05	0.00	None
3	8	5.35	1	0.1	8.75	0.0001	0.01	0.00	None
4	8	1.66	2	0.1	8.75	0.0003	0.03	0.00	None
5	4	2.81	1	0.1	8.50	0.0002	0.02	0.00	None
6	4	0.33	2	0.1	8.50	0.0006	0.06	0.00	None
7	7	5.55	1	0.1	8.00	0.0002	0.02	0.00	None
8	7	1.08	2	0.1	8.00	0.0003	0.03	0.00	None
9	6	2.18	1	0.1	8.00	0.0001	0.01	0.00	None
10	6	0.69	2	0.1	8.00	0.0237	2.37	1.00	Major
11	10	4.31	1	0.1	8.42	0.0002	0.02	0.00	None
12	10	1.17	2	0.1	8.42	0.0002	0.02	0.00	None
13	5	3.08	1	0.1	8.83	0.0001	0.01	0.00	None
14	5	0.5	2	0.1	8.83	0.0007	0.07	0.00	None
15	3	5.3	1	0.1	8.00	0.0001	0.01	0.00	None
16	3	1.33	2	0.1	8.00	0.0003	0.03	0.00	None
17	3	5.61	1	0.1	8.00	0.0000	0	0.00	None
18	3	1.2	2	0.1	8.00	0.0003	0.03	0.00	None
19	4	20.56	1	0.1	8.67	0.0000	0	0.00	None
20	4	6.73	2	0.1	8.67	0.0000	0	0.00	None
21	4	27.84	1	0.1	8.67	0.0000	0	0.00	None
22	4	2.54	2	0.1	8.67	0.0007	0.07	0.00	None
23	3	3.88	1	0.1	8.42	0.0002	0.02	0.00	None
24	3	1.37	2	0.1	8.42	0.0007	0.07	0.00	None
25	4	2.69	1	0.1	8.42	0.0001	0.01	0.00	None
26	4	0.74	2	0.1	8.42	0.0005	0.05	0.00	None

Table C- 185. Analysis Result: San Juan Earthquake (0.2g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	0.2	9.42	0.0004	0.04	0.00	None
2	8	1.03	2	0.2	9.42	0.0008	0.08	0.00	None
3	8	5.35	1	0.2	8.75	0.0003	0.03	0.00	None
4	8	1.66	2	0.2	8.75	0.0007	0.07	0.00	None
5	4	2.81	1	0.2	8.50	0.0004	0.04	0.00	None
6	4	0.33	2	0.2	8.50	0.0024	0.24	0.00	None
7	7	5.55	1	0.2	8.00	0.0003	0.03	0.00	None
8	7	1.08	2	0.2	8.00	0.0018	0.18	0.00	None
9	6	2.18	1	0.2	8.00	0.0002	0.02	0.00	None
10	6	0.69	2	0.2	8.00	0.0473	4.73	1.00	Major
11	10	4.31	1	0.2	8.42	0.0003	0.03	0.00	None
12	10	1.17	2	0.2	8.42	0.0008	0.08	0.00	None
13	5	3.08	1	0.2	8.83	0.0003	0.03	0.00	None
14	5	0.5	2	0.2	8.83	0.0016	0.16	0.00	None
15	3	5.3	1	0.2	8.00	0.0001	0.01	0.00	None
16	3	1.33	2	0.2	8.00	0.0007	0.07	0.00	None
17	3	5.61	1	0.2	8.00	0.0001	0.01	0.00	None
18	3	1.2	2	0.2	8.00	0.0012	0.12	0.00	None
19	4	20.56	1	0.2	8.67	0.0001	0.01	0.00	None
20	4	6.73	2	0.2	8.67	0.0000	0	0.00	None
21	4	27.84	1	0.2	8.67	0.0001	0.01	0.00	None
22	4	2.54	2	0.2	8.67	0.0015	0.15	0.00	None
23	3	3.88	1	0.2	8.42	0.0004	0.04	0.00	None
24	3	1.37	2	0.2	8.42	0.0018	0.18	0.00	None
25	4	2.69	1	0.2	8.42	0.0002	0.02	0.00	None
26	4	0.74	2	0.2	8.42	0.0014	0.14	0.00	None

Table C- 186. Analysis Result: San Juan Earthquake (0.3g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	0.3	9.42	0.0008	0.08	0.00	None
2	8	1.03	2	0.3	9.42	0.0018	0.18	0.00	None
3	8	5.35	1	0.3	8.75	0.0004	0.04	0.00	None
4	8	1.66	2	0.3	8.75	0.0002	0.02	0.00	None
5	4	2.81	1	0.3	8.50	0.0077	0.77	0.18	Minor
6	4	0.33	2	0.3	8.50	0.0051	0.51	0.01	None
7	7	5.55	1	0.3	8.00	0.0005	0.05	0.00	None
8	7	1.08	2	0.3	8.00	0.0120	1.2	0.47	Moderate
9	6	2.18	1	0.3	8.00	0.0004	0.04	0.00	None
10	6	0.69	2	0.3	8.00	0.0709	7.09	1.00	Major
11	10	4.31	1	0.3	8.42	0.0007	0.07	0.00	None
12	10	1.17	2	0.3	8.42	0.0014	0.14	0.00	None
13	5	3.08	1	0.3	8.83	0.0007	0.07	0.00	None
14	5	0.5	2	0.3	8.83	0.0038	0.38	0.00	None
15	3	5.3	1	0.3	8.00	0.0002	0.02	0.00	None
16	3	1.33	2	0.3	8.00	0.0023	0.23	0.00	None
17	3	5.61	1	0.3	8.00	0.0001	0.01	0.00	None
18	3	1.2	2	0.3	8.00	0.0027	0.27	0.00	None
19	4	20.56	1	0.3	8.67	0.0001	0.01	0.00	None
20	4	6.73	2	0.3	8.67	0.0000	0	0.00	None
21	4	27.84	1	0.3	8.67	0.0001	0.01	0.00	None
22	4	2.54	2	0.3	8.67	0.0029	0.29	0.00	None
23	3	3.88	1	0.3	8.42	0.0006	0.06	0.00	None
24	3	1.37	2	0.3	8.42	0.0022	0.22	0.00	None
25	4	2.69	1	0.3	8.42	0.0003	0.03	0.00	None
26	4	0.74	2	0.3	8.42	0.0022	0.22	0.00	None

Table C- 187. Analysis Result: San Juan Earthquake (0.4g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	0.4	9.42	0.0009	0.09	0.00	None
2	8	1.03	2	0.4	9.42	0.0028	0.28	0.00	None
3	8	5.35	1	0.4	8.75	0.0012	0.12	0.00	None
4	8	1.66	2	0.4	8.75	0.0014	0.14	0.00	None
5	4	2.81	1	0.4	8.50	0.0094	0.94	0.29	Minor
6	4	0.33	2	0.4	8.50	0.0069	0.69	0.13	Minor
7	7	5.55	1	0.4	8.00	0.0008	0.08	0.00	None
8	7	1.08	2	0.4	8.00	0.0107	1.07	0.38	Moderate
9	6	2.18	1	0.4	8.00	0.0006	0.06	0.00	None
10	6	0.69	2	0.4	8.00	0.0944	9.44	1.00	Major
11	10	4.31	1	0.4	8.42	0.0007	0.07	0.00	None
12	10	1.17	2	0.4	8.42	0.0020	0.2	0.00	None
13	5	3.08	1	0.4	8.83	0.0014	0.14	0.00	None
14	5	0.5	2	0.4	8.83	0.0071	0.71	0.14	Minor
15	3	5.3	1	0.4	8.00	0.0003	0.03	0.00	None
16	3	1.33	2	0.4	8.00	0.0039	0.39	0.00	None
17	3	5.61	1	0.4	8.00	0.0001	0.01	0.00	None
18	3	1.2	2	0.4	8.00	0.0037	0.37	0.00	None
19	4	20.56	1	0.4	8.67	0.0001	0.01	0.00	None
20	4	6.73	2	0.4	8.67	0.0001	0.01	0.00	None
21	4	27.84	1	0.4	8.67	0.0002	0.02	0.00	None
22	4	2.54	2	0.4	8.67	0.0044	0.44	0.00	None
23	3	3.88	1	0.4	8.42	0.0009	0.09	0.00	None
24	3	1.37	2	0.4	8.42	0.0036	0.36	0.00	None
25	4	2.69	1	0.4	8.42	0.0006	0.06	0.00	None
26	4	0.74	2	0.4	8.42	0.0033	0.33	0.00	None

Table C- 188. Analysis Result: San Juan Earthquake (0.5g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	0.5	9.42	0.0011	0.11	0.00	None
2	8	1.03	2	0.5	9.42	0.0039	0.39	0.00	None
3	8	5.35	1	0.5	8.75	0.0015	0.15	0.00	None
4	8	1.66	2	0.5	8.75	0.0020	0.2	0.00	None
5	4	2.81	1	0.5	8.50	0.0121	1.21	0.47	Moderate
6	4	0.33	2	0.5	8.50	0.0132	1.32	0.55	Moderate
7	7	5.55	1	0.5	8.00	0.0007	0.07	0.00	None
8	7	1.08	2	0.5	8.00	0.0085	0.85	0.23	Minor
9	6	2.18	1	0.5	8.00	0.0012	0.12	0.00	None
10	6	0.69	2	0.5	8.00	0.1179	11.79	1.00	Major
11	10	4.31	1	0.5	8.42	0.0009	0.09	0.00	None
12	10	1.17	2	0.5	8.42	0.0026	0.26	0.00	None
13	5	3.08	1	0.5	8.83	0.0021	0.21	0.00	None
14	5	0.5	2	0.5	8.83	0.0105	1.05	0.37	Moderate
15	3	5.3	1	0.5	8.00	0.0003	0.03	0.00	None
16	3	1.33	2	0.5	8.00	0.0055	0.55	0.03	None
17	3	5.61	1	0.5	8.00	0.0010	0.1	0.00	None
18	3	1.2	2	0.5	8.00	0.0044	0.44	0.00	None
19	4	20.56	1	0.5	8.67	0.0002	0.02	0.00	None
20	4	6.73	2	0.5	8.67	0.0001	0.01	0.00	None
21	4	27.84	1	0.5	8.67	0.0002	0.02	0.00	None
22	4	2.54	2	0.5	8.67	0.0057	0.57	0.05	None
23	3	3.88	1	0.5	8.42	0.0012	0.12	0.00	None
24	3	1.37	2	0.5	8.42	0.0058	0.58	0.05	Minor
25	4	2.69	1	0.5	8.42	0.0008	0.08	0.00	None
26	4	0.74	2	0.5	8.42	0.0051	0.51	0.01	None

Table C- 189. Analysis Result: San Juan Earthquake (0.6g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	0.6	9.42	0.0014	0.14	0.00	None
2	8	1.03	2	0.6	9.42	0.0064	0.64	0.09	Minor
3	8	5.35	1	0.6	8.75	0.0021	0.21	0.00	None
4	8	1.66	2	0.6	8.75	0.0024	0.24	0.00	None
5	4	2.81	1	0.6	8.50	0.0131	1.31	0.54	Moderate
6	4	0.33	2	0.6	8.50	0.0143	1.43	0.62	Substantial
7	7	5.55	1	0.6	8.00	0.0008	0.08	0.00	None
8	7	1.08	2	0.6	8.00	0.0184	1.84	0.89	Major
9	6	2.18	1	0.6	8.00	0.0016	0.16	0.00	None
10	6	0.69	2	0.6	8.00	0.1414	14.14	1.00	Major
11	10	4.31	1	0.6	8.42	0.0011	0.11	0.00	None
12	10	1.17	2	0.6	8.42	0.0042	0.42	0.00	None
13	5	3.08	1	0.6	8.83	0.0028	0.28	0.00	None
14	5	0.5	2	0.6	8.83	0.0152	1.52	0.68	Substantial
15	3	5.3	1	0.6	8.00	0.0004	0.04	0.00	None
16	3	1.33	2	0.6	8.00	0.0070	0.7	0.13	Minor
17	3	5.61	1	0.6	8.00	0.0022	0.22	0.00	None
18	3	1.2	2	0.6	8.00	0.0077	0.77	0.18	Minor
19	4	20.56	1	0.6	8.67	0.0005	0.05	0.00	None
20	4	6.73	2	0.6	8.67	0.0001	0.01	0.00	None
21	4	27.84	1	0.6	8.67	0.0003	0.03	0.00	None
22	4	2.54	2	0.6	8.67	0.0069	0.69	0.13	Minor
23	3	3.88	1	0.6	8.42	0.0013	0.13	0.00	None
24	3	1.37	2	0.6	8.42	0.0058	0.58	0.05	Minor
25	4	2.69	1	0.6	8.42	0.0010	0.1	0.00	None
26	4	0.74	2	0.6	8.42	0.0083	0.83	0.22	Minor

Table C- 190. Analysis Result: San Juan Earthquake (0.7g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	0.7	9.42	0.0017	0.17	0.00	None
2	8	1.03	2	0.7	9.42	0.0082	0.82	0.21	Minor
3	8	5.35	1	0.7	8.75	0.0028	0.28	0.00	None
4	8	1.66	2	0.7	8.75	0.0058	0.58	0.05	Minor
5	4	2.81	1	0.7	8.50	0.0141	1.41	0.61	Substantial
6	4	0.33	2	0.7	8.50	0.0205	2.05	1.00	Major
7	7	5.55	1	0.7	8.00	0.0008	0.08	0.00	None
8	7	1.08	2	0.7	8.00	0.0290	2.9	1.00	Major
9	6	2.18	1	0.7	8.00	0.0019	0.19	0.00	None
10	6	0.69	2	0.7	8.00	0.1644	16.44	1.00	Major
11	10	4.31	1	0.7	8.42	0.0014	0.14	0.00	None
12	10	1.17	2	0.7	8.42	0.0048	0.48	0.00	None
13	5	3.08	1	0.7	8.83	0.0036	0.36	0.00	None
14	5	0.5	2	0.7	8.83	0.0176	1.76	0.84	Major
15	3	5.3	1	0.7	8.00	0.0005	0.05	0.00	None
16	3	1.33	2	0.7	8.00	0.0076	0.76	0.17	Minor
17	3	5.61	1	0.7	8.00	0.0020	0.2	0.00	None
18	3	1.2	2	0.7	8.00	0.0082	0.82	0.21	Minor
19	4	20.56	1	0.7	8.67	0.0007	0.07	0.00	None
20	4	6.73	2	0.7	8.67	0.0001	0.01	0.00	None
21	4	27.84	1	0.7	8.67	0.0003	0.03	0.00	None
22	4	2.54	2	0.7	8.67	0.0078	0.78	0.19	Minor
23	3	3.88	1	0.7	8.42	0.0018	0.18	0.00	None
24	3	1.37	2	0.7	8.42	0.0073	0.73	0.15	Minor
25	4	2.69	1	0.7	8.42	0.0015	0.15	0.00	None
26	4	0.74	2	0.7	8.42	0.0100	1	0.33	Minor

Table C- 191. Analysis Result: San Juan Earthquake (0.8g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	0.8	9.42	0.0025	0.25	0.00	None
2	8	1.03	2	0.8	9.42	0.0096	0.96	0.31	Minor
3	8	5.35	1	0.8	8.75	0.0034	0.34	0.00	None
4	8	1.66	2	0.8	8.75	0.0065	0.65	0.10	Minor
5	4	2.81	1	0.8	8.50	0.0152	1.52	0.68	Substantial
6	4	0.33	2	0.8	8.50	0.0297	2.97	1.00	Major
7	7	5.55	1	0.8	8.00	0.0008	0.08	0.00	None
8	7	1.08	2	0.8	8.00	0.0290	2.9	1.00	Major
9	6	2.18	1	0.8	8.00	0.0074	0.74	0.16	Minor
10	6	0.69	2	0.8	8.00	0.1872	18.72	1.00	Major
11	10	4.31	1	0.8	8.42	0.0020	0.2	0.00	None
12	10	1.17	2	0.8	8.42	0.0063	0.63	0.09	Minor
13	5	3.08	1	0.8	8.83	0.0043	0.43	0.00	None
14	5	0.5	2	0.8	8.83	0.0211	2.11	1.00	Major
15	3	5.3	1	0.8	8.00	0.0006	0.06	0.00	None
16	3	1.33	2	0.8	8.00	0.0093	0.93	0.29	Minor
17	3	5.61	1	0.8	8.00	0.0008	0.08	0.00	None
18	3	1.2	2	0.8	8.00	0.0089	0.89	0.26	Minor
19	4	20.56	1	0.8	8.67	0.0007	0.07	0.00	None
20	4	6.73	2	0.8	8.67	0.0001	0.01	0.00	None
21	4	27.84	1	0.8	8.67	0.0004	0.04	0.00	None
22	4	2.54	2	0.8	8.67	0.0123	1.23	0.49	Moderate
23	3	3.88	1	0.8	8.42	0.0027	0.27	0.00	None
24	3	1.37	2	0.8	8.42	0.0105	1.05	0.37	Moderate
25	4	2.69	1	0.8	8.42	0.0019	0.19	0.00	None
26	4	0.74	2	0.8	8.42	0.0110	1.1	0.40	Moderate

Table C- 192. Analysis Result: San Juan Earthquake (0.9g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	0.9	9.42	0.0033	0.33	0.00	None
2	8	1.03	2	0.9	9.42	0.0117	1.17	0.45	Moderate
3	8	5.35	1	0.9	8.75	0.0044	0.44	0.00	None
4	8	1.66	2	0.9	8.75	0.0060	0.6	0.07	Minor
5	4	2.81	1	0.9	8.50	0.0136	1.36	0.57	Substantial
6	4	0.33	2	0.9	8.50	0.0297	2.97	1.00	Major
7	7	5.55	1	0.9	8.00	0.0010	0.1	0.00	None
8	7	1.08	2	0.9	8.00	0.0354	3.54	1.00	Major
9	6	2.18	1	0.9	8.00	0.0127	1.27	0.51	Moderate
10	6	0.69	2	0.9	8.00	0.1878	18.78	1.00	Major
11	10	4.31	1	0.9	8.42	0.0027	0.27	0.00	None
12	10	1.17	2	0.9	8.42	0.0077	0.77	0.18	Minor
13	5	3.08	1	0.9	8.83	0.0046	0.46	0.00	None
14	5	0.5	2	0.9	8.83	0.0327	3.27	1.00	Major
15	3	5.3	1	0.9	8.00	0.0008	0.08	0.00	None
16	3	1.33	2	0.9	8.00	0.0130	1.3	0.53	Moderate
17	3	5.61	1	0.9	8.00	0.0041	0.41	0.00	None
18	3	1.2	2	0.9	8.00	0.0148	1.48	0.65	Substantial
19	4	20.56	1	0.9	8.67	0.0009	0.09	0.00	None
20	4	6.73	2	0.9	8.67	0.0001	0.01	0.00	None
21	4	27.84	1	0.9	8.67	0.0004	0.04	0.00	None
22	4	2.54	2	0.9	8.67	0.0148	1.48	0.65	Substantial
23	3	3.88	1	0.9	8.42	0.0036	0.36	0.00	None
24	3	1.37	2	0.9	8.42	0.0144	1.44	0.63	Substantial
25	4	2.69	1	0.9	8.42	0.0026	0.26	0.00	None
26	4	0.74	2	0.9	8.42	0.0132	1.32	0.55	Moderate

Table C- 193. Analysis Result: San Juan Earthquake (1g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	1	9.42	0.0039	0.39	0.00	None
2	8	1.03	2	1	9.42	0.0145	1.45	0.63	Substantial
3	8	5.35	1	1	8.75	0.0049	0.49	0.00	None
4	8	1.66	2	1	8.75	0.0097	0.97	0.31	Minor
5	4	2.81	1	1	8.50	0.0249	2.49	1.00	Major
6	4	0.33	2	1	8.50	0.0366	3.66	1.00	Major
7	7	5.55	1	1	8.00	0.0011	0.11	0.00	None
8	7	1.08	2	1	8.00	0.0381	3.81	1.00	Major
9	6	2.18	1	1	8.00	0.0095	0.95	0.30	Minor
10	6	0.69	2	1	8.00	0.1884	18.84	1.00	Major
11	10	4.31	1	1	8.42	0.0032	0.32	0.00	None
12	10	1.17	2	1	8.42	0.0084	0.84	0.23	Minor
13	5	3.08	1	1	8.83	0.0057	0.57	0.05	None
14	5	0.5	2	1	8.83	0.0406	4.06	1.00	Major
15	3	5.3	1	1	8.00	0.0010	0.1	0.00	None
16	3	1.33	2	1	8.00	0.0121	1.21	0.47	Moderate
17	3	5.61	1	1	8.00	0.0047	0.47	0.00	None
18	3	1.2	2	1	8.00	0.0222	2.22	1.00	Major
19	4	20.56	1	1	8.67	0.0006	0.06	0.00	None
20	4	6.73	2	1	8.67	0.0001	0.01	0.00	None
21	4	27.84	1	1	8.67	0.0005	0.05	0.00	None
22	4	2.54	2	1	8.67	0.0193	1.93	0.95	Major
23	3	3.88	1	1	8.42	0.0044	0.44	0.00	None
24	3	1.37	2	1	8.42	0.0169	1.69	0.79	Major
25	4	2.69	1	1	8.42	0.0091	0.91	0.27	Minor
26	4	0.74	2	1	8.42	0.0158	1.58	0.72	Substantial

Table C- 194. Analysis Result: San Juan Earthquake (1.1g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	1.1	9.42	0.0046	0.46	0.00	None
2	8	1.03	2	1.1	9.42	0.0177	1.77	0.85	Major
3	8	5.35	1	1.1	8.75	0.0056	0.56	0.04	None
4	8	1.66	2	1.1	8.75	0.0104	1.04	0.36	Moderate
5	4	2.81	1	1.1	8.50	0.0271	2.71	1.00	Major
6	4	0.33	2	1.1	8.50	0.0481	4.81	1.00	Major
7	7	5.55	1	1.1	8.00	0.0020	0.2	0.00	None
8	7	1.08	2	1.1	8.00	0.0425	4.25	1.00	Major
9	6	2.18	1	1.1	8.00	0.0127	1.27	0.51	Moderate
10	6	0.69	2	1.1	8.00	0.1885	18.85	1.00	Major
11	10	4.31	1	1.1	8.42	0.0036	0.36	0.00	None
12	10	1.17	2	1.1	8.42	0.0098	0.98	0.32	Minor
13	5	3.08	1	1.1	8.83	0.0062	0.62	0.08	Minor
14	5	0.5	2	1.1	8.83	0.0429	4.29	1.00	Major
15	3	5.3	1	1.1	8.00	0.0013	0.13	0.00	None
16	3	1.33	2	1.1	8.00	0.0222	2.22	1.00	Major
17	3	5.61	1	1.1	8.00	0.0055	0.55	0.03	None
18	3	1.2	2	1.1	8.00	0.0266	2.66	1.00	Major
19	4	20.56	1	1.1	8.67	0.0013	0.13	0.00	None
20	4	6.73	2	1.1	8.67	0.0001	0.01	0.00	None
21	4	27.84	1	1.1	8.67	0.0005	0.05	0.00	None
22	4	2.54	2	1.1	8.67	0.0235	2.35	1.00	Major
23	3	3.88	1	1.1	8.42	0.0056	0.56	0.04	None
24	3	1.37	2	1.1	8.42	0.0202	2.02	1.00	Major
25	4	2.69	1	1.1	8.42	0.0045	0.45	0.00	None
26	4	0.74	2	1.1	8.42	0.0189	1.89	0.93	Major

Table C- 195. Analysis Result: San Juan Earthquake (1.2g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	1.2	9.42	0.0056	0.56	0.04	None
2	8	1.03	2	1.2	9.42	0.0227	2.27	1.00	Major
3	8	5.35	1	1.2	8.75	0.0064	0.64	0.09	Minor
4	8	1.66	2	1.2	8.75	0.0109	1.09	0.39	Moderate
5	4	2.81	1	1.2	8.50	0.0324	3.24	1.00	Major
6	4	0.33	2	1.2	8.50	0.0543	5.43	1.00	Major
7	7	5.55	1	1.2	8.00	0.0007	0.07	0.00	None
8	7	1.08	2	1.2	8.00	0.0338	3.38	1.00	Major
9	6	2.18	1	1.2	8.00	0.0135	1.35	0.57	Substantial
10	6	0.69	2	1.2	8.00	0.1875	18.75	1.00	Major
11	10	4.31	1	1.2	8.42	0.0042	0.42	0.00	None
12	10	1.17	2	1.2	8.42	0.0140	1.4	0.60	Substantial
13	5	3.08	1	1.2	8.83	0.0074	0.74	0.16	Minor
14	5	0.5	2	1.2	8.83	0.0443	4.43	1.00	Major
15	3	5.3	1	1.2	8.00	0.0015	0.15	0.00	None
16	3	1.33	2	1.2	8.00	0.0285	2.85	1.00	Major
17	3	5.61	1	1.2	8.00	0.0056	0.56	0.04	None
18	3	1.2	2	1.2	8.00	0.0294	2.94	1.00	Major
19	4	20.56	1	1.2	8.67	0.0021	0.21	0.00	None
20	4	6.73	2	1.2	8.67	0.0002	0.02	0.00	None
21	4	27.84	1	1.2	8.67	0.0006	0.06	0.00	None
22	4	2.54	2	1.2	8.67	0.0271	2.71	1.00	Major
23	3	3.88	1	1.2	8.42	0.0065	0.65	0.10	Minor
24	3	1.37	2	1.2	8.42	0.0226	2.26	1.00	Major
25	4	2.69	1	1.2	8.42	0.0076	0.76	0.17	Minor
26	4	0.74	2	1.2	8.42	0.0213	2.13	1.00	Major

Table C- 196. Analysis Result: San Juan Earthquake (1.3g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	1.3	9.42	0.0055	0.55	0.03	None
2	8	1.03	2	1.3	9.42	0.0263	2.63	1.00	Major
3	8	5.35	1	1.3	8.75	0.0065	0.65	0.10	Minor
4	8	1.66	2	1.3	8.75	0.0133	1.33	0.55	Substantial
5	4	2.81	1	1.3	8.50	0.0340	3.4	1.00	Major
6	4	0.33	2	1.3	8.50	0.0571	5.71	1.00	Major
7	7	5.55	1	1.3	8.00	0.0015	0.15	0.00	None
8	7	1.08	2	1.3	8.00	0.0424	4.24	1.00	Major
9	6	2.18	1	1.3	8.00	0.0133	1.33	0.55	Substantial
10	6	0.69	2	1.3	8.00	0.1874	18.74	1.00	Major
11	10	4.31	1	1.3	8.42	0.0045	0.45	0.00	None
12	10	1.17	2	1.3	8.42	0.0167	1.67	0.78	Major
13	5	3.08	1	1.3	8.83	0.0088	0.88	0.25	Minor
14	5	0.5	2	1.3	8.83	0.0408	4.08	1.00	Major
15	3	5.3	1	1.3	8.00	0.0018	0.18	0.00	None
16	3	1.33	2	1.3	8.00	0.0318	3.18	1.00	Major
17	3	5.61	1	1.3	8.00	0.0078	0.78	0.19	Minor
18	3	1.2	2	1.3	8.00	0.0346	3.46	1.00	Major
19	4	20.56	1	1.3	8.67	0.0018	0.18	0.00	None
20	4	6.73	2	1.3	8.67	0.0002	0.02	0.00	None
21	4	27.84	1	1.3	8.67	0.0006	0.06	0.00	None
22	4	2.54	2	1.3	8.67	0.0263	2.63	1.00	Major
23	3	3.88	1	1.3	8.42	0.0075	0.75	0.17	Minor
24	3	1.37	2	1.3	8.42	0.0259	2.59	1.00	Major
25	4	2.69	1	1.3	8.42	0.0131	1.31	0.54	Moderate
26	4	0.74	2	1.3	8.42	0.0229	2.29	1.00	Major

Table C- 197. Analysis Result: San Juan Earthquake (1.4g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	1.4	9.42	0.0061	0.61	0.07	Minor
2	8	1.03	2	1.4	9.42	0.0261	2.61	1.00	Major
3	8	5.35	1	1.4	8.75	0.0057	0.57	0.05	None
4	8	1.66	2	1.4	8.75	0.0012	0.12	0.00	None
5	4	2.81	1	1.4	8.50	0.0382	3.82	1.00	Major
6	4	0.33	2	1.4	8.50	0.0601	6.01	1.00	Major
7	7	5.55	1	1.4	8.00	0.0007	0.07	0.00	None
8	7	1.08	2	1.4	8.00	0.0327	3.27	1.00	Major
9	6	2.18	1	1.4	8.00	0.0134	1.34	0.56	Substantial
10	6	0.69	2	1.4	8.00	0.1878	18.78	1.00	Major
11	10	4.31	1	1.4	8.42	0.0044	0.44	0.00	None
12	10	1.17	2	1.4	8.42	0.0188	1.88	0.92	Major
13	5	3.08	1	1.4	8.83	0.0107	1.07	0.38	Moderate
14	5	0.5	2	1.4	8.83	0.0418	4.18	1.00	Major
15	3	5.3	1	1.4	8.00	0.0022	0.22	0.00	None
16	3	1.33	2	1.4	8.00	0.0362	3.62	1.00	Major
17	3	5.61	1	1.4	8.00	0.0090	0.9	0.27	Minor
18	3	1.2	2	1.4	8.00	0.0340	3.4	1.00	Major
19	4	20.56	1	1.4	8.67	0.0018	0.18	0.00	None
20	4	6.73	2	1.4	8.67	0.0002	0.02	0.00	None
21	4	27.84	1	1.4	8.67	0.0008	0.08	0.00	None
22	4	2.54	2	1.4	8.67	0.0280	2.8	1.00	Major
23	3	3.88	1	1.4	8.42	0.0078	0.78	0.19	Minor
24	3	1.37	2	1.4	8.42	0.0284	2.84	1.00	Major
25	4	2.69	1	1.4	8.42	0.0140	1.4	0.60	Substantial
26	4	0.74	2	1.4	8.42	0.0293	2.93	1.00	Major

Table C- 198. Analysis Result: San Juan Earthquake (1.5g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	1.5	9.42	0.0069	0.69	0.13	Minor
2	8	1.03	2	1.5	9.42	0.0245	2.45	1.00	Major
3	8	5.35	1	1.5	8.75	0.0071	0.71	0.14	Minor
4	8	1.66	2	1.5	8.75	0.0152	1.52	0.68	Substantial
5	4	2.81	1	1.5	8.50	0.0406	4.06	1.00	Major
6	4	0.33	2	1.5	8.50	0.0657	6.57	1.00	Major
7	7	5.55	1	1.5	8.00	0.0007	0.07	0.00	None
8	7	1.08	2	1.5	8.00	0.0394	3.94	1.00	Major
9	6	2.18	1	1.5	8.00	0.0117	1.17	0.45	Moderate
10	6	0.69	2	1.5	8.00	0.1883	18.83	1.00	Major
11	10	4.31	1	1.5	8.42	0.0050	0.5	0.00	None
12	10	1.17	2	1.5	8.42	0.0211	2.11	1.00	Major
13	5	3.08	1	1.5	8.83	0.0114	1.14	0.43	Moderate
14	5	0.5	2	1.5	8.83	0.0514	5.14	1.00	Major
15	3	5.3	1	1.5	8.00	0.0026	0.26	0.00	None
16	3	1.33	2	1.5	8.00	0.0368	3.68	1.00	Major
17	3	5.61	1	1.5	8.00	0.0070	0.7	0.13	Minor
18	3	1.2	2	1.5	8.00	0.0403	4.03	1.00	Major
19	4	20.56	1	1.5	8.67	0.0026	0.26	0.00	None
20	4	6.73	2	1.5	8.67	0.0002	0.02	0.00	None
21	4	27.84	1	1.5	8.67	0.0009	0.09	0.00	None
22	4	2.54	2	1.5	8.67	0.0312	3.12	1.00	Major
23	3	3.88	1	1.5	8.42	0.0107	1.07	0.38	Moderate
24	3	1.37	2	1.5	8.42	0.0303	3.03	1.00	Major
25	4	2.69	1	1.5	8.42	0.0130	1.3	0.53	Moderate
26	4	0.74	2	1.5	8.42	0.0324	3.24	1.00	Major

Table C- 199. Analysis Result: Northridge Earthquake (0.1g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	0.1	9.42	0.0001	0.01	0.00	None
2	8	1.03	2	0.1	9.42	0.0006	0.06	0.00	None
3	8	5.35	1	0.1	8.75	0.0002	0.02	0.00	None
4	8	1.66	2	0.1	8.75	0.0004	0.04	0.00	None
5	4	2.81	1	0.1	8.50	0.0002	0.02	0.00	None
6	4	0.33	2	0.1	8.50	0.0011	0.11	0.00	None
7	7	5.55	1	0.1	8.00	0.0002	0.02	0.00	None
8	7	1.08	2	0.1	8.00	0.0003	0.03	0.00	None
9	6	2.18	1	0.1	8.00	0.0000	0	0.00	None
10	6	0.69	2	0.1	8.00	0.0081	0.81	0.21	Minor
11	10	4.31	1	0.1	8.42	0.0001	0.01	0.00	None
12	10	1.17	2	0.1	8.42	0.0003	0.03	0.00	None
13	5	3.08	1	0.1	8.83	0.0001	0.01	0.00	None
14	5	0.5	2	0.1	8.83	0.0014	0.14	0.00	None
15	3	5.3	1	0.1	8.00	0.0000	0	0.00	None
16	3	1.33	2	0.1	8.00	0.0001	0.01	0.00	None
17	3	5.61	1	0.1	8.00	0.0000	0	0.00	None
18	3	1.2	2	0.1	8.00	0.0001	0.01	0.00	None
19	4	20.56	1	0.1	8.67	0.0000	0	0.00	None
20	4	6.73	2	0.1	8.67	0.0000	0	0.00	None
21	4	27.84	1	0.1	8.67	0.0000	0	0.00	None
22	4	2.54	2	0.1	8.67	0.0013	0.13	0.00	None
23	3	3.88	1	0.1	8.42	0.0001	0.01	0.00	None
24	3	1.37	2	0.1	8.42	0.0006	0.06	0.00	None
25	4	2.69	1	0.1	8.42	0.0000	0	0.00	None
26	4	0.74	2	0.1	8.42	0.0006	0.06	0.00	None

Table C- 200. Analysis Result: Northridge Earthquake (0.2g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	0.2	9.42	0.0005	0.05	0.00	None
2	8	1.03	2	0.2	9.42	0.0008	0.08	0.00	None
3	8	5.35	1	0.2	8.75	0.0004	0.04	0.00	None
4	8	1.66	2	0.2	8.75	0.0009	0.09	0.00	None
5	4	2.81	1	0.2	8.50	0.0004	0.04	0.00	None
6	4	0.33	2	0.2	8.50	0.0028	0.28	0.00	None
7	7	5.55	1	0.2	8.00	0.0004	0.04	0.00	None
8	7	1.08	2	0.2	8.00	0.0014	0.14	0.00	None
9	6	2.18	1	0.2	8.00	0.0001	0.01	0.00	None
10	6	0.69	2	0.2	8.00	0.0162	1.62	0.75	Substantial
11	10	4.31	1	0.2	8.42	0.0003	0.03	0.00	None
12	10	1.17	2	0.2	8.42	0.0009	0.09	0.00	None
13	5	3.08	1	0.2	8.83	0.0002	0.02	0.00	None
14	5	0.5	2	0.2	8.83	0.0031	0.31	0.00	None
15	3	5.3	1	0.2	8.00	0.0001	0.01	0.00	None
16	3	1.33	2	0.2	8.00	0.0005	0.05	0.00	None
17	3	5.61	1	0.2	8.00	0.0000	0	0.00	None
18	3	1.2	2	0.2	8.00	0.0013	0.13	0.00	None
19	4	20.56	1	0.2	8.67	0.0000	0	0.00	None
20	4	6.73	2	0.2	8.67	0.0000	0	0.00	None
21	4	27.84	1	0.2	8.67	0.0000	0	0.00	None
22	4	2.54	2	0.2	8.67	0.0028	0.28	0.00	None
23	3	3.88	1	0.2	8.42	0.0003	0.03	0.00	None
24	3	1.37	2	0.2	8.42	0.0013	0.13	0.00	None
25	4	2.69	1	0.2	8.42	0.0001	0.01	0.00	None
26	4	0.74	2	0.2	8.42	0.0016	0.16	0.00	None

Table C- 201. Analysis Result: Northridge Earthquake (0.3g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	0.3	9.42	0.0007	0.07	0.00	None
2	8	1.03	2	0.3	9.42	0.0017	0.17	0.00	None
3	8	5.35	1	0.3	8.75	0.0005	0.05	0.00	None
4	8	1.66	2	0.3	8.75	0.0016	0.16	0.00	None
5	4	2.81	1	0.3	8.50	0.0078	0.78	0.19	Minor
6	4	0.33	2	0.3	8.50	0.0050	0.5	0.00	None
7	7	5.55	1	0.3	8.00	0.0007	0.07	0.00	None
8	7	1.08	2	0.3	8.00	0.0118	1.18	0.45	Moderate
9	6	2.18	1	0.3	8.00	0.0002	0.02	0.00	None
10	6	0.69	2	0.3	8.00	0.0244	2.44	1.00	Major
11	10	4.31	1	0.3	8.42	0.0007	0.07	0.00	None
12	10	1.17	2	0.3	8.42	0.0017	0.17	0.00	None
13	5	3.08	1	0.3	8.83	0.0010	0.1	0.00	None
14	5	0.5	2	0.3	8.83	0.0038	0.38	0.00	None
15	3	5.3	1	0.3	8.00	0.0001	0.01	0.00	None
16	3	1.33	2	0.3	8.00	0.0025	0.25	0.00	None
17	3	5.61	1	0.3	8.00	0.0000	0	0.00	None
18	3	1.2	2	0.3	8.00	0.0036	0.36	0.00	None
19	4	20.56	1	0.3	8.67	0.0000	0	0.00	None
20	4	6.73	2	0.3	8.67	0.0000	0	0.00	None
21	4	27.84	1	0.3	8.67	0.0001	0.01	0.00	None
22	4	2.54	2	0.3	8.67	0.0049	0.49	0.00	None
23	3	3.88	1	0.3	8.42	0.0004	0.04	0.00	None
24	3	1.37	2	0.3	8.42	0.0027	0.27	0.00	None
25	4	2.69	1	0.3	8.42	0.0001	0.01	0.00	None
26	4	0.74	2	0.3	8.42	0.0035	0.35	0.00	None

Table C- 202. Analysis Result: Northridge Earthquake (0.4g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	0.4	9.42	0.0012	0.12	0.00	None
2	8	1.03	2	0.4	9.42	0.0032	0.32	0.00	None
3	8	5.35	1	0.4	8.75	0.0014	0.14	0.00	None
4	8	1.66	2	0.4	8.75	0.0026	0.26	0.00	None
5	4	2.81	1	0.4	8.50	0.0086	0.86	0.24	Minor
6	4	0.33	2	0.4	8.50	0.0085	0.85	0.23	Minor
7	7	5.55	1	0.4	8.00	0.0011	0.11	0.00	None
8	7	1.08	2	0.4	8.00	0.0159	1.59	0.73	Substantial
9	6	2.18	1	0.4	8.00	0.0006	0.06	0.00	None
10	6	0.69	2	0.4	8.00	0.0325	3.25	1.00	Major
11	10	4.31	1	0.4	8.42	0.0010	0.1	0.00	None
12	10	1.17	2	0.4	8.42	0.0022	0.22	0.00	None
13	5	3.08	1	0.4	8.83	0.0017	0.17	0.00	None
14	5	0.5	2	0.4	8.83	0.0073	0.73	0.15	Minor
15	3	5.3	1	0.4	8.00	0.0001	0.01	0.00	None
16	3	1.33	2	0.4	8.00	0.0044	0.44	0.00	None
17	3	5.61	1	0.4	8.00	0.0000	0	0.00	None
18	3	1.2	2	0.4	8.00	0.0045	0.45	0.00	None
19	4	20.56	1	0.4	8.67	0.0000	0	0.00	None
20	4	6.73	2	0.4	8.67	0.0000	0	0.00	None
21	4	27.84	1	0.4	8.67	0.0001	0.01	0.00	None
22	4	2.54	2	0.4	8.67	0.0080	0.8	0.20	Minor
23	3	3.88	1	0.4	8.42	0.0008	0.08	0.00	None
24	3	1.37	2	0.4	8.42	0.0043	0.43	0.00	None
25	4	2.69	1	0.4	8.42	0.0001	0.01	0.00	None
26	4	0.74	2	0.4	8.42	0.0046	0.46	0.00	None

Table C- 203. Analysis Result: Northridge Earthquake (0.5g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	0.5	9.42	0.0018	0.18	0.00	None
2	8	1.03	2	0.5	9.42	0.0047	0.47	0.00	None
3	8	5.35	1	0.5	8.75	0.0022	0.22	0.00	None
4	8	1.66	2	0.5	8.75	0.0033	0.33	0.00	None
5	4	2.81	1	0.5	8.50	0.0135	1.35	0.57	Substantial
6	4	0.33	2	0.5	8.50	0.0111	1.11	0.41	Moderate
7	7	5.55	1	0.5	8.00	0.0010	0.1	0.00	None
8	7	1.08	2	0.5	8.00	0.0261	2.61	1.00	Major
9	6	2.18	1	0.5	8.00	0.0013	0.13	0.00	None
10	6	0.69	2	0.5	8.00	0.0406	4.06	1.00	Major
11	10	4.31	1	0.5	8.42	0.0014	0.14	0.00	None
12	10	1.17	2	0.5	8.42	0.0029	0.29	0.00	None
13	5	3.08	1	0.5	8.83	0.0024	0.24	0.00	None
14	5	0.5	2	0.5	8.83	0.0101	1.01	0.34	Minor
15	3	5.3	1	0.5	8.00	0.0002	0.02	0.00	None
16	3	1.33	2	0.5	8.00	0.0055	0.55	0.03	None
17	3	5.61	1	0.5	8.00	0.0001	0.01	0.00	None
18	3	1.2	2	0.5	8.00	0.0057	0.57	0.05	None
19	4	20.56	1	0.5	8.67	0.0000	0	0.00	None
20	4	6.73	2	0.5	8.67	0.0000	0	0.00	None
21	4	27.84	1	0.5	8.67	0.0001	0.01	0.00	None
22	4	2.54	2	0.5	8.67	0.0109	1.09	0.39	Moderate
23	3	3.88	1	0.5	8.42	0.0011	0.11	0.00	None
24	3	1.37	2	0.5	8.42	0.0070	0.7	0.13	Minor
25	4	2.69	1	0.5	8.42	0.0002	0.02	0.00	None
26	4	0.74	2	0.5	8.42	0.0066	0.66	0.11	Minor

Table C- 204. Analysis Result: Northridge Earthquake (0.6g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	0.6	9.42	0.0020	0.2	0.00	None
2	8	1.03	2	0.6	9.42	0.0067	0.67	0.11	Minor
3	8	5.35	1	0.6	8.75	0.0026	0.26	0.00	None
4	8	1.66	2	0.6	8.75	0.0038	0.38	0.00	None
5	4	2.81	1	0.6	8.50	0.0191	1.91	0.94	Major
6	4	0.33	2	0.6	8.50	0.0134	1.34	0.56	Substantial
7	7	5.55	1	0.6	8.00	0.0009	0.09	0.00	None
8	7	1.08	2	0.6	8.00	0.0263	2.63	1.00	Major
9	6	2.18	1	0.6	8.00	0.0018	0.18	0.00	None
10	6	0.69	2	0.6	8.00	0.0487	4.87	1.00	Major
11	10	4.31	1	0.6	8.42	0.0016	0.16	0.00	None
12	10	1.17	2	0.6	8.42	0.0035	0.35	0.00	None
13	5	3.08	1	0.6	8.83	0.0034	0.34	0.00	None
14	5	0.5	2	0.6	8.83	0.0152	1.52	0.68	Substantial
15	3	5.3	1	0.6	8.00	0.0002	0.02	0.00	None
16	3	1.33	2	0.6	8.00	0.0066	0.66	0.11	Minor
17	3	5.61	1	0.6	8.00	0.0001	0.01	0.00	None
18	3	1.2	2	0.6	8.00	0.0080	0.8	0.20	Minor
19	4	20.56	1	0.6	8.67	0.0001	0.01	0.00	None
20	4	6.73	2	0.6	8.67	0.0000	0	0.00	None
21	4	27.84	1	0.6	8.67	0.0001	0.01	0.00	None
22	4	2.54	2	0.6	8.67	0.0131	1.31	0.54	Moderate
23	3	3.88	1	0.6	8.42	0.0015	0.15	0.00	None
24	3	1.37	2	0.6	8.42	0.0078	0.78	0.19	Minor
25	4	2.69	1	0.6	8.42	0.0004	0.04	0.00	None
26	4	0.74	2	0.6	8.42	0.0091	0.91	0.27	Minor

Table C- 205. Analysis Result: Northridge Earthquake (0.7g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	0.7	9.42	0.0023	0.23	0.00	None
2	8	1.03	2	0.7	9.42	0.0083	0.83	0.22	Minor
3	8	5.35	1	0.7	8.75	0.0035	0.35	0.00	None
4	8	1.66	2	0.7	8.75	0.0044	0.44	0.00	None
5	4	2.81	1	0.7	8.50	0.0231	2.31	1.00	Major
6	4	0.33	2	0.7	8.50	0.0171	1.71	0.81	Major
7	7	5.55	1	0.7	8.00	0.0009	0.09	0.00	None
8	7	1.08	2	0.7	8.00	0.0241	2.41	1.00	Major
9	6	2.18	1	0.7	8.00	0.0023	0.23	0.00	None
10	6	0.69	2	0.7	8.00	0.0568	5.68	1.00	Major
11	10	4.31	1	0.7	8.42	0.0019	0.19	0.00	None
12	10	1.17	2	0.7	8.42	0.0050	0.5	0.00	None
13	5	3.08	1	0.7	8.83	0.0038	0.38	0.00	None
14	5	0.5	2	0.7	8.83	0.0172	1.72	0.81	Major
15	3	5.3	1	0.7	8.00	0.0003	0.03	0.00	None
16	3	1.33	2	0.7	8.00	0.0094	0.94	0.29	Minor
17	3	5.61	1	0.7	8.00	0.0001	0.01	0.00	None
18	3	1.2	2	0.7	8.00	0.0106	1.06	0.37	Moderate
19	4	20.56	1	0.7	8.67	0.0001	0.01	0.00	None
20	4	6.73	2	0.7	8.67	0.0000	0	0.00	None
21	4	27.84	1	0.7	8.67	0.0002	0.02	0.00	None
22	4	2.54	2	0.7	8.67	0.0148	1.48	0.65	Substantial
23	3	3.88	1	0.7	8.42	0.0026	0.26	0.00	None
24	3	1.37	2	0.7	8.42	0.0100	1	0.33	Minor
25	4	2.69	1	0.7	8.42	0.0011	0.11	0.00	None
26	4	0.74	2	0.7	8.42	0.0102	1.02	0.35	Minor

Table C- 206. Analysis Result: Northridge Earthquake (0.8g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	0.8	9.42	0.0027	0.27	0.00	None
2	8	1.03	2	0.8	9.42	0.0096	0.96	0.31	Minor
3	8	5.35	1	0.8	8.75	0.0040	0.4	0.00	None
4	8	1.66	2	0.8	8.75	0.0052	0.52	0.01	None
5	4	2.81	1	0.8	8.50	0.0250	2.5	1.00	Major
6	4	0.33	2	0.8	8.50	0.0261	2.61	1.00	Major
7	7	5.55	1	0.8	8.00	0.0008	0.08	0.00	None
8	7	1.08	2	0.8	8.00	0.0216	2.16	1.00	Major
9	6	2.18	1	0.8	8.00	0.0027	0.27	0.00	None
10	6	0.69	2	0.8	8.00	0.0650	6.5	1.00	Major
11	10	4.31	1	0.8	8.42	0.0021	0.21	0.00	None
12	10	1.17	2	0.8	8.42	0.0079	0.79	0.19	Minor
13	5	3.08	1	0.8	8.83	0.0043	0.43	0.00	None
14	5	0.5	2	0.8	8.83	0.0193	1.93	0.95	Major
15	3	5.3	1	0.8	8.00	0.0003	0.03	0.00	None
16	3	1.33	2	0.8	8.00	0.0113	1.13	0.42	Moderate
17	3	5.61	1	0.8	8.00	0.0001	0.01	0.00	None
18	3	1.2	2	0.8	8.00	0.0127	1.27	0.51	Moderate
19	4	20.56	1	0.8	8.67	0.0001	0.01	0.00	None
20	4	6.73	2	0.8	8.67	0.0000	0	0.00	None
21	4	27.84	1	0.8	8.67	0.0002	0.02	0.00	None
22	4	2.54	2	0.8	8.67	0.0169	1.69	0.79	Major
23	3	3.88	1	0.8	8.42	0.0038	0.38	0.00	None
24	3	1.37	2	0.8	8.42	0.0113	1.13	0.42	Moderate
25	4	2.69	1	0.8	8.42	0.0015	0.15	0.00	None
26	4	0.74	2	0.8	8.42	0.0123	1.23	0.49	Moderate

Table C- 207. Analysis Result: Northridge Earthquake (0.9g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	0.9	9.42	0.0032	0.32	0.00	None
2	8	1.03	2	0.9	9.42	0.0095	0.95	0.30	Minor
3	8	5.35	1	0.9	8.75	0.0049	0.49	0.00	None
4	8	1.66	2	0.9	8.75	0.0062	0.62	0.08	Minor
5	4	2.81	1	0.9	8.50	0.0290	2.9	1.00	Major
6	4	0.33	2	0.9	8.50	0.0266	2.66	1.00	Major
7	7	5.55	1	0.9	8.00	0.0007	0.07	0.00	None
8	7	1.08	2	0.9	8.00	0.0276	2.76	1.00	Major
9	6	2.18	1	0.9	8.00	0.0032	0.32	0.00	None
10	6	0.69	2	0.9	8.00	0.0731	7.31	1.00	Major
11	10	4.31	1	0.9	8.42	0.0025	0.25	0.00	None
12	10	1.17	2	0.9	8.42	0.0092	0.92	0.28	Minor
13	5	3.08	1	0.9	8.83	0.0051	0.51	0.01	None
14	5	0.5	2	0.9	8.83	0.0182	1.82	0.88	Major
15	3	5.3	1	0.9	8.00	0.0004	0.04	0.00	None
16	3	1.33	2	0.9	8.00	0.0134	1.34	0.56	Substantial
17	3	5.61	1	0.9	8.00	0.0001	0.01	0.00	None
18	3	1.2	2	0.9	8.00	0.0167	1.67	0.78	Major
19	4	20.56	1	0.9	8.67	0.0001	0.01	0.00	None
20	4	6.73	2	0.9	8.67	0.0001	0.01	0.00	None
21	4	27.84	1	0.9	8.67	0.0002	0.02	0.00	None
22	4	2.54	2	0.9	8.67	0.0185	1.85	0.90	Major
23	3	3.88	1	0.9	8.42	0.0049	0.49	0.00	None
24	3	1.37	2	0.9	8.42	0.0148	1.48	0.65	Substantial
25	4	2.69	1	0.9	8.42	0.0026	0.26	0.00	None
26	4	0.74	2	0.9	8.42	0.0151	1.51	0.67	Substantial

Table C- 208. Analysis Result: Northridge Earthquake (1g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	1	9.42	0.0039	0.39	0.00	None
2	8	1.03	2	1	9.42	0.0090	0.9	0.27	Minor
3	8	5.35	1	1	8.75	0.0059	0.59	0.06	Minor
4	8	1.66	2	1	8.75	0.0092	0.92	0.28	Minor
5	4	2.81	1	1	8.50	0.0185	1.85	0.90	Major
6	4	0.33	2	1	8.50	0.0296	2.96	1.00	Major
7	7	5.55	1	1	8.00	0.0009	0.09	0.00	None
8	7	1.08	2	1	8.00	0.0324	3.24	1.00	Major
9	6	2.18	1	1	8.00	0.0034	0.34	0.00	None
10	6	0.69	2	1	8.00	0.0812	8.12	1.00	Major
11	10	4.31	1	1	8.42	0.0030	0.3	0.00	None
12	10	1.17	2	1	8.42	0.0103	1.03	0.35	Moderate
13	5	3.08	1	1	8.83	0.0063	0.63	0.09	Minor
14	5	0.5	2	1	8.83	0.0193	1.93	0.95	Major
15	3	5.3	1	1	8.00	0.0004	0.04	0.00	None
16	3	1.33	2	1	8.00	0.0169	1.69	0.79	Major
17	3	5.61	1	1	8.00	0.0001	0.01	0.00	None
18	3	1.2	2	1	8.00	0.0185	1.85	0.90	Major
19	4	20.56	1	1	8.67	0.0001	0.01	0.00	None
20	4	6.73	2	1	8.67	0.0001	0.01	0.00	None
21	4	27.84	1	1	8.67	0.0002	0.02	0.00	None
22	4	2.54	2	1	8.67	0.0217	2.17	1.00	Major
23	3	3.88	1	1	8.42	0.0056	0.56	0.04	None
24	3	1.37	2	1	8.42	0.0164	1.64	0.76	Major
25	4	2.69	1	1	8.42	0.0045	0.45	0.00	None
26	4	0.74	2	1	8.42	0.0185	1.85	0.90	Major

Table C- 209. Analysis Result: Northridge Earthquake (1.1g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	1.1	9.42	0.0046	0.46	0.00	None
2	8	1.03	2	1.1	9.42	0.0117	1.17	0.45	Moderate
3	8	5.35	1	1.1	8.75	0.0067	0.67	0.11	Minor
4	8	1.66	2	1.1	8.75	0.0110	1.1	0.40	Moderate
5	4	2.81	1	1.1	8.50	0.0200	2	1.00	Major
6	4	0.33	2	1.1	8.50	0.0342	3.42	1.00	Major
7	7	5.55	1	1.1	8.00	0.0007	0.07	0.00	None
8	7	1.08	2	1.1	8.00	0.0431	4.31	1.00	Major
9	6	2.18	1	1.1	8.00	0.0035	0.35	0.00	None
10	6	0.69	2	1.1	8.00	0.0894	8.94	1.00	Major
11	10	4.31	1	1.1	8.42	0.0035	0.35	0.00	None
12	10	1.17	2	1.1	8.42	0.0115	1.15	0.43	Moderate
13	5	3.08	1	1.1	8.83	0.0066	0.66	0.11	Minor
14	5	0.5	2	1.1	8.83	0.0248	2.48	1.00	Major
15	3	5.3	1	1.1	8.00	0.0004	0.04	0.00	None
16	3	1.33	2	1.1	8.00	0.0213	2.13	1.00	Major
17	3	5.61	1	1.1	8.00	0.0001	0.01	0.00	None
18	3	1.2	2	1.1	8.00	0.0222	2.22	1.00	Major
19	4	20.56	1	1.1	8.67	0.0001	0.01	0.00	None
20	4	6.73	2	1.1	8.67	0.0001	0.01	0.00	None
21	4	27.84	1	1.1	8.67	0.0003	0.03	0.00	None
22	4	2.54	2	1.1	8.67	0.0244	2.44	1.00	Major
23	3	3.88	1	1.1	8.42	0.0069	0.69	0.13	Minor
24	3	1.37	2	1.1	8.42	0.0203	2.03	1.00	Major
25	4	2.69	1	1.1	8.42	0.0057	0.57	0.05	None
26	4	0.74	2	1.1	8.42	0.0208	2.08	1.00	Major

Table C- 210. Analysis Result: Northridge Earthquake (1.2g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	1.2	9.42	0.0051	0.51	0.01	None
2	8	1.03	2	1.2	9.42	0.0128	1.28	0.52	Moderate
3	8	5.35	1	1.2	8.75	0.0070	0.7	0.13	Minor
4	8	1.66	2	1.2	8.75	0.0122	1.22	0.48	Moderate
5	4	2.81	1	1.2	8.50	0.0229	2.29	1.00	Major
6	4	0.33	2	1.2	8.50	0.0390	3.9	1.00	Major
7	7	5.55	1	1.2	8.00	0.0007	0.07	0.00	None
8	7	1.08	2	1.2	8.00	0.0705	7.05	1.00	Major
9	6	2.18	1	1.2	8.00	0.0037	0.37	0.00	None
10	6	0.69	2	1.2	8.00	0.0975	9.75	1.00	Major
11	10	4.31	1	1.2	8.42	0.0037	0.37	0.00	None
12	10	1.17	2	1.2	8.42	0.0126	1.26	0.51	Moderate
13	5	3.08	1	1.2	8.83	0.0074	0.74	0.16	Minor
14	5	0.5	2	1.2	8.83	0.0297	2.97	1.00	Major
15	3	5.3	1	1.2	8.00	0.0005	0.05	0.00	None
16	3	1.33	2	1.2	8.00	0.0221	2.21	1.00	Major
17	3	5.61	1	1.2	8.00	0.0001	0.01	0.00	None
18	3	1.2	2	1.2	8.00	0.0249	2.49	1.00	Major
19	4	20.56	1	1.2	8.67	0.0001	0.01	0.00	None
20	4	6.73	2	1.2	8.67	0.0001	0.01	0.00	None
21	4	27.84	1	1.2	8.67	0.0003	0.03	0.00	None
22	4	2.54	2	1.2	8.67	0.0296	2.96	1.00	Major
23	3	3.88	1	1.2	8.42	0.0083	0.83	0.22	Minor
24	3	1.37	2	1.2	8.42	0.0228	2.28	1.00	Major
25	4	2.69	1	1.2	8.42	0.0065	0.65	0.10	Minor
26	4	0.74	2	1.2	8.42	0.0243	2.43	1.00	Major

Table C- 211. Analysis Result: Northridge Earthquake (1.3g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	1.3	9.42	0.0056	0.56	0.04	None
2	8	1.03	2	1.3	9.42	0.0131	1.31	0.54	Moderate
3	8	5.35	1	1.3	8.75	0.0078	0.78	0.19	Minor
4	8	1.66	2	1.3	8.75	0.0168	1.68	0.79	Major
5	4	2.81	1	1.3	8.50	0.0260	2.6	1.00	Major
6	4	0.33	2	1.3	8.50	0.0404	4.04	1.00	Major
7	7	5.55	1	1.3	8.00	0.0008	0.08	0.00	None
8	7	1.08	2	1.3	8.00	0.0745	7.45	1.00	Major
9	6	2.18	1	1.3	8.00	0.0040	0.4	0.00	None
10	6	0.69	2	1.3	8.00	0.1056	10.56	1.00	Major
11	10	4.31	1	1.3	8.42	0.0041	0.41	0.00	None
12	10	1.17	2	1.3	8.42	0.0135	1.35	0.57	Substantial
13	5	3.08	1	1.3	8.83	0.0080	0.8	0.20	Minor
14	5	0.5	2	1.3	8.83	0.0318	3.18	1.00	Major
15	3	5.3	1	1.3	8.00	0.0006	0.06	0.00	None
16	3	1.33	2	1.3	8.00	0.0260	2.6	1.00	Major
17	3	5.61	1	1.3	8.00	0.0001	0.01	0.00	None
18	3	1.2	2	1.3	8.00	0.0273	2.73	1.00	Major
19	4	20.56	1	1.3	8.67	0.0001	0.01	0.00	None
20	4	6.73	2	1.3	8.67	0.0001	0.01	0.00	None
21	4	27.84	1	1.3	8.67	0.0003	0.03	0.00	None
22	4	2.54	2	1.3	8.67	0.0331	3.31	1.00	Major
23	3	3.88	1	1.3	8.42	0.0098	0.98	0.32	Minor
24	3	1.37	2	1.3	8.42	0.0260	2.6	1.00	Major
25	4	2.69	1	1.3	8.42	0.0087	0.87	0.25	Minor
26	4	0.74	2	1.3	8.42	0.0273	2.73	1.00	Major

Table C- 212. Analysis Result: Northridge Earthquake (1.4g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	1.4	9.42	0.0058	0.58	0.05	Minor
2	8	1.03	2	1.4	9.42	0.0136	1.36	0.57	Substantial
3	8	5.35	1	1.4	8.75	0.0080	0.8	0.20	Minor
4	8	1.66	2	1.4	8.75	0.0178	1.78	0.85	Major
5	4	2.81	1	1.4	8.50	0.0272	2.72	1.00	Major
6	4	0.33	2	1.4	8.50	0.0439	4.39	1.00	Major
7	7	5.55	1	1.4	8.00	0.0010	0.1	0.00	None
8	7	1.08	2	1.4	8.00	0.0570	5.7	1.00	Major
9	6	2.18	1	1.4	8.00	0.0041	0.41	0.00	None
10	6	0.69	2	1.4	8.00	0.1138	11.38	1.00	Major
11	10	4.31	1	1.4	8.42	0.0046	0.46	0.00	None
12	10	1.17	2	1.4	8.42	0.0132	1.32	0.55	Moderate
13	5	3.08	1	1.4	8.83	0.0097	0.97	0.31	Minor
14	5	0.5	2	1.4	8.83	0.0351	3.51	1.00	Major
15	3	5.3	1	1.4	8.00	0.0006	0.06	0.00	None
16	3	1.33	2	1.4	8.00	0.0283	2.83	1.00	Major
17	3	5.61	1	1.4	8.00	0.0002	0.02	0.00	None
18	3	1.2	2	1.4	8.00	0.0282	2.82	1.00	Major
19	4	20.56	1	1.4	8.67	0.0002	0.02	0.00	None
20	4	6.73	2	1.4	8.67	0.0001	0.01	0.00	None
21	4	27.84	1	1.4	8.67	0.0003	0.03	0.00	None
22	4	2.54	2	1.4	8.67	0.0355	3.55	1.00	Major
23	3	3.88	1	1.4	8.42	0.0110	1.1	0.40	Moderate
24	3	1.37	2	1.4	8.42	0.0283	2.83	1.00	Major
25	4	2.69	1	1.4	8.42	0.0118	1.18	0.45	Moderate
26	4	0.74	2	1.4	8.42	0.0280	2.8	1.00	Major

Table C- 213. Analysis Result: Northridge Earthquake (1.5g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	1.5	9.42	0.0068	0.68	0.12	Minor
2	8	1.03	2	1.5	9.42	0.0147	1.47	0.65	Substantial
3	8	5.35	1	1.5	8.75	0.0086	0.86	0.24	Minor
4	8	1.66	2	1.5	8.75	0.0194	1.94	0.96	Major
5	4	2.81	1	1.5	8.50	0.0442	4.42	1.00	Major
6	4	0.33	2	1.5	8.50	0.0451	4.51	1.00	Major
7	7	5.55	1	1.5	8.00	0.0009	0.09	0.00	None
8	7	1.08	2	1.5	8.00	0.0614	6.14	1.00	Major
9	6	2.18	1	1.5	8.00	0.0124	1.24	0.49	Moderate
10	6	0.69	2	1.5	8.00	0.1219	12.19	1.00	Major
11	10	4.31	1	1.5	8.42	0.0052	0.52	0.01	None
12	10	1.17	2	1.5	8.42	0.0158	1.58	0.72	Substantial
13	5	3.08	1	1.5	8.83	0.0117	1.17	0.45	Moderate
14	5	0.5	2	1.5	8.83	0.0395	3.95	1.00	Major
15	3	5.3	1	1.5	8.00	0.0007	0.07	0.00	None
16	3	1.33	2	1.5	8.00	0.0304	3.04	1.00	Major
17	3	5.61	1	1.5	8.00	0.0002	0.02	0.00	None
18	3	1.2	2	1.5	8.00	0.0319	3.19	1.00	Major
19	4	20.56	1	1.5	8.67	0.0002	0.02	0.00	None
20	4	6.73	2	1.5	8.67	0.0001	0.01	0.00	None
21	4	27.84	1	1.5	8.67	0.0004	0.04	0.00	None
22	4	2.54	2	1.5	8.67	0.0372	3.72	1.00	Major
23	3	3.88	1	1.5	8.42	0.0119	1.19	0.46	Moderate
24	3	1.37	2	1.5	8.42	0.0314	3.14	1.00	Major
25	4	2.69	1	1.5	8.42	0.0142	1.42	0.61	Substantial
26	4	0.74	2	1.5	8.42	0.0291	2.91	1.00	Major

Table C- 214. Analysis Result: Centro Earthquake (0.1g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	0.1	9.42	0.0001	0.01	0.00	None
2	8	1.03	2	0.1	9.42	0.0006	0.06	0.00	None
3	8	5.35	1	0.1	8.75	0.0003	0.03	0.00	None
4	8	1.66	2	0.1	8.75	0.0004	0.04	0.00	None
5	4	2.81	1	0.1	8.50	0.0001	0.01	0.00	None
6	4	0.33	2	0.1	8.50	0.0009	0.09	0.00	None
7	7	5.55	1	0.1	8.00	0.0003	0.03	0.00	None
8	7	1.08	2	0.1	8.00	0.0002	0.02	0.00	None
9	6	2.18	1	0.1	8.00	0.0001	0.01	0.00	None
10	6	0.69	2	0.1	8.00	0.0095	0.95	0.30	Minor
11	10	4.31	1	0.1	8.42	0.0001	0.01	0.00	None
12	10	1.17	2	0.1	8.42	0.0005	0.05	0.00	None
13	5	3.08	1	0.1	8.83	0.0001	0.01	0.00	None
14	5	0.5	2	0.1	8.83	0.0016	0.16	0.00	None
15	3	5.3	1	0.1	8.00	0.0000	0	0.00	None
16	3	1.33	2	0.1	8.00	0.0001	0.01	0.00	None
17	3	5.61	1	0.1	8.00	0.0000	0	0.00	None
18	3	1.2	2	0.1	8.00	0.0002	0.02	0.00	None
19	4	20.56	1	0.1	8.67	0.0000	0	0.00	None
20	4	6.73	2	0.1	8.67	0.0000	0	0.00	None
21	4	27.84	1	0.1	8.67	0.0000	0	0.00	None
22	4	2.54	2	0.1	8.67	0.0012	0.12	0.00	None
23	3	3.88	1	0.1	8.42	0.0001	0.01	0.00	None
24	3	1.37	2	0.1	8.42	0.0005	0.05	0.00	None
25	4	2.69	1	0.1	8.42	0.0000	0	0.00	None
26	4	0.74	2	0.1	8.42	0.0004	0.04	0.00	None

Table C- 215. Analysis Result: Centro Earthquake (0.2g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	0.2	9.42	0.0003	0.03	0.00	None
2	8	1.03	2	0.2	9.42	0.0015	0.15	0.00	None
3	8	5.35	1	0.2	8.75	0.0007	0.07	0.00	None
4	8	1.66	2	0.2	8.75	0.0013	0.13	0.00	None
5	4	2.81	1	0.2	8.50	0.0002	0.02	0.00	None
6	4	0.33	2	0.2	8.50	0.0032	0.32	0.00	None
7	7	5.55	1	0.2	8.00	0.0007	0.07	0.00	None
8	7	1.08	2	0.2	8.00	0.0004	0.04	0.00	None
9	6	2.18	1	0.2	8.00	0.0001	0.01	0.00	None
10	6	0.69	2	0.2	8.00	0.0189	1.89	0.93	Major
11	10	4.31	1	0.2	8.42	0.0002	0.02	0.00	None
12	10	1.17	2	0.2	8.42	0.0013	0.13	0.00	None
13	5	3.08	1	0.2	8.83	0.0002	0.02	0.00	None
14	5	0.5	2	0.2	8.83	0.0032	0.32	0.00	None
15	3	5.3	1	0.2	8.00	0.0001	0.01	0.00	None
16	3	1.33	2	0.2	8.00	0.0004	0.04	0.00	None
17	3	5.61	1	0.2	8.00	0.0000	0	0.00	None
18	3	1.2	2	0.2	8.00	0.0006	0.06	0.00	None
19	4	20.56	1	0.2	8.67	0.0000	0	0.00	None
20	4	6.73	2	0.2	8.67	0.0000	0	0.00	None
21	4	27.84	1	0.2	8.67	0.0000	0	0.00	None
22	4	2.54	2	0.2	8.67	0.0034	0.34	0.00	None
23	3	3.88	1	0.2	8.42	0.0003	0.03	0.00	None
24	3	1.37	2	0.2	8.42	0.0011	0.11	0.00	None
25	4	2.69	1	0.2	8.42	0.0001	0.01	0.00	None
26	4	0.74	2	0.2	8.42	0.0013	0.13	0.00	None

Table C- 216. Analysis Result: Centro Earthquake (0.3g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	0.3	9.42	0.0007	0.07	0.00	None
2	8	1.03	2	0.3	9.42	0.0026	0.26	0.00	None
3	8	5.35	1	0.3	8.75	0.0018	0.18	0.00	None
4	8	1.66	2	0.3	8.75	0.0021	0.21	0.00	None
5	4	2.81	1	0.3	8.50	0.0004	0.04	0.00	None
6	4	0.33	2	0.3	8.50	0.0068	0.68	0.12	Minor
7	7	5.55	1	0.3	8.00	0.0009	0.09	0.00	None
8	7	1.08	2	0.3	8.00	0.0075	0.75	0.17	Minor
9	6	2.18	1	0.3	8.00	0.0002	0.02	0.00	None
10	6	0.69	2	0.3	8.00	0.0284	2.84	1.00	Major
11	10	4.31	1	0.3	8.42	0.0005	0.05	0.00	None
12	10	1.17	2	0.3	8.42	0.0017	0.17	0.00	None
13	5	3.08	1	0.3	8.83	0.0004	0.04	0.00	None
14	5	0.5	2	0.3	8.83	0.0062	0.62	0.08	Minor
15	3	5.3	1	0.3	8.00	0.0001	0.01	0.00	None
16	3	1.33	2	0.3	8.00	0.0010	0.1	0.00	None
17	3	5.61	1	0.3	8.00	0.0000	0	0.00	None
18	3	1.2	2	0.3	8.00	0.0013	0.13	0.00	None
19	4	20.56	1	0.3	8.67	0.0000	0	0.00	None
20	4	6.73	2	0.3	8.67	0.0000	0	0.00	None
21	4	27.84	1	0.3	8.67	0.0001	0.01	0.00	None
22	4	2.54	2	0.3	8.67	0.0049	0.49	0.00	None
23	3	3.88	1	0.3	8.42	0.0004	0.04	0.00	None
24	3	1.37	2	0.3	8.42	0.0022	0.22	0.00	None
25	4	2.69	1	0.3	8.42	0.0001	0.01	0.00	None
26	4	0.74	2	0.3	8.42	0.0028	0.28	0.00	None

Table C- 217. Analysis Result: Centro Earthquake (0.4g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	0.4	9.42	0.0011	0.11	0.00	None
2	8	1.03	2	0.4	9.42	0.0036	0.36	0.00	None
3	8	5.35	1	0.4	8.75	0.0023	0.23	0.00	None
4	8	1.66	2	0.4	8.75	0.0027	0.27	0.00	None
5	4	2.81	1	0.4	8.50	0.0005	0.05	0.00	None
6	4	0.33	2	0.4	8.50	0.0092	0.92	0.28	Minor
7	7	5.55	1	0.4	8.00	0.0007	0.07	0.00	None
8	7	1.08	2	0.4	8.00	0.0185	1.85	0.90	Major
9	6	2.18	1	0.4	8.00	0.0004	0.04	0.00	None
10	6	0.69	2	0.4	8.00	0.0378	3.78	1.00	Major
11	10	4.31	1	0.4	8.42	0.0009	0.09	0.00	None
12	10	1.17	2	0.4	8.42	0.0022	0.22	0.00	None
13	5	3.08	1	0.4	8.83	0.0007	0.07	0.00	None
14	5	0.5	2	0.4	8.83	0.0082	0.82	0.21	Minor
15	3	5.3	1	0.4	8.00	0.0001	0.01	0.00	None
16	3	1.33	2	0.4	8.00	0.0029	0.29	0.00	None
17	3	5.61	1	0.4	8.00	0.0001	0.01	0.00	None
18	3	1.2	2	0.4	8.00	0.0030	0.3	0.00	None
19	4	20.56	1	0.4	8.67	0.0000	0	0.00	None
20	4	6.73	2	0.4	8.67	0.0000	0	0.00	None
21	4	27.84	1	0.4	8.67	0.0001	0.01	0.00	None
22	4	2.54	2	0.4	8.67	0.0080	0.8	0.20	Minor
23	3	3.88	1	0.4	8.42	0.0006	0.06	0.00	None
24	3	1.37	2	0.4	8.42	0.0036	0.36	0.00	None
25	4	2.69	1	0.4	8.42	0.0002	0.02	0.00	None
26	4	0.74	2	0.4	8.42	0.0057	0.57	0.05	None

Table C- 218. Analysis Result: Centro Earthquake (0.5g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	0.5	9.42	0.0017	0.17	0.00	None
2	8	1.03	2	0.5	9.42	0.0045	0.45	0.00	None
3	8	5.35	1	0.5	8.75	0.0028	0.28	0.00	None
4	8	1.66	2	0.5	8.75	0.0031	0.31	0.00	None
5	4	2.81	1	0.5	8.50	0.0159	1.59	0.73	Substantial
6	4	0.33	2	0.5	8.50	0.0108	1.08	0.39	Moderate
7	7	5.55	1	0.5	8.00	0.0011	0.11	0.00	None
8	7	1.08	2	0.5	8.00	0.0250	2.5	1.00	Major
9	6	2.18	1	0.5	8.00	0.0007	0.07	0.00	None
10	6	0.69	2	0.5	8.00	0.0474	4.74	1.00	Major
11	10	4.31	1	0.5	8.42	0.0014	0.14	0.00	None
12	10	1.17	2	0.5	8.42	0.0029	0.29	0.00	None
13	5	3.08	1	0.5	8.83	0.0012	0.12	0.00	None
14	5	0.5	2	0.5	8.83	0.0108	1.08	0.39	Moderate
15	3	5.3	1	0.5	8.00	0.0002	0.02	0.00	None
16	3	1.33	2	0.5	8.00	0.0042	0.42	0.00	None
17	3	5.61	1	0.5	8.00	0.0001	0.01	0.00	None
18	3	1.2	2	0.5	8.00	0.0069	0.69	0.13	Minor
19	4	20.56	1	0.5	8.67	0.0001	0.01	0.00	None
20	4	6.73	2	0.5	8.67	0.0000	0	0.00	None
21	4	27.84	1	0.5	8.67	0.0001	0.01	0.00	None
22	4	2.54	2	0.5	8.67	0.0114	1.14	0.43	Moderate
23	3	3.88	1	0.5	8.42	0.0008	0.08	0.00	None
24	3	1.37	2	0.5	8.42	0.0081	0.81	0.21	Minor
25	4	2.69	1	0.5	8.42	0.0003	0.03	0.00	None
26	4	0.74	2	0.5	8.42	0.0071	0.71	0.14	Minor

Table C- 219. Analysis Result: Centro Earthquake (0.6g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	0.6	9.42	0.0024	0.24	0.00	None
2	8	1.03	2	0.6	9.42	0.0050	0.5	0.00	None
3	8	5.35	1	0.6	8.75	0.0036	0.36	0.00	None
4	8	1.66	2	0.6	8.75	0.0040	0.4	0.00	None
5	4	2.81	1	0.6	8.50	0.0178	1.78	0.85	Major
6	4	0.33	2	0.6	8.50	0.0151	1.51	0.67	Substantial
7	7	5.55	1	0.6	8.00	0.0011	0.11	0.00	None
8	7	1.08	2	0.6	8.00	0.0306	3.06	1.00	Major
9	6	2.18	1	0.6	8.00	0.0008	0.08	0.00	None
10	6	0.69	2	0.6	8.00	0.0568	5.68	1.00	Major
11	10	4.31	1	0.6	8.42	0.0019	0.19	0.00	None
12	10	1.17	2	0.6	8.42	0.0037	0.37	0.00	None
13	5	3.08	1	0.6	8.83	0.0018	0.18	0.00	None
14	5	0.5	2	0.6	8.83	0.0133	1.33	0.55	Substantial
15	3	5.3	1	0.6	8.00	0.0002	0.02	0.00	None
16	3	1.33	2	0.6	8.00	0.0078	0.78	0.19	Minor
17	3	5.61	1	0.6	8.00	0.0001	0.01	0.00	None
18	3	1.2	2	0.6	8.00	0.0101	1.01	0.34	Minor
19	4	20.56	1	0.6	8.67	0.0001	0.01	0.00	None
20	4	6.73	2	0.6	8.67	0.0000	0	0.00	None
21	4	27.84	1	0.6	8.67	0.0002	0.02	0.00	None
22	4	2.54	2	0.6	8.67	0.0130	1.3	0.53	Moderate
23	3	3.88	1	0.6	8.42	0.0010	0.1	0.00	None
24	3	1.37	2	0.6	8.42	0.0116	1.16	0.44	Moderate
25	4	2.69	1	0.6	8.42	0.0006	0.06	0.00	None
26	4	0.74	2	0.6	8.42	0.0107	1.07	0.38	Moderate

Table C- 220. Analysis Result: Centro Earthquake (0.7g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	0.7	9.42	0.0029	0.29	0.00	None
2	8	1.03	2	0.7	9.42	0.0053	0.53	0.02	None
3	8	5.35	1	0.7	8.75	0.0042	0.42	0.00	None
4	8	1.66	2	0.7	8.75	0.0049	0.49	0.00	None
5	4	2.81	1	0.7	8.50	0.0241	2.41	1.00	Major
6	4	0.33	2	0.7	8.50	0.0143	1.43	0.62	Substantial
7	7	5.55	1	0.7	8.00	0.0008	0.08	0.00	None
8	7	1.08	2	0.7	8.00	0.0431	4.31	1.00	Major
9	6	2.18	1	0.7	8.00	0.0012	0.12	0.00	None
10	6	0.69	2	0.7	8.00	0.0663	6.63	1.00	Major
11	10	4.31	1	0.7	8.42	0.0023	0.23	0.00	None
12	10	1.17	2	0.7	8.42	0.0041	0.41	0.00	None
13	5	3.08	1	0.7	8.83	0.0025	0.25	0.00	None
14	5	0.5	2	0.7	8.83	0.0124	1.24	0.49	Moderate
15	3	5.3	1	0.7	8.00	0.0003	0.03	0.00	None
16	3	1.33	2	0.7	8.00	0.0109	1.09	0.39	Moderate
17	3	5.61	1	0.7	8.00	0.0001	0.01	0.00	None
18	3	1.2	2	0.7	8.00	0.0128	1.28	0.52	Moderate
19	4	20.56	1	0.7	8.67	0.0001	0.01	0.00	None
20	4	6.73	2	0.7	8.67	0.0000	0	0.00	None
21	4	27.84	1	0.7	8.67	0.0002	0.02	0.00	None
22	4	2.54	2	0.7	8.67	0.0151	1.51	0.67	Substantial
23	3	3.88	1	0.7	8.42	0.0015	0.15	0.00	None
24	3	1.37	2	0.7	8.42	0.0148	1.48	0.65	Substantial
25	4	2.69	1	0.7	8.42	0.0007	0.07	0.00	None
26	4	0.74	2	0.7	8.42	0.0129	1.29	0.53	Moderate

Table C- 221. Analysis Result: Centro Earthquake (0.8g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	0.8	9.42	0.0032	0.32	0.00	None
2	8	1.03	2	0.8	9.42	0.0067	0.67	0.11	Minor
3	8	5.35	1	0.8	8.75	0.0051	0.51	0.01	None
4	8	1.66	2	0.8	8.75	0.0057	0.57	0.05	None
5	4	2.81	1	0.8	8.50	0.0220	2.2	1.00	Major
6	4	0.33	2	0.8	8.50	0.0150	1.5	0.67	Substantial
7	7	5.55	1	0.8	8.00	0.0009	0.09	0.00	None
8	7	1.08	2	0.8	8.00	0.0516	5.16	1.00	Major
9	6	2.18	1	0.8	8.00	0.0016	0.16	0.00	None
10	6	0.69	2	0.8	8.00	0.0757	7.57	1.00	Major
11	10	4.31	1	0.8	8.42	0.0025	0.25	0.00	None
12	10	1.17	2	0.8	8.42	0.0045	0.45	0.00	None
13	5	3.08	1	0.8	8.83	0.0038	0.38	0.00	None
14	5	0.5	2	0.8	8.83	0.0147	1.47	0.65	Substantial
15	3	5.3	1	0.8	8.00	0.0003	0.03	0.00	None
16	3	1.33	2	0.8	8.00	0.0147	1.47	0.65	Substantial
17	3	5.61	1	0.8	8.00	0.0001	0.01	0.00	None
18	3	1.2	2	0.8	8.00	0.0160	1.6	0.73	Substantial
19	4	20.56	1	0.8	8.67	0.0001	0.01	0.00	None
20	4	6.73	2	0.8	8.67	0.0001	0.01	0.00	None
21	4	27.84	1	0.8	8.67	0.0002	0.02	0.00	None
22	4	2.54	2	0.8	8.67	0.0175	1.75	0.83	Major
23	3	3.88	1	0.8	8.42	0.0019	0.19	0.00	None
24	3	1.37	2	0.8	8.42	0.0156	1.56	0.71	Substantial
25	4	2.69	1	0.8	8.42	0.0011	0.11	0.00	None
26	4	0.74	2	0.8	8.42	0.0152	1.52	0.68	Substantial

Table C- 222. Analysis Result: Centro Earthquake (0.9g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	0.9	9.42	0.0038	0.38	0.00	None
2	8	1.03	2	0.9	9.42	0.0083	0.83	0.22	Minor
3	8	5.35	1	0.9	8.75	0.0057	0.57	0.05	None
4	8	1.66	2	0.9	8.75	0.0065	0.65	0.10	Minor
5	4	2.81	1	0.9	8.50	0.0220	2.2	1.00	Major
6	4	0.33	2	0.9	8.50	0.0167	1.67	0.78	Major
7	7	5.55	1	0.9	8.00	0.0009	0.09	0.00	None
8	7	1.08	2	0.9	8.00	0.0552	5.52	1.00	Major
9	6	2.18	1	0.9	8.00	0.0019	0.19	0.00	None
10	6	0.69	2	0.9	8.00	0.0851	8.51	1.00	Major
11	10	4.31	1	0.9	8.42	0.0030	0.3	0.00	None
12	10	1.17	2	0.9	8.42	0.0045	0.45	0.00	None
13	5	3.08	1	0.9	8.83	0.0038	0.38	0.00	None
14	5	0.5	2	0.9	8.83	0.0199	1.99	0.99	Major
15	3	5.3	1	0.9	8.00	0.0004	0.04	0.00	None
16	3	1.33	2	0.9	8.00	0.0177	1.77	0.85	Major
17	3	5.61	1	0.9	8.00	0.0001	0.01	0.00	None
18	3	1.2	2	0.9	8.00	0.0179	1.79	0.86	Major
19	4	20.56	1	0.9	8.67	0.0001	0.01	0.00	None
20	4	6.73	2	0.9	8.67	0.0001	0.01	0.00	None
21	4	27.84	1	0.9	8.67	0.0002	0.02	0.00	None
22	4	2.54	2	0.9	8.67	0.0175	1.75	0.83	Major
23	3	3.88	1	0.9	8.42	0.0019	0.19	0.00	None
24	3	1.37	2	0.9	8.42	0.0156	1.56	0.71	Substantial
25	4	2.69	1	0.9	8.42	0.0015	0.15	0.00	None
26	4	0.74	2	0.9	8.42	0.0172	1.72	0.81	Major

Table C- 223. Analysis Result: Centro Earthquake (1g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	1	9.42	0.0048	0.48	0.00	None
2	8	1.03	2	1	9.42	0.0103	1.03	0.35	Moderate
3	8	5.35	1	1	8.75	0.0065	0.65	0.10	Minor
4	8	1.66	2	1	8.75	0.0074	0.74	0.16	Minor
5	4	2.81	1	1	8.50	0.0274	2.74	1.00	Major
6	4	0.33	2	1	8.50	0.0189	1.89	0.93	Major
7	7	5.55	1	1	8.00	0.0008	0.08	0.00	None
8	7	1.08	2	1	8.00	0.0608	6.08	1.00	Major
9	6	2.18	1	1	8.00	0.0023	0.23	0.00	None
10	6	0.69	2	1	8.00	0.0945	9.45	1.00	Major
11	10	4.31	1	1	8.42	0.0038	0.38	0.00	None
12	10	1.17	2	1	8.42	0.0055	0.55	0.03	None
13	5	3.08	1	1	8.83	0.0074	0.74	0.16	Minor
14	5	0.5	2	1	8.83	0.0272	2.72	1.00	Major
15	3	5.3	1	1	8.00	0.0005	0.05	0.00	None
16	3	1.33	2	1	8.00	0.0193	1.93	0.95	Major
17	3	5.61	1	1	8.00	0.0001	0.01	0.00	None
18	3	1.2	2	1	8.00	0.0200	2	1.00	Major
19	4	20.56	1	1	8.67	0.0001	0.01	0.00	None
20	4	6.73	2	1	8.67	0.0001	0.01	0.00	None
21	4	27.84	1	1	8.67	0.0003	0.03	0.00	None
22	4	2.54	2	1	8.67	0.0227	2.27	1.00	Major
23	3	3.88	1	1	8.42	0.0027	0.27	0.00	None
24	3	1.37	2	1	8.42	0.0219	2.19	1.00	Major
25	4	2.69	1	1	8.42	0.0019	0.19	0.00	None
26	4	0.74	2	1	8.42	0.0185	1.85	0.90	Major

Table C- 224. Analysis Result: Centro Earthquake (1.1g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	1.1	9.42	0.0053	0.53	0.02	None
2	8	1.03	2	1.1	9.42	0.0062	0.62	0.08	Minor
3	8	5.35	1	1.1	8.75	0.0071	0.71	0.14	Minor
4	8	1.66	2	1.1	8.75	0.0084	0.84	0.23	Minor
5	4	2.81	1	1.1	8.50	0.0365	3.65	1.00	Major
6	4	0.33	2	1.1	8.50	0.0307	3.07	1.00	Major
7	7	5.55	1	1.1	8.00	0.0008	0.08	0.00	None
8	7	1.08	2	1.1	8.00	0.0668	6.68	1.00	Major
9	6	2.18	1	1.1	8.00	0.0028	0.28	0.00	None
10	6	0.69	2	1.1	8.00	0.1039	10.39	1.00	Major
11	10	4.31	1	1.1	8.42	0.0042	0.42	0.00	None
12	10	1.17	2	1.1	8.42	0.0070	0.7	0.13	Minor
13	5	3.08	1	1.1	8.83	0.0083	0.83	0.22	Minor
14	5	0.5	2	1.1	8.83	0.0336	3.36	1.00	Major
15	3	5.3	1	1.1	8.00	0.0005	0.05	0.00	None
16	3	1.33	2	1.1	8.00	0.0210	2.1	1.00	Major
17	3	5.61	1	1.1	8.00	0.0002	0.02	0.00	None
18	3	1.2	2	1.1	8.00	0.0263	2.63	1.00	Major
19	4	20.56	1	1.1	8.67	0.0001	0.01	0.00	None
20	4	6.73	2	1.1	8.67	0.0001	0.01	0.00	None
21	4	27.84	1	1.1	8.67	0.0003	0.03	0.00	None
22	4	2.54	2	1.1	8.67	0.0292	2.92	1.00	Major
23	3	3.88	1	1.1	8.42	0.0029	0.29	0.00	None
24	3	1.37	2	1.1	8.42	0.0282	2.82	1.00	Major
25	4	2.69	1	1.1	8.42	0.0028	0.28	0.00	None
26	4	0.74	2	1.1	8.42	0.0194	1.94	0.96	Major

Table C- 225. Analysis Result: Centro Earthquake (1.2g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	1.2	9.42	0.0061	0.61	0.07	Minor
2	8	1.03	2	1.2	9.42	0.0163	1.63	0.75	Major
3	8	5.35	1	1.2	8.75	0.0076	0.76	0.17	Minor
4	8	1.66	2	1.2	8.75	0.0090	0.9	0.27	Minor
5	4	2.81	1	1.2	8.50	0.0405	4.05	1.00	Major
6	4	0.33	2	1.2	8.50	0.0454	4.54	1.00	Major
7	7	5.55	1	1.2	8.00	0.0008	0.08	0.00	None
8	7	1.08	2	1.2	8.00	0.0714	7.14	1.00	Major
9	6	2.18	1	1.2	8.00	0.0035	0.35	0.00	None
10	6	0.69	2	1.2	8.00	0.1133	11.33	1.00	Major
11	10	4.31	1	1.2	8.42	0.0045	0.45	0.00	None
12	10	1.17	2	1.2	8.42	0.0077	0.77	0.18	Minor
13	5	3.08	1	1.2	8.83	0.0096	0.96	0.31	Minor
14	5	0.5	2	1.2	8.83	0.0333	3.33	1.00	Major
15	3	5.3	1	1.2	8.00	0.0006	0.06	0.00	None
16	3	1.33	2	1.2	8.00	0.0259	2.59	1.00	Major
17	3	5.61	1	1.2	8.00	0.0002	0.02	0.00	None
18	3	1.2	2	1.2	8.00	0.0264	2.64	1.00	Major
19	4	20.56	1	1.2	8.67	0.0002	0.02	0.00	None
20	4	6.73	2	1.2	8.67	0.0001	0.01	0.00	None
21	4	27.84	1	1.2	8.67	0.0003	0.03	0.00	None
22	4	2.54	2	1.2	8.67	0.0339	3.39	1.00	Major
23	3	3.88	1	1.2	8.42	0.0034	0.34	0.00	None
24	3	1.37	2	1.2	8.42	0.0285	2.85	1.00	Major
25	4	2.69	1	1.2	8.42	0.0032	0.32	0.00	None
26	4	0.74	2	1.2	8.42	0.0216	2.16	1.00	Major

Table C- 226. Analysis Result: Centro Earthquake (1.3g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	1.3	9.42	0.0067	0.67	0.11	Minor
2	8	1.03	2	1.3	9.42	0.0186	1.86	0.91	Major
3	8	5.35	1	1.3	8.75	0.0081	0.81	0.21	Minor
4	8	1.66	2	1.3	8.75	0.0093	0.93	0.29	Minor
5	4	2.81	1	1.3	8.50	0.0407	4.07	1.00	Major
6	4	0.33	2	1.3	8.50	0.0423	4.23	1.00	Major
7	7	5.55	1	1.3	8.00	0.0012	0.12	0.00	None
8	7	1.08	2	1.3	8.00	0.0766	7.66	1.00	Major
9	6	2.18	1	1.3	8.00	0.0115	1.15	0.43	Moderate
10	6	0.69	2	1.3	8.00	0.1227	12.27	1.00	Major
11	10	4.31	1	1.3	8.42	0.0051	0.51	0.01	None
12	10	1.17	2	1.3	8.42	0.0098	0.98	0.32	Minor
13	5	3.08	1	1.3	8.83	0.0097	0.97	0.31	Minor
14	5	0.5	2	1.3	8.83	0.0405	4.05	1.00	Major
15	3	5.3	1	1.3	8.00	0.0006	0.06	0.00	None
16	3	1.33	2	1.3	8.00	0.0333	3.33	1.00	Major
17	3	5.61	1	1.3	8.00	0.0013	0.13	0.00	None
18	3	1.2	2	1.3	8.00	0.0356	3.56	1.00	Major
19	4	20.56	1	1.3	8.67	0.0004	0.04	0.00	None
20	4	6.73	2	1.3	8.67	0.0001	0.01	0.00	None
21	4	27.84	1	1.3	8.67	0.0003	0.03	0.00	None
22	4	2.54	2	1.3	8.67	0.0365	3.65	1.00	Major
23	3	3.88	1	1.3	8.42	0.0045	0.45	0.00	None
24	3	1.37	2	1.3	8.42	0.0310	3.1	1.00	Major
25	4	2.69	1	1.3	8.42	0.0120	1.2	0.47	Moderate
26	4	0.74	2	1.3	8.42	0.0233	2.33	1.00	Major

Table C- 227. Analysis Result: Centro Earthquake (1.4g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	1.4	9.42	0.0069	0.69	0.13	Minor
2	8	1.03	2	1.4	9.42	0.0201	2.01	1.00	Major
3	8	5.35	1	1.4	8.75	0.0085	0.85	0.23	Minor
4	8	1.66	2	1.4	8.75	0.0104	1.04	0.36	Moderate
5	4	2.81	1	1.4	8.50	0.0456	4.56	1.00	Major
6	4	0.33	2	1.4	8.50	0.0510	5.1	1.00	Major
7	7	5.55	1	1.4	8.00	0.0016	0.16	0.00	None
8	7	1.08	2	1.4	8.00	0.0791	7.91	1.00	Major
9	6	2.18	1	1.4	8.00	0.0175	1.75	0.83	Major
10	6	0.69	2	1.4	8.00	0.1321	13.21	1.00	Major
11	10	4.31	1	1.4	8.42	0.0053	0.53	0.02	None
12	10	1.17	2	1.4	8.42	0.0112	1.12	0.41	Moderate
13	5	3.08	1	1.4	8.83	0.0101	1.01	0.34	Minor
14	5	0.5	2	1.4	8.83	0.0445	4.45	1.00	Major
15	3	5.3	1	1.4	8.00	0.0007	0.07	0.00	None
16	3	1.33	2	1.4	8.00	0.0347	3.47	1.00	Major
17	3	5.61	1	1.4	8.00	0.0041	0.41	0.00	None
18	3	1.2	2	1.4	8.00	0.0377	3.77	1.00	Major
19	4	20.56	1	1.4	8.67	0.0004	0.04	0.00	None
20	4	6.73	2	1.4	8.67	0.0001	0.01	0.00	None
21	4	27.84	1	1.4	8.67	0.0004	0.04	0.00	None
22	4	2.54	2	1.4	8.67	0.0329	3.29	1.00	Major
23	3	3.88	1	1.4	8.42	0.0055	0.55	0.03	None
24	3	1.37	2	1.4	8.42	0.0315	3.15	1.00	Major
25	4	2.69	1	1.4	8.42	0.0055	0.55	0.03	None
26	4	0.74	2	1.4	8.42	0.0251	2.51	1.00	Major

Table C- 228. Analysis Result: Centro Earthquake (1.5g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	1.5	9.42	0.0072	0.72	0.15	Minor
2	8	1.03	2	1.5	9.42	0.0211	2.11	1.00	Major
3	8	5.35	1	1.5	8.75	0.0089	0.89	0.26	Minor
4	8	1.66	2	1.5	8.75	0.0098	0.98	0.32	Minor
5	4	2.81	1	1.5	8.50	0.0489	4.89	1.00	Major
6	4	0.33	2	1.5	8.50	0.0534	5.34	1.00	Major
7	7	5.55	1	1.5	8.00	0.0012	0.12	0.00	None
8	7	1.08	2	1.5	8.00	0.0815	8.15	1.00	Major
9	6	2.18	1	1.5	8.00	0.0215	2.15	1.00	Major
10	6	0.69	2	1.5	8.00	0.1416	14.16	1.00	Major
11	10	4.31	1	1.5	8.42	0.0057	0.57	0.05	None
12	10	1.17	2	1.5	8.42	0.0139	1.39	0.59	Substantial
13	5	3.08	1	1.5	8.83	0.0110	1.1	0.40	Moderate
14	5	0.5	2	1.5	8.83	0.0473	4.73	1.00	Major
15	3	5.3	1	1.5	8.00	0.0010	0.1	0.00	None
16	3	1.33	2	1.5	8.00	0.0383	3.83	1.00	Major
17	3	5.61	1	1.5	8.00	0.0049	0.49	0.00	None
18	3	1.2	2	1.5	8.00	0.0382	3.82	1.00	Major
19	4	20.56	1	1.5	8.67	0.0008	0.08	0.00	None
20	4	6.73	2	1.5	8.67	0.0001	0.01	0.00	None
21	4	27.84	1	1.5	8.67	0.0004	0.04	0.00	None
22	4	2.54	2	1.5	8.67	0.0346	3.46	1.00	Major
23	3	3.88	1	1.5	8.42	0.0063	0.63	0.09	Minor
24	3	1.37	2	1.5	8.42	0.0337	3.37	1.00	Major
25	4	2.69	1	1.5	8.42	0.0128	1.28	0.52	Moderate
26	4	0.74	2	1.5	8.42	0.0270	2.7	1.00	Major

Table C- 229. Analysis Result: San Salvador Earthquake (0.1g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	0.1	9.42	0.0002	0.02	0.00	None
2	8	1.03	2	0.1	9.42	0.0004	0.04	0.00	None
3	8	5.35	1	0.1	8.75	0.0003	0.03	0.00	None
4	8	1.66	2	0.1	8.75	0.0003	0.03	0.00	None
5	4	2.81	1	0.1	8.50	0.0001	0.01	0.00	None
6	4	0.33	2	0.1	8.50	0.0013	0.13	0.00	None
7	7	5.55	1	0.1	8.00	0.0005	0.05	0.00	None
8	7	1.08	2	0.1	8.00	0.0002	0.02	0.00	None
9	6	2.18	1	0.1	8.00	0.0000	0	0.00	None
10	6	0.69	2	0.1	8.00	0.0050	0.5	0.00	None
11	10	4.31	1	0.1	8.42	0.0001	0.01	0.00	None
12	10	1.17	2	0.1	8.42	0.0005	0.05	0.00	None
13	5	3.08	1	0.1	8.83	0.0000	0	0.00	None
14	5	0.5	2	0.1	8.83	0.0009	0.09	0.00	None
15	3	5.3	1	0.1	8.00	0.0000	0	0.00	None
16	3	1.33	2	0.1	8.00	0.0001	0.01	0.00	None
17	3	5.61	1	0.1	8.00	0.0000	0	0.00	None
18	3	1.2	2	0.1	8.00	0.0001	0.01	0.00	None
19	4	20.56	1	0.1	8.67	0.0000	0	0.00	None
20	4	6.73	2	0.1	8.67	0.0000	0	0.00	None
21	4	27.84	1	0.1	8.67	0.0000	0	0.00	None
22	4	2.54	2	0.1	8.67	0.0010	0.1	0.00	None
23	3	3.88	1	0.1	8.42	0.0001	0.01	0.00	None
24	3	1.37	2	0.1	8.42	0.0008	0.08	0.00	None
25	4	2.69	1	0.1	8.42	0.0000	0	0.00	None
26	4	0.74	2	0.1	8.42	0.0006	0.06	0.00	None

Table C- 230. Analysis Result: San Salvador Earthquake (0.2g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	0.2	9.42	0.0006	0.06	0.00	None
2	8	1.03	2	0.2	9.42	0.0008	0.08	0.00	None
3	8	5.35	1	0.2	8.75	0.0005	0.05	0.00	None
4	8	1.66	2	0.2	8.75	0.0006	0.06	0.00	None
5	4	2.81	1	0.2	8.50	0.0003	0.03	0.00	None
6	4	0.33	2	0.2	8.50	0.0032	0.32	0.00	None
7	7	5.55	1	0.2	8.00	0.0008	0.08	0.00	None
8	7	1.08	2	0.2	8.00	0.0005	0.05	0.00	None
9	6	2.18	1	0.2	8.00	0.0001	0.01	0.00	None
10	6	0.69	2	0.2	8.00	0.0099	0.99	0.33	Minor
11	10	4.31	1	0.2	8.42	0.0004	0.04	0.00	None
12	10	1.17	2	0.2	8.42	0.0008	0.08	0.00	None
13	5	3.08	1	0.2	8.83	0.0001	0.01	0.00	None
14	5	0.5	2	0.2	8.83	0.0023	0.23	0.00	None
15	3	5.3	1	0.2	8.00	0.0000	0	0.00	None
16	3	1.33	2	0.2	8.00	0.0002	0.02	0.00	None
17	3	5.61	1	0.2	8.00	0.0000	0	0.00	None
18	3	1.2	2	0.2	8.00	0.0002	0.02	0.00	None
19	4	20.56	1	0.2	8.67	0.0000	0	0.00	None
20	4	6.73	2	0.2	8.67	0.0000	0	0.00	None
21	4	27.84	1	0.2	8.67	0.0000	0	0.00	None
22	4	2.54	2	0.2	8.67	0.0026	0.26	0.00	None
23	3	3.88	1	0.2	8.42	0.0002	0.02	0.00	None
24	3	1.37	2	0.2	8.42	0.0032	0.32	0.00	None
25	4	2.69	1	0.2	8.42	0.0001	0.01	0.00	None
26	4	0.74	2	0.2	8.42	0.0026	0.26	0.00	None

Table C- 231. Analysis Results: San Salvador Earthquake (0.3g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	0.3	9.42	0.0012	0.12	0.00	None
2	8	1.03	2	0.3	9.42	0.0011	0.11	0.00	None
3	8	5.35	1	0.3	8.75	0.0017	0.17	0.00	None
4	8	1.66	2	0.3	8.75	0.0012	0.12	0.00	None
5	4	2.81	1	0.3	8.50	0.0003	0.03	0.00	None
6	4	0.33	2	0.3	8.50	0.0039	0.39	0.00	None
7	7	5.55	1	0.3	8.00	0.0009	0.09	0.00	None
8	7	1.08	2	0.3	8.00	0.0185	1.85	0.90	Major
9	6	2.18	1	0.3	8.00	0.0001	0.01	0.00	None
10	6	0.69	2	0.3	8.00	0.0149	1.49	0.66	Substantial
11	10	4.31	1	0.3	8.42	0.0010	0.1	0.00	None
12	10	1.17	2	0.3	8.42	0.0012	0.12	0.00	None
13	5	3.08	1	0.3	8.83	0.0002	0.02	0.00	None
14	5	0.5	2	0.3	8.83	0.0028	0.28	0.00	None
15	3	5.3	1	0.3	8.00	0.0001	0.01	0.00	None
16	3	1.33	2	0.3	8.00	0.0009	0.09	0.00	None
17	3	5.61	1	0.3	8.00	0.0000	0	0.00	None
18	3	1.2	2	0.3	8.00	0.0033	0.33	0.00	None
19	4	20.56	1	0.3	8.67	0.0000	0	0.00	None
20	4	6.73	2	0.3	8.67	0.0000	0	0.00	None
21	4	27.84	1	0.3	8.67	0.0001	0.01	0.00	None
22	4	2.54	2	0.3	8.67	0.0047	0.47	0.00	None
23	3	3.88	1	0.3	8.42	0.0002	0.02	0.00	None
24	3	1.37	2	0.3	8.42	0.0040	0.4	0.00	None
25	4	2.69	1	0.3	8.42	0.0001	0.01	0.00	None
26	4	0.74	2	0.3	8.42	0.0036	0.36	0.00	None

Table C- 232. Analysis Result: San Salvador Earthquake (0.4g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	0.4	9.42	0.0013	0.13	0.00	None
2	8	1.03	2	0.4	9.42	0.0015	0.15	0.00	None
3	8	5.35	1	0.4	8.75	0.0026	0.26	0.00	None
4	8	1.66	2	0.4	8.75	0.0016	0.16	0.00	None
5	4	2.81	1	0.4	8.50	0.0005	0.05	0.00	None
6	4	0.33	2	0.4	8.50	0.0062	0.62	0.08	Minor
7	7	5.55	1	0.4	8.00	0.0007	0.07	0.00	None
8	7	1.08	2	0.4	8.00	0.0153	1.53	0.69	Substantial
9	6	2.18	1	0.4	8.00	0.0002	0.02	0.00	None
10	6	0.69	2	0.4	8.00	0.0198	1.98	0.99	Major
11	10	4.31	1	0.4	8.42	0.0011	0.11	0.00	None
12	10	1.17	2	0.4	8.42	0.0015	0.15	0.00	None
13	5	3.08	1	0.4	8.83	0.0007	0.07	0.00	None
14	5	0.5	2	0.4	8.83	0.0040	0.4	0.00	None
15	3	5.3	1	0.4	8.00	0.0001	0.01	0.00	None
16	3	1.33	2	0.4	8.00	0.0055	0.55	0.03	None
17	3	5.61	1	0.4	8.00	0.0000	0	0.00	None
18	3	1.2	2	0.4	8.00	0.0061	0.61	0.07	Minor
19	4	20.56	1	0.4	8.67	0.0000	0	0.00	None
20	4	6.73	2	0.4	8.67	0.0000	0	0.00	None
21	4	27.84	1	0.4	8.67	0.0001	0.01	0.00	None
22	4	2.54	2	0.4	8.67	0.0064	0.64	0.09	Minor
23	3	3.88	1	0.4	8.42	0.0003	0.03	0.00	None
24	3	1.37	2	0.4	8.42	0.0062	0.62	0.08	Minor
25	4	2.69	1	0.4	8.42	0.0001	0.01	0.00	None
26	4	0.74	2	0.4	8.42	0.0062	0.62	0.08	Minor

Table C- 233. Analysis Result: San Salvador Earthquake (0.5g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	0.5	9.42	0.0019	0.19	0.00	None
2	8	1.03	2	0.5	9.42	0.0018	0.18	0.00	None
3	8	5.35	1	0.5	8.75	0.0029	0.29	0.00	None
4	8	1.66	2	0.5	8.75	0.0020	0.2	0.00	None
5	4	2.81	1	0.5	8.50	0.0167	1.67	0.78	Major
6	4	0.33	2	0.5	8.50	0.0079	0.79	0.19	Minor
7	7	5.55	1	0.5	8.00	0.0008	0.08	0.00	None
8	7	1.08	2	0.5	8.00	0.0198	1.98	0.99	Major
9	6	2.18	1	0.5	8.00	0.0005	0.05	0.00	None
10	6	0.69	2	0.5	8.00	0.0248	2.48	1.00	Major
11	10	4.31	1	0.5	8.42	0.0015	0.15	0.00	None
12	10	1.17	2	0.5	8.42	0.0019	0.19	0.00	None
13	5	3.08	1	0.5	8.83	0.0030	0.3	0.00	None
14	5	0.5	2	0.5	8.83	0.0051	0.51	0.01	None
15	3	5.3	1	0.5	8.00	0.0001	0.01	0.00	None
16	3	1.33	2	0.5	8.00	0.0064	0.64	0.09	Minor
17	3	5.61	1	0.5	8.00	0.0001	0.01	0.00	None
18	3	1.2	2	0.5	8.00	0.0067	0.67	0.11	Minor
19	4	20.56	1	0.5	8.67	0.0000	0	0.00	None
20	4	6.73	2	0.5	8.67	0.0000	0	0.00	None
21	4	27.84	1	0.5	8.67	0.0001	0.01	0.00	None
22	4	2.54	2	0.5	8.67	0.0061	0.61	0.07	Minor
23	3	3.88	1	0.5	8.42	0.0004	0.04	0.00	None
24	3	1.37	2	0.5	8.42	0.0107	1.07	0.38	Moderate
25	4	2.69	1	0.5	8.42	0.0002	0.02	0.00	None
26	4	0.74	2	0.5	8.42	0.0072	0.72	0.15	Minor

Table C- 234. Analysis Result: San Salvador Earthquake (0.6g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	0.6	9.42	0.0024	0.24	0.00	None
2	8	1.03	2	0.6	9.42	0.0020	0.2	0.00	None
3	8	5.35	1	0.6	8.75	0.0032	0.32	0.00	None
4	8	1.66	2	0.6	8.75	0.0025	0.25	0.00	None
5	4	2.81	1	0.6	8.50	0.0124	1.24	0.49	Moderate
6	4	0.33	2	0.6	8.50	0.0094	0.94	0.29	Minor
7	7	5.55	1	0.6	8.00	0.0008	0.08	0.00	None
8	7	1.08	2	0.6	8.00	0.0279	2.79	1.00	Major
9	6	2.18	1	0.6	8.00	0.0012	0.12	0.00	None
10	6	0.69	2	0.6	8.00	0.0298	2.98	1.00	Major
11	10	4.31	1	0.6	8.42	0.0020	0.2	0.00	None
12	10	1.17	2	0.6	8.42	0.0024	0.24	0.00	None
13	5	3.08	1	0.6	8.83	0.0043	0.43	0.00	None
14	5	0.5	2	0.6	8.83	0.0062	0.62	0.08	Minor
15	3	5.3	1	0.6	8.00	0.0002	0.02	0.00	None
16	3	1.33	2	0.6	8.00	0.0080	0.8	0.20	Minor
17	3	5.61	1	0.6	8.00	0.0001	0.01	0.00	None
18	3	1.2	2	0.6	8.00	0.0094	0.94	0.29	Minor
19	4	20.56	1	0.6	8.67	0.0001	0.01	0.00	None
20	4	6.73	2	0.6	8.67	0.0000	0	0.00	None
21	4	27.84	1	0.6	8.67	0.0001	0.01	0.00	None
22	4	2.54	2	0.6	8.67	0.0078	0.78	0.19	Minor
23	3	3.88	1	0.6	8.42	0.0005	0.05	0.00	None
24	3	1.37	2	0.6	8.42	0.0135	1.35	0.57	Substantial
25	4	2.69	1	0.6	8.42	0.0002	0.02	0.00	None
26	4	0.74	2	0.6	8.42	0.0080	0.8	0.20	Minor

Table C- 235. Analysis Result: San Salvador Earthquake (0.7g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	0.7	9.42	0.0028	0.28	0.00	None
2	8	1.03	2	0.7	9.42	0.0022	0.22	0.00	None
3	8	5.35	1	0.7	8.75	0.0032	0.32	0.00	None
4	8	1.66	2	0.7	8.75	0.0029	0.29	0.00	None
5	4	2.81	1	0.7	8.50	0.0224	2.24	1.00	Major
6	4	0.33	2	0.7	8.50	0.0111	1.11	0.41	Moderate
7	7	5.55	1	0.7	8.00	0.0011	0.11	0.00	None
8	7	1.08	2	0.7	8.00	0.0365	3.65	1.00	Major
9	6	2.18	1	0.7	8.00	0.0026	0.26	0.00	None
10	6	0.69	2	0.7	8.00	0.0347	3.47	1.00	Major
11	10	4.31	1	0.7	8.42	0.0023	0.23	0.00	None
12	10	1.17	2	0.7	8.42	0.0029	0.29	0.00	None
13	5	3.08	1	0.7	8.83	0.0047	0.47	0.00	None
14	5	0.5	2	0.7	8.83	0.0069	0.69	0.13	Minor
15	3	5.3	1	0.7	8.00	0.0002	0.02	0.00	None
16	3	1.33	2	0.7	8.00	0.0117	1.17	0.45	Moderate
17	3	5.61	1	0.7	8.00	0.0001	0.01	0.00	None
18	3	1.2	2	0.7	8.00	0.0126	1.26	0.51	Moderate
19	4	20.56	1	0.7	8.67	0.0001	0.01	0.00	None
20	4	6.73	2	0.7	8.67	0.0000	0	0.00	None
21	4	27.84	1	0.7	8.67	0.0001	0.01	0.00	None
22	4	2.54	2	0.7	8.67	0.0097	0.97	0.31	Minor
23	3	3.88	1	0.7	8.42	0.0008	0.08	0.00	None
24	3	1.37	2	0.7	8.42	0.0153	1.53	0.69	Substantial
25	4	2.69	1	0.7	8.42	0.0006	0.06	0.00	None
26	4	0.74	2	0.7	8.42	0.0084	0.84	0.23	Minor

Table C- 236. Analysis Result: San Salvador Earthquake (0.8g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	0.8	9.42	0.0031	0.31	0.00	None
2	8	1.03	2	0.8	9.42	0.0024	0.24	0.00	None
3	8	5.35	1	0.8	8.75	0.0030	0.3	0.00	None
4	8	1.66	2	0.8	8.75	0.0031	0.31	0.00	None
5	4	2.81	1	0.8	8.50	0.0239	2.39	1.00	Major
6	4	0.33	2	0.8	8.50	0.0124	1.24	0.49	Moderate
7	7	5.55	1	0.8	8.00	0.0012	0.12	0.00	None
8	7	1.08	2	0.8	8.00	0.0405	4.05	1.00	Major
9	6	2.18	1	0.8	8.00	0.0033	0.33	0.00	None
10	6	0.69	2	0.8	8.00	0.0397	3.97	1.00	Major
11	10	4.31	1	0.8	8.42	0.0025	0.25	0.00	None
12	10	1.17	2	0.8	8.42	0.0034	0.34	0.00	None
13	5	3.08	1	0.8	8.83	0.0049	0.49	0.00	None
14	5	0.5	2	0.8	8.83	0.0077	0.77	0.18	Minor
15	3	5.3	1	0.8	8.00	0.0003	0.03	0.00	None
16	3	1.33	2	0.8	8.00	0.0141	1.41	0.61	Substantial
17	3	5.61	1	0.8	8.00	0.0001	0.01	0.00	None
18	3	1.2	2	0.8	8.00	0.0149	1.49	0.66	Substantial
19	4	20.56	1	0.8	8.67	0.0001	0.01	0.00	None
20	4	6.73	2	0.8	8.67	0.0000	0	0.00	None
21	4	27.84	1	0.8	8.67	0.0002	0.02	0.00	None
22	4	2.54	2	0.8	8.67	0.0109	1.09	0.39	Moderate
23	3	3.88	1	0.8	8.42	0.0011	0.11	0.00	None
24	3	1.37	2	0.8	8.42	0.0167	1.67	0.78	Major
25	4	2.69	1	0.8	8.42	0.0011	0.11	0.00	None
26	4	0.74	2	0.8	8.42	0.0099	0.99	0.33	Minor

Table C- 237. Analysis Result: San Salvador Earthquake (0.9g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	0.9	9.42	0.0034	0.34	0.00	None
2	8	1.03	2	0.9	9.42	0.0037	0.37	0.00	None
3	8	5.35	1	0.9	8.75	0.0034	0.34	0.00	None
4	8	1.66	2	0.9	8.75	0.0036	0.36	0.00	None
5	4	2.81	1	0.9	8.50	0.0277	2.77	1.00	Major
6	4	0.33	2	0.9	8.50	0.0130	1.3	0.53	Moderate
7	7	5.55	1	0.9	8.00	0.0014	0.14	0.00	None
8	7	1.08	2	0.9	8.00	0.0432	4.32	1.00	Major
9	6	2.18	1	0.9	8.00	0.0040	0.4	0.00	None
10	6	0.69	2	0.9	8.00	0.0446	4.46	1.00	Major
11	10	4.31	1	0.9	8.42	0.0027	0.27	0.00	None
12	10	1.17	2	0.9	8.42	0.0038	0.38	0.00	None
13	5	3.08	1	0.9	8.83	0.0061	0.61	0.07	Minor
14	5	0.5	2	0.9	8.83	0.0154	1.54	0.69	Substantial
15	3	5.3	1	0.9	8.00	0.0003	0.03	0.00	None
16	3	1.33	2	0.9	8.00	0.0167	1.67	0.78	Major
17	3	5.61	1	0.9	8.00	0.0001	0.01	0.00	None
18	3	1.2	2	0.9	8.00	0.0163	1.63	0.75	Major
19	4	20.56	1	0.9	8.67	0.0001	0.01	0.00	None
20	4	6.73	2	0.9	8.67	0.0001	0.01	0.00	None
21	4	27.84	1	0.9	8.67	0.0002	0.02	0.00	None
22	4	2.54	2	0.9	8.67	0.0120	1.2	0.47	Moderate
23	3	3.88	1	0.9	8.42	0.0016	0.16	0.00	None
24	3	1.37	2	0.9	8.42	0.0174	1.74	0.83	Major
25	4	2.69	1	0.9	8.42	0.0018	0.18	0.00	None
26	4	0.74	2	0.9	8.42	0.0116	1.16	0.44	Moderate

Table C- 238. Analysis Result: San Salvador Earthquake (1g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	1	9.42	0.0035	0.35	0.00	None
2	8	1.03	2	1	9.42	0.0060	0.6	0.07	Minor
3	8	5.35	1	1	8.75	0.0039	0.39	0.00	None
4	8	1.66	2	1	8.75	0.0040	0.4	0.00	None
5	4	2.81	1	1	8.50	0.0206	2.06	1.00	Major
6	4	0.33	2	1	8.50	0.0162	1.62	0.75	Substantial
7	7	5.55	1	1	8.00	0.0012	0.12	0.00	None
8	7	1.08	2	1	8.00	0.0450	4.5	1.00	Major
9	6	2.18	1	1	8.00	0.0042	0.42	0.00	None
10	6	0.69	2	1	8.00	0.0496	4.96	1.00	Major
11	10	4.31	1	1	8.42	0.0028	0.28	0.00	None
12	10	1.17	2	1	8.42	0.0048	0.48	0.00	None
13	5	3.08	1	1	8.83	0.0076	0.76	0.17	Minor
14	5	0.5	2	1	8.83	0.0214	2.14	1.00	Major
15	3	5.3	1	1	8.00	0.0004	0.04	0.00	None
16	3	1.33	2	1	8.00	0.0188	1.88	0.92	Major
17	3	5.61	1	1	8.00	0.0001	0.01	0.00	None
18	3	1.2	2	1	8.00	0.0176	1.76	0.84	Major
19	4	20.56	1	1	8.67	0.0001	0.01	0.00	None
20	4	6.73	2	1	8.67	0.0001	0.01	0.00	None
21	4	27.84	1	1	8.67	0.0002	0.02	0.00	None
22	4	2.54	2	1	8.67	0.0137	1.37	0.58	Substantial
23	3	3.88	1	1	8.42	0.0027	0.27	0.00	None
24	3	1.37	2	1	8.42	0.0175	1.75	0.83	Major
25	4	2.69	1	1	8.42	0.0034	0.34	0.00	None
26	4	0.74	2	1	8.42	0.0134	1.34	0.56	Substantial

Table C- 239. Analysis Result: San Salvador Earthquake (1.1g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	1.1	9.42	0.0035	0.35	0.00	None
2	8	1.03	2	1.1	9.42	0.0082	0.82	0.21	Minor
3	8	5.35	1	1.1	8.75	0.0044	0.44	0.00	None
4	8	1.66	2	1.1	8.75	0.0044	0.44	0.00	None
5	4	2.81	1	1.1	8.50	0.0214	2.14	1.00	Major
6	4	0.33	2	1.1	8.50	0.0330	3.3	1.00	Major
7	7	5.55	1	1.1	8.00	0.0014	0.14	0.00	None
8	7	1.08	2	1.1	8.00	0.0466	4.66	1.00	Major
9	6	2.18	1	1.1	8.00	0.0045	0.45	0.00	None
10	6	0.69	2	1.1	8.00	0.0546	5.46	1.00	Major
11	10	4.31	1	1.1	8.42	0.0028	0.28	0.00	None
12	10	1.17	2	1.1	8.42	0.0062	0.62	0.08	Minor
13	5	3.08	1	1.1	8.83	0.0083	0.83	0.22	Minor
14	5	0.5	2	1.1	8.83	0.0257	2.57	1.00	Major
15	3	5.3	1	1.1	8.00	0.0004	0.04	0.00	None
16	3	1.33	2	1.1	8.00	0.0197	1.97	0.98	Major
17	3	5.61	1	1.1	8.00	0.0001	0.01	0.00	None
18	3	1.2	2	1.1	8.00	0.0183	1.83	0.89	Major
19	4	20.56	1	1.1	8.67	0.0001	0.01	0.00	None
20	4	6.73	2	1.1	8.67	0.0001	0.01	0.00	None
21	4	27.84	1	1.1	8.67	0.0002	0.02	0.00	None
22	4	2.54	2	1.1	8.67	0.0153	1.53	0.69	Substantial
23	3	3.88	1	1.1	8.42	0.0042	0.42	0.00	None
24	3	1.37	2	1.1	8.42	0.0184	1.84	0.89	Major
25	4	2.69	1	1.1	8.42	0.0102	1.02	0.35	Minor
26	4	0.74	2	1.1	8.42	0.0153	1.53	0.69	Substantial

Table C- 240. Analysis Result: San Salvador Earthquake (1.2g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	1.2	9.42	0.0037	0.37	0.00	None
2	8	1.03	2	1.2	9.42	0.0103	1.03	0.35	Moderate
3	8	5.35	1	1.2	8.75	0.0049	0.49	0.00	None
4	8	1.66	2	1.2	8.75	0.0048	0.48	0.00	None
5	4	2.81	1	1.2	8.50	0.0233	2.33	1.00	Major
6	4	0.33	2	1.2	8.50	0.0445	4.45	1.00	Major
7	7	5.55	1	1.2	8.00	0.0013	0.13	0.00	None
8	7	1.08	2	1.2	8.00	0.0438	4.38	1.00	Major
9	6	2.18	1	1.2	8.00	0.0093	0.93	0.29	Minor
10	6	0.69	2	1.2	8.00	0.0595	5.95	1.00	Major
11	10	4.31	1	1.2	8.42	0.0030	0.3	0.00	None
12	10	1.17	2	1.2	8.42	0.0084	0.84	0.23	Minor
13	5	3.08	1	1.2	8.83	0.0093	0.93	0.29	Minor
14	5	0.5	2	1.2	8.83	0.0287	2.87	1.00	Major
15	3	5.3	1	1.2	8.00	0.0004	0.04	0.00	None
16	3	1.33	2	1.2	8.00	0.0200	2	1.00	Major
17	3	5.61	1	1.2	8.00	0.0001	0.01	0.00	None
18	3	1.2	2	1.2	8.00	0.0199	1.99	0.99	Major
19	4	20.56	1	1.2	8.67	0.0001	0.01	0.00	None
20	4	6.73	2	1.2	8.67	0.0001	0.01	0.00	None
21	4	27.84	1	1.2	8.67	0.0002	0.02	0.00	None
22	4	2.54	2	1.2	8.67	0.0171	1.71	0.81	Major
23	3	3.88	1	1.2	8.42	0.0066	0.66	0.11	Minor
24	3	1.37	2	1.2	8.42	0.0210	2.1	1.00	Major
25	4	2.69	1	1.2	8.42	0.0096	0.96	0.31	Minor
26	4	0.74	2	1.2	8.42	0.0168	1.68	0.79	Major

Table C- 241. Analysis Results: San Salvador Earthquake (1.3g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	1.3	9.42	0.0041	0.41	0.00	None
2	8	1.03	2	1.3	9.42	0.0111	1.11	0.41	Moderate
3	8	5.35	1	1.3	8.75	0.0055	0.55	0.03	None
4	8	1.66	2	1.3	8.75	0.0053	0.53	0.02	None
5	4	2.81	1	1.3	8.50	0.0272	2.72	1.00	Major
6	4	0.33	2	1.3	8.50	0.0560	5.6	1.00	Major
7	7	5.55	1	1.3	8.00	0.0010	0.1	0.00	None
8	7	1.08	2	1.3	8.00	0.0452	4.52	1.00	Major
9	6	2.18	1	1.3	8.00	0.0094	0.94	0.29	Minor
10	6	0.69	2	1.3	8.00	0.0645	6.45	1.00	Major
11	10	4.31	1	1.3	8.42	0.0033	0.33	0.00	None
12	10	1.17	2	1.3	8.42	0.0168	1.68	0.79	Major
13	5	3.08	1	1.3	8.83	0.0099	0.99	0.33	Minor
14	5	0.5	2	1.3	8.83	0.0298	2.98	1.00	Major
15	3	5.3	1	1.3	8.00	0.0005	0.05	0.00	None
16	3	1.33	2	1.3	8.00	0.0210	2.1	1.00	Major
17	3	5.61	1	1.3	8.00	0.0001	0.01	0.00	None
18	3	1.2	2	1.3	8.00	0.0234	2.34	1.00	Major
19	4	20.56	1	1.3	8.67	0.0001	0.01	0.00	None
20	4	6.73	2	1.3	8.67	0.0001	0.01	0.00	None
21	4	27.84	1	1.3	8.67	0.0003	0.03	0.00	None
22	4	2.54	2	1.3	8.67	0.0188	1.88	0.92	Major
23	3	3.88	1	1.3	8.42	0.0114	1.14	0.43	Moderate
24	3	1.37	2	1.3	8.42	0.0230	2.3	1.00	Major
25	4	2.69	1	1.3	8.42	0.0180	1.8	0.87	Major
26	4	0.74	2	1.3	8.42	0.0185	1.85	0.90	Major

Table C- 242. Analysis Result: San Salvador Earthquake (1.4g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	1.4	9.42	0.0045	0.45	0.00	None
2	8	1.03	2	1.4	9.42	0.0115	1.15	0.43	Moderate
3	8	5.35	1	1.4	8.75	0.0060	0.6	0.07	Minor
4	8	1.66	2	1.4	8.75	0.0056	0.56	0.04	None
5	4	2.81	1	1.4	8.50	0.0243	2.43	1.00	Major
6	4	0.33	2	1.4	8.50	0.0636	6.36	1.00	Major
7	7	5.55	1	1.4	8.00	0.0010	0.1	0.00	None
8	7	1.08	2	1.4	8.00	0.0457	4.57	1.00	Major
9	6	2.18	1	1.4	8.00	0.0187	1.87	0.91	Major
10	6	0.69	2	1.4	8.00	0.0694	6.94	1.00	Major
11	10	4.31	1	1.4	8.42	0.0036	0.36	0.00	None
12	10	1.17	2	1.4	8.42	0.0216	2.16	1.00	Major
13	5	3.08	1	1.4	8.83	0.0105	1.05	0.37	Moderate
14	5	0.5	2	1.4	8.83	0.0295	2.95	1.00	Major
15	3	5.3	1	1.4	8.00	0.0005	0.05	0.00	None
16	3	1.33	2	1.4	8.00	0.0248	2.48	1.00	Major
17	3	5.61	1	1.4	8.00	0.0001	0.01	0.00	None
18	3	1.2	2	1.4	8.00	0.0262	2.62	1.00	Major
19	4	20.56	1	1.4	8.67	0.0002	0.02	0.00	None
20	4	6.73	2	1.4	8.67	0.0001	0.01	0.00	None
21	4	27.84	1	1.4	8.67	0.0003	0.03	0.00	None
22	4	2.54	2	1.4	8.67	0.0202	2.02	1.00	Major
23	3	3.88	1	1.4	8.42	0.0119	1.19	0.46	Moderate
24	3	1.37	2	1.4	8.42	0.0255	2.55	1.00	Major
25	4	2.69	1	1.4	8.42	0.0154	1.54	0.69	Substantial
26	4	0.74	2	1.4	8.42	0.0200	2	1.00	Major

Table C- 243. Analysis Result: San Salvador Earthquake (1.5g) of Multistory Concrete Shear Wall models

MODEL	N	Column (%)	Direction	PGA(%)	Story Height(ft)	T_i	DI(%)	DS	DS
1	8	2.3	1	1.5	9.42	0.0048	0.48	0.00	None
2	8	1.03	2	1.5	9.42	0.0120	1.2	0.47	Moderate
3	8	5.35	1	1.5	8.75	0.0065	0.65	0.10	Minor
4	8	1.66	2	1.5	8.75	0.0059	0.59	0.06	Minor
5	4	2.81	1	1.5	8.50	0.0283	2.83	1.00	Major
6	4	0.33	2	1.5	8.50	0.0622	6.22	1.00	Major
7	7	5.55	1	1.5	8.00	0.0015	0.15	0.00	None
8	7	1.08	2	1.5	8.00	0.0581	5.81	1.00	Major
9	6	2.18	1	1.5	8.00	0.0188	1.88	0.92	Major
10	6	0.69	2	1.5	8.00	0.0744	7.44	1.00	Major
11	10	4.31	1	1.5	8.42	0.0039	0.39	0.00	None
12	10	1.17	2	1.5	8.42	0.0250	2.5	1.00	Major
13	5	3.08	1	1.5	8.83	0.0103	1.03	0.35	Moderate
14	5	0.5	2	1.5	8.83	0.0335	3.35	1.00	Major
15	3	5.3	1	1.5	8.00	0.0005	0.05	0.00	None
16	3	1.33	2	1.5	8.00	0.0270	2.7	1.00	Major
17	3	5.61	1	1.5	8.00	0.0002	0.02	0.00	None
18	3	1.2	2	1.5	8.00	0.0288	2.88	1.00	Major
19	4	20.56	1	1.5	8.67	0.0003	0.03	0.00	None
20	4	6.73	2	1.5	8.67	0.0001	0.01	0.00	None
21	4	27.84	1	1.5	8.67	0.0003	0.03	0.00	None
22	4	2.54	2	1.5	8.67	0.0218	2.18	1.00	Major
23	3	3.88	1	1.5	8.42	0.0138	1.38	0.59	Substantial
24	3	1.37	2	1.5	8.42	0.0281	2.81	1.00	Major
25	4	2.69	1	1.5	8.42	0.0158	1.58	0.72	Substantial
26	4	0.74	2	1.5	8.42	0.0215	2.15	1.00	Major