OPTIMIZATION OF ISOLATORS BETWEEN FLOORS OF A HIGH-RISE BUILDING

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by

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ABSTRACT

OPTIMIZATION OF ISOLATORS BETWEEN FLOORS OF A HIGH-RISE BUILDING

Earthquake vibrations are natural phenomena that can cause tremors on the ground surface and lead to serious loss of life and property. Especially large-scale earthquakes have the potential to significantly damage infrastructure systems and the durability of structures. Several strategies are available to reduce these damages and increase the resistance of structures to earthquakes.

One of these strategies is the implementation of seismic isolators. Seismic isolation minimizes earthquake damage to structures. The main purpose of the study is to examine the effectiveness of the seismic isolator being installed at various story levels of 3D 20-story steel building model. The building had two sets of 20 evaluation models, each with a different isolator story. The first set had identical evaluation models, except for the isolation story which is incremented in each model. The second set is similar to the first set except that the lower stories are strengthened by shear walls.

The goal was to determine the best dimensions for the isolator to minimize the inter-story drift values. For this purpose, a set of 12 earthquake records are selected. These records are scaled according to the determined design spectrum. The optimization is performed for one of these earthquake records. Nonlinear dynamic analyses are carried out to evaluate the building model responses for all 12 earthquake records. Response values such as story shear forces and story drift ratios were analyzed and interpreted. This analysis will contribute to a better understanding of the impact of isolators with optimization methods on structural performance.

Keywords: *Midstory isolation, Base isolation, Optimization, Opensees, Time-history analysis*

ÖZET

YÜKSEK BİR BİNANIN KATLARI ARASINDA KULLANILACAK İZOLATÖRLERİN OPTİMİZASYONU

Deprem titreşimleri, zemin yüzeyinde titremelere neden olabilen ve ciddi can ve mal kaybına yol açabilen doğal olaylardır. Özellikle büyük ölçekli depremler altyapı sistemlerine ve yapıların dayanıklılığına önemli ölçüde zarar verme potansiyeline sahiptir. Bu hasarları azaltmak ve yapıların depreme karşı direncini artırmak için çeşitli strateji ve yöntemler mevcuttur.

Bu stratejilerden biri sismik izolatörlerin uygulanmasıdır. Sismik izolasyon, deprem sırasında yapılarda oluşabilecek hasarı en aza indirmek için etkili bir strateji olarak öne çıkmaktadır. Bu çalışmanın temel amacı, 3 boyutlu 20 katlı çelik çerçeve bina modelinin çeşitli kat seviyelerinde kurulan sismik izolatörün etkinliğini incelemektir. Bina modeli, her biri izolatör katının farklı olduğu 20 değerlendirme modeline sahip iki farklı sete bölünmüştür. İlk sette, her modelde artan izolasyon katı dışında değerlendirme modelleri aynıdır. İkinci set ise, izolatör altında kalan katlara perde duvar ile güçlendirilmesi dışında birinci sete benzerdir.

Amaç, en az göreli kat ötelemesi oranı değerleriyle sonuçlanan en uygun izolatör boyutlarını bulmaktır. Bu amaçla bir dizi 12 deprem kaydı seçilmiştir. Bu kayıtlar belirlenen tasarım spektrumuna göre ölçeklendirilir. Bu deprem kayıtlarından biri için optimizasyon yapılır. 12 deprem kaydının tamamında bina modeli tepkilerini değerlendirmek için doğrusal olmayan dinamik analizler yapılmaktadır. Kat kesme kuvvetleri ve göreli kat ötelemesi oranları gibi tepki değerleri analiz edildi ve yorumlandı. Bu kapsamlı analiz, optimizasyon yöntemleriyle 20 katlı bir bina için tasarlanan izolatörlerin yapısal performans üzerindeki etkisinin daha iyi anlaşılmasına katkıda bulunacaktır.

Anahtar kelimeler: *Ara kat sismik izolasyonu, taban sismik izolasyonu, optimizasyon, Opensees, zaman tanım analizi*

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CHAPTER 1

INTRODUCTION

1.1 Inter-story Isolation

Earthquakes are seismic waves that result from the movement of tectonic plates in the earth's crust. These waves can create tremors on the ground surface, which can result in significant loss of life and property. Large earthquakes can cause extensive damage to infrastructure and compromise the structural integrity of buildings.

Various techniques have been devised to mitigate the destructive impact of earthquakes and fortify constructions against seismic activity. Among these methods is seismic isolation, which aims to minimize the potential harm inflicted on structures during an earthquake.

Seismic isolation involves increasing the fundamental period of a structure (1st mode) and relocating it to an area where earthquake acceleration is lower. This helps to minimize any floor displacements that may occur during an earthquake by utilizing seismic isolators that have high damping, low rigidity, and high displacement capacity. Seismic isolation is a crucial technique for reducing the impact of earthquakes on structures and enhancing the safety of individuals. It is extensively utilized in engineering applications to make structures more secure in earthquake-prone areas.

Building type structures focus on two basic applications in which seismic isolators can be applied: "base isolation" and "inter-story isolation". These two applications offer different approaches to the earthquake effects of the structure. The main purpose of base isolation is to reduce the energy input to the structure by increasing the fundamental period of the structure, while the purpose of inter-story isolation is to provide additional damping by triggering the transfer of vibration energy from the substructure to the isolated superstructure (Opensees Wiki - Shell Element 2022) . In addition, some of the seismic energy is absorbed by the isolators and less earthquake load is applied to the load-bearing elements of the structure.

The application of base isolators is limited to low-rise buildings, and therefore high-rise buildings may not be base isolated. However, inter-story isolator systems can be used for the isolation of top-level floors of high-rise buildings.

This thesis considers the design of isolators for middle floors in buildings, as a means of mitigating the effects of earthquakes. To achieve maximum effectiveness, isolator properties must be carefully selected based on the building's dynamics. Numerous research studies (Zhou, P. and Y. 2016) (Tsuneki, et al. 2008) (Earl 2007) (Chey, et al. 2013) have been conducted on this topic, resulting in the development of several methods for optimizing inter-story isolation systems. These studies utilized two different lumped models to formulate optimized values for isolator parameters, namely a structure with two degrees of freedom and a structure with three degrees of freedom. According to Tsuneki, the ratio of superstructure mass to total structure mass has a great effect on reducing earthquake reactions in the structure (Tsuneki, et al. 2008). It is also not necessary that the rigidity of the substructure is very large. It is possible that the rigidity of the substructure exceeds the rigidity of the isolator, and when it is ensured that the structure will remain elastic during vibration, the seismic energy will be concentrated in the isolation layer.

In the study by Zhou, the aim was to minimize base shear forces in order to calculate isolator parameters. He used a two-degree-of-freedom system to optimize isolator parameters. It is assumed that the structural elements will remain elastic under strong ground motion, and the calculated optimum isolator parameters correspond to the equivalent stiffness and damping ratio of the isolator (Zhou, P. and Y. 2016).

In Earl's study, isolators were placed on only one floor in 4 different models: ground floor, first floor, middle floor and roof floor. As a second configuration this study considered the placement of two isolators in the building model – one at the base and one at mid-height. In another model, isolators were placed on all floors. As a result, 6 different linear elastic models were created. The isolator parameters are optimized so that the first mode period of the structure models is 2.5 seconds. (Earl 2007)

Chey considered a different approach to reduce earthquake response of a high-rise building by implementing seismic isolators. He considers the design approach for tuned mass dampers (TMD) in which the isolated top two or four floors were considered as the tuned mass and the isolator stiffness is considered as the tuned stiffness (Chey, et al. 2013).

In this study, a 20 story and three-dimensional steel frame building structure is modelled. The Bridgestone catalog is used for the optimum isolator design parameter such that story drift ratios are minimized. The isolator is placed at each story to identify the best isolator floor level. The parameters are optimized according to simulation results of one earthquake and its effectiveness is analyzed by simulations with respect to a total of 12 different scaled earthquake ground motions.

1.2 Optimization Technique

In the pursuit of optimization for seismic resilience, the Bolu Earthquake has been selected as the ground excitation. Isolator parameters are the main optimization variables, however the selection is limited to available isolators which are reported in the Bridgestone catalog (Bridgestone Corporation 2022). Thus, the optimization procedure obtained isolator rubber height, cross-sectional area, and axial compression stiffness from Table 1.1. The implementation of this table constraints the optimization process which probably leads to less optimum design, however the end product may be considered being more realistic.

For the optimal isolator location and dimensions, the floor drift ratio of the structure was found by using each type of isolator in each model after the time history analysis. According to the results obtained later, the type of isolator that gave the minimum drift ratio was accepted as the optimal type of isolator.

Table 1.1 Bridgestone HDR isolator parameters

PRODUCT	Compressive ($x10^3$kN/m) stiffness	Effective plane area ($x10^2$ mm^2)	Total rubber thickness (mm)
HM060X3R	1740	2826	160,00
HM070X3R	2370	3847	159,30
HM080X3R	3140	5023	156,40
HN060X3R	1390	2826	200,00
HN070X3R	1880	3847	200,60
HN080X3R	2490	5023	197,20
HH060X4S	1700	2826	200,00
HH065X4S	2020	3317	198,00
HH070X4S	2290	3847	202,00
HH075X4S	2660	4416	200,00
HH080X4S	3030	5023	200,00
HH085X4S	3420	5671	200,00
HH090X4S	3870	6359	198,00
HH095X4S	4300	7085	198,00
HH100X4S	4700	7849	201,00
HH110X4S	5690	9480	200,00
HH120X4S	6780	11286	200,00
HH130X4S	7960	13249	200,00
HH140X4S	9230	15361	200,00
HH150X4S	10600	17638	200,00
HH160X4S	12200	20056	198,00
HH060X6R	1970	2826	200,00
HH065X6R	2340	3317	198,00
HH070X6R	2660	3847	202,00
HH075X6R	3090	4416	200,00
HH080X6R	3510	5023	200,00
HH085X6R	3970	5671	200,00
HH090X6R	4490	6359	198,00
HH095X6R	4980	7085	198,00
HH100X6R	5450	7849	201,00
HH110X6R	6590	9480	200,00
HH120X6R	7860	11286	200,00
HH130X6R	9220	13249	200,00
HH140X6R	10700	15361	200,00
HH150X6R	12300	17638	200,00
HH160X6R	14200	20056	198,00
HL060X4S	2110	2826	162,00
HL065X4S	2450	3317	163,00
HL070X4S	2760	3847	167,00

(cont. on the next page)

Table 1.1 (cont.)

PRODUCT	Compressive ($x10^3$kN/m) stiffness	Effective plane area ($x10^2$ mm^2)	Total rubber thickness (mm)
HL075X4S	3240	4416	165,00
HL080X4S	3620	5023	168,00
HL085X4S	4110	5671	168,00
HL090X4S	4560	6359	170,00
HL095X4S	5120	7085	168,00
HL100X4S	5770	7849	165,00
HL110X4S	6890	9480	166,00
HL120X4S	8050	11286	169,00
HL130X4S	9590	13249	168,00
HL060X6R	2440	2826	162,00
HL065X6R	2840	3317	163,00
HL070X6R	3200	3847	167,00
HL075X6R	3760	4416	165,00
HL080X6R	4190	5023	168,00
HL085X6R	4760	5671	168,00
HL090X6R	5280	6359	170,00
HL100X6R	6680	7849	165,00
HL110X6R	7990	9480	166,00
HL120X6R	9330	11286	169,00
HL130X6R	11100	13249	168,00
HT090X4S	3040	6359	252,00
HT095X4S	3420	7085	250,00
HT100X4S	3810	7849	248,00
HT110X4S	4520	9480	252,00
HT120X4S	5470	11286	248,00
HT130X4S	6310	13249	252,00
HT140X4S	7450	15361	247,00
HT150X4S	8480	17638	250,00
HT160X4S	9690	20056	250,00
HT090X6R	3530	6359	252,00
HT095X6R	3960	7085	250,00
HT100X6R	4420	7849	248,00
HT110X6R	5240	9480	252,00
HT120X6R	6340	11286	248,00
HT130X6R	7310	13249	252,00
HT140X6R	8640	15361	247,00
HT150X6R	9830	17638	250,00
HT160X6R	11200	20056	250,00
HS070X4S	3290	3847	141,00
HS075X4S	3550	4416	150,00

(cont. on the next page)

Table 1.1 (cont.)

PRODUCT	Compressive ($x10^3$kN/m) stiffness	Effective plane area ($x10^2$ mm^2)	Total rubber thickness (mm)
HS080X4S	3730	5023	162,00
HS085X4S	4000	5671	171,00
HS090X4S	4260	6359	180,00
HS095X4S	4440	7085	192,00
HS100X4S	4700	7849	201,00
HS110X4S	5120	9480	222,00
HS120X4S	5650	11286	240,00
HS130X4S	6100	13249	261,00
HS140X4S	6620	15361	279,00
HU150X4S	7280	17638	298,00
HD160X6R	8690	20056	322,00
HD170X6R	9890	22641	322,00
HD180X6R	10900	25328	322,00

CHAPTER 2

APPLICATION OF TWENTY STORY BUILDING

2.1 Example Model

In this study, a 20-storey building was modeled from Medina (Medina and Mathiasson 2014). The building is designed for office and first floor has a height of 4.57 meters and all other story has 3.96. The overall dimensions of the building are 58x36.58 meters and the total height is 79.8 meters. The column application plan of the building is shown in Figure 2.1. In the design of the building, steel structural elements were used in accordance with the (ASCE 7-10 2010), (ANSI/AISC 341-10 2010), and (ANSI/AISC 360-10 2010) regulations. Three-dimensional structure was analyzed for optimization using OpenSeesPy and the necessary analyzes were made and compared for the optimum isolator parameters and location.

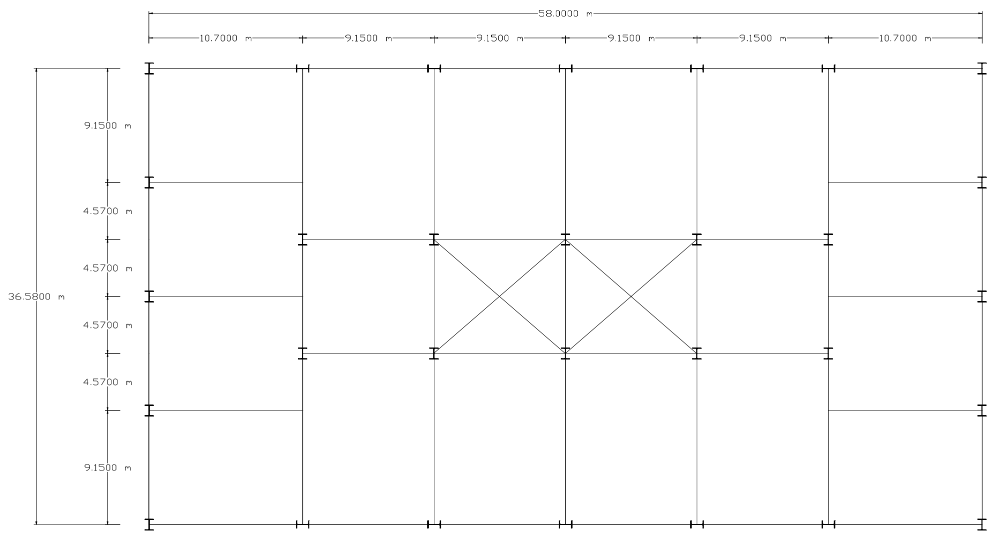


Figure 2.1 Plan view of the structure

The sectional characteristics are delineated in Table 2.1. Each beam exhibits uniformity within the same floor level, whereby identical sections are employed across identical floors. For instance, the W36X282 section is utilized for the first story, while the W24X94 section is designated for the twentieth story. Within each story, the columns are categorized into two distinct groups: inner columns and outer columns. Inner columns share identical section properties, ensuring uniformity within their designated group. Also, outer columns exhibit same section properties across the entirety of the same floor level. Steel profile properties are presented in

Table 2.2. Building floors were given 407 kgf/m2 dead load and 243 kgf/m2 live load. This load is treated as structure load in OpenSeespy software. In OpenSeespy, steel columns and beams were designed as "ElasticTimoshenkoBeam" elements, and reinforced concrete shear walls were used as "ShellMITC4" elements and "ElasticMembranePlateSection" material properties.

Table 2.1 Profile name of the building

Story	Beams	Interior columns	Exterior columns
20	W24X94	W36X231	W36X231
19	W24X103	W36X231	W36X231
18	W30X148	W36X231	W36X231
17	W30X148	W36X231	W36X231
16	W36X182	W36X247	W36X231
15	W36X182	W36X247	W36X231
14	W36X194	W36X302	W36X262
13	W36X194	W36X302	W36X262
12	W36X232	W36X330	W36X302
11	W36X232	W36X330	W36X302
10	W36X256	W36X395	W36X361
9	W36X256	W36X395	W36X361
8	W36X256	W36X395	W36X395
7	W36X256	W36X395	W36X395
6	W36X262	W36X441	W36X487
5	W36X262	W36X441	W36X487
4	W36X282	W36X487	W36X529
3	W36X282	W36X487	W36X529
2	W36X282	W36X487	W36X652
1	W36X282	W36X487	W36X652

Table 2.2 Properties of the steel sections

Section Name	Material	Area	Torsional Constant	Moment of Inertia (Major)	Moment of Inertia (Minor)	Shear Area (Minor)	Shear Area (Major)
		m^2	m^4	m^4	m^4	m^2	m^2
W24X103	S355	0.019548	0.000002943	0.001249	0.00005	0.008694	0.009484
W24X94	S355	0.017871	0.000002189	0.001124	0.000045	0.008074	0.008534
W30X148	S355	0.028064	0.000006035	0.00278	0.000094	0.012874	0.013323
W36X182	S355	0.034581	0.0000077	0.004703	0.000144	0.016979	0.015353
W36X194	S355	0.036774	0.00000924	0.005036	0.000156	0.018014	0.016394
W36X231	S355	0.043935	0.000012	0.006493	0.000391	0.017897	0.022355
W36X232	S355	0.043935	0.000016	0.006243	0.000195	0.020824	0.020427
W36X247	S355	0.046774	0.000014	0.006951	0.00042	0.018942	0.023952
W36X256	S355	0.048645	0.000022	0.006993	0.00022	0.023164	0.022695
W36X262	S355	0.049677	0.000017	0.007451	0.000454	0.019997	0.025703
W36X282	S355	0.053484	0.000022	0.008158	0.000499	0.021183	0.028024
W36X302	S355	0.05729	0.000027	0.008782	0.000541	0.022741	0.030168
W36X330	S355	0.062581	0.000035	0.009698	0.000591	0.024809	0.033021
W36X361	S355	0.068387	0.000045	0.010697	0.000653	0.027458	0.036093
W36X395	S355	0.074839	0.000059	0.011863	0.000728	0.030224	0.039742
W36X441	S355	0.083871	0.000081	0.013361	0.000828	0.034132	0.044602
W36X487	S355	0.092258	0.000107	0.014984	0.000937	0.038032	0.049277
W36X529	S355	0.100645	0.000136	0.016483	0.001036	0.041341	0.053819
W36X652	S355	0.123871	0.000247	0.021061	0.001344	0.052237	0.066993

20 models were prepared to optimize the isolator parameters and location for midstory (19 models) and base isolation (1 models), and in each model the isolator was positioned on a different floor. “KikuchiAikenHDR” material was used for the isolator and the isolator was defined with the “twoNodeLink” element. 'X0.6' was used as the elastomer type and optimum isolator parameters were tried to be found by changing the elastomer area and rubber height. The “ElasticTimoshenkoBeam” element used for steel columns and beams is modeled based on the Timoshenko–Ehrenfest beam theory, taking into account the shear deformation effect that will occur in the element. The “ShellMITC4” element used in the modeling of reinforced concrete shear walls is modeled using the bilinear isometric formulation with modified shear interpolation to improve the thin plate bending performance [10]. The “ElasticMembranePlateSection” section is section where we can define the plate assigned to the “ShellMITC4” element and the elasticity modulus, Poisson ratio, section depth and density of the element mass

of the element suitable for the Shell element. The model will be defined in openseespy with the elements defined here and optimization will be made with time history analysis.

2.2 Earthquake Time Histories

This section provides detailed information about earthquakes used to analyze the structure in the time history. A total of 12 different earthquakes were used in the structural analysis and these earthquakes are as follows:

EQ1. Menderes(Izmir, Turkey) Earthquake of November 06, 1992
EQ2. Seferihisar(Izmir, Turkey) Earthquake of October 20, 2020
EQ3. Karaburun(Izmir, Turkey) Earthquake of June 12, 2020
EQ4. The Chi-Chi (Taiwan) Earthquake of September 20, 1999
EQ5. The Friuli (Italy) Earthquake of May 06, 1976
EQ6. The Hollister (USA) Earthquake of April 09, 1961
EQ7. The Imperial Valley (USA) Earthquake of October 15, 1979
EQ8. The Kobe (Japan) Earthquake of January 16, 1995
EQ9. The Kocaeli (Turkey) Earthquake of August 17, 1999
EQ10. The Northridge (USA) Earthquake of January 17, 1994
EQ11. Pazarcık (Kahramanmaras, Turkey) Earthquake of February 06, 2023
EQ12. The Bolu (Turkey) Earthquake of November 11, 1999

Of these 12 earthquakes, 9 are known important earthquakes and the remaining 3 are important major earthquakes that occurred in Izmir, Turkey. Additionally, earthquakes were recorded with a step interval of 0.01 seconds.

The earthquake data have been scaled according to the earthquake design spectrum used for the structure design which is presented in Figure 2.2. The conceptual reason is to obtain maximum displacements within the same range, so that the effective isolator stiffness does not significantly vary among the different earthquake excitations. TEC 2018 regulation was used to create earthquake design spectra. The coordinates of the building location is selected as 38.380151, 27.191009, and the earthquake ground motion level was taken as DD-2. DD-2 ground motion level corresponds to a 10% probability of being exceeded in 50 years with a recurrence period of 475 years. Accordingly, the short-term map spectral acceleration (Ss) was taken as 1.093 and the 1-second period map spectral acceleration (S1) was taken as 0.267. The soil class was chosen as ZD whose features are as follows:

- The average shear wave velocity (Vs)30 is between 180-360 m/s.
- The average standard penetration number of blows (N60)30 pulses/30cm is between 15-50.
- The average undrained shear strength (cu)30 kPa is between 70-250.

According to TBDY 2018, the short period design spectral acceleration coefficient (SDS) is calculated as 1.162, the design spectral acceleration coefficient (SD1) for the 1.0 second period is calculated as 0.552, and the corner periods of the horizontal elastic design acceleration spectrum, T_A and T_B, are 0.095 s and 0.475 s, respectively. T_L, which is the transition period to the constant displacement region in the horizontal elastic design spectrum, is 6 seconds. By substituting these data in Figure 2.2, the horizontal elastic design acceleration graph was obtained, and Figure 2.3 was obtained for the DD-2 earthquake ground motion level.

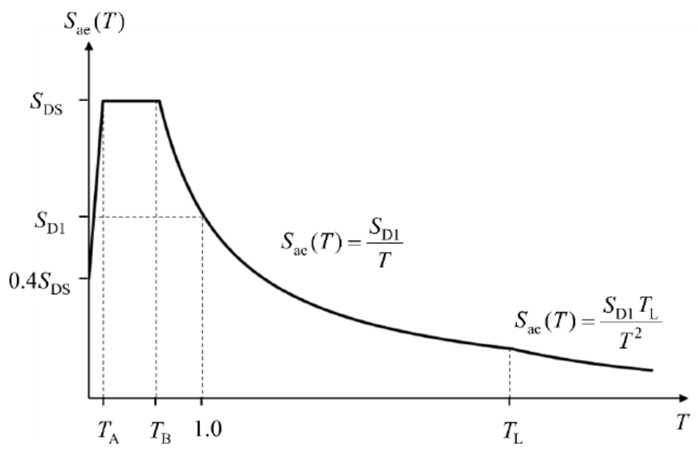


Figure 2.2 Horizontal design spectrum from TEC 2018

The scaling process was done by determining the range that would be suitable for the fundamental period of all building models. SeismoMatch (Seismosoft 2023) program was used to scale earthquake data and this software uses the algorithm developed by Al Atik & Abrahamson (Atik and Abrahamson 2010) . In this algorithm, to avoid the possibility of drift in the tuned velocity and displacement time series, a tuning waveform with zero integral for velocity and displacement is selected.

The earthquakes to be used for optimization have been scaled based on the design spectral acceleration graph (Figure 2.3) used when the structure was initially designed, and this scaling process covers the range of 1.4-6 seconds. Scaled and unscaled versions of earthquake spectral accelerations are given in Figure 2.5 and Figure 2.3, respectively. Additionally, the scaled period region is shown in more detail in its scaled version in Figure 2.6 and its unscaled version in Figure 2.4. Earthquake ground motion parameters are given in and Table 2.4 for unscaled and scaled earthquakes, respectively.

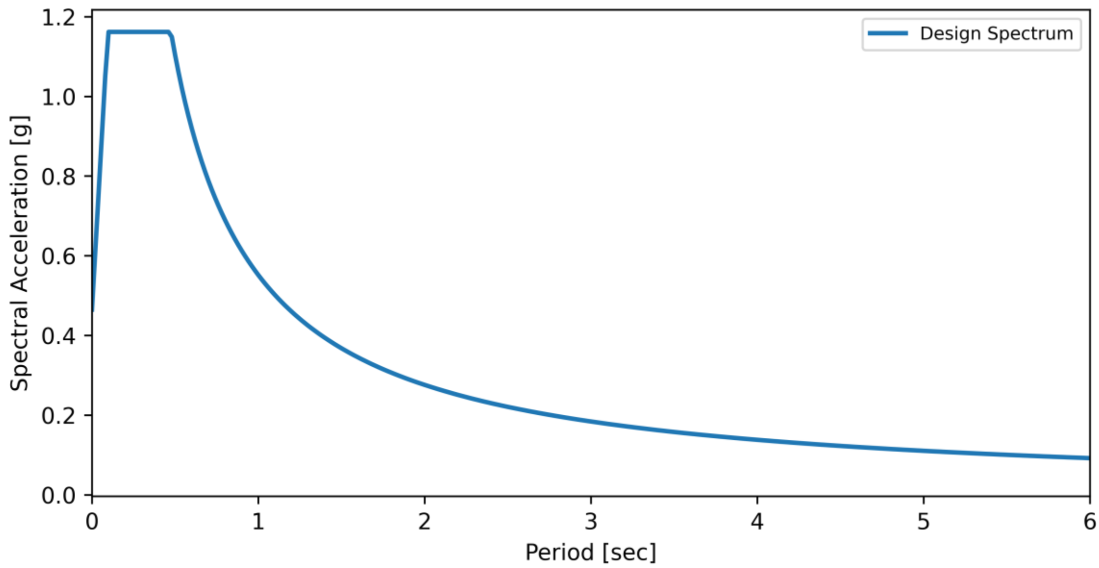


Figure 2.3 Design horizontal spectrum of 3D structure

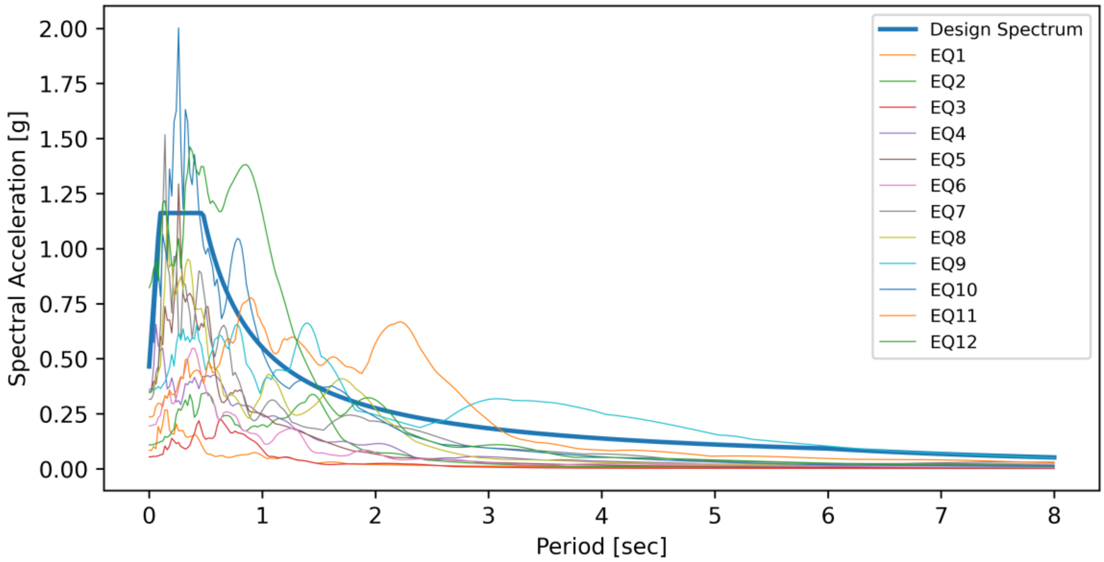


Figure 2.4 Unmatched Spectral Acceleration for all Earthquake

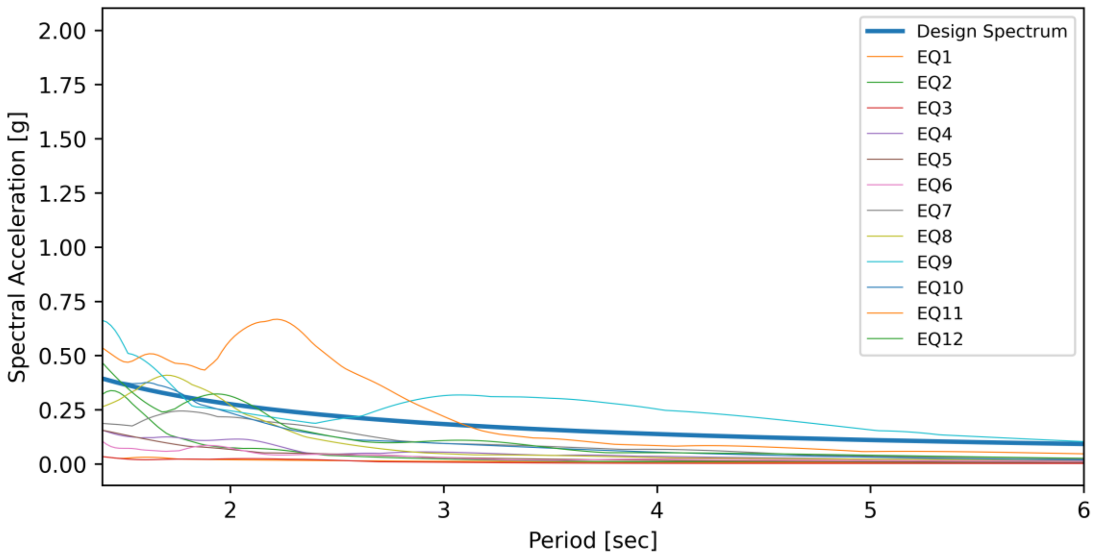


Figure 2.5 Close look unmatched Spectral Acceleration for all Earthquake

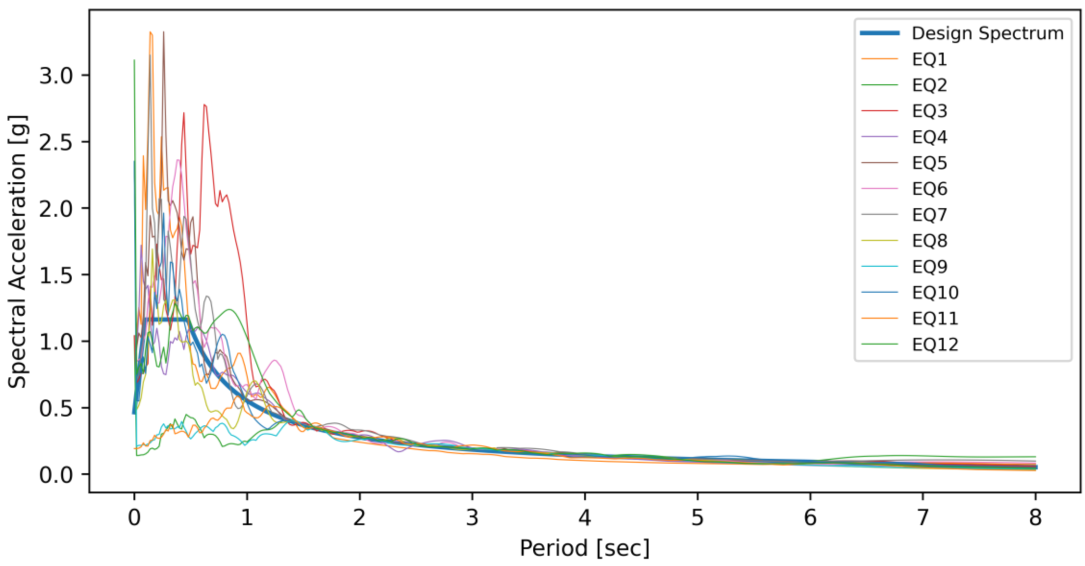


Figure 2.6 Matched Spectral Acceleration for all Earthquake

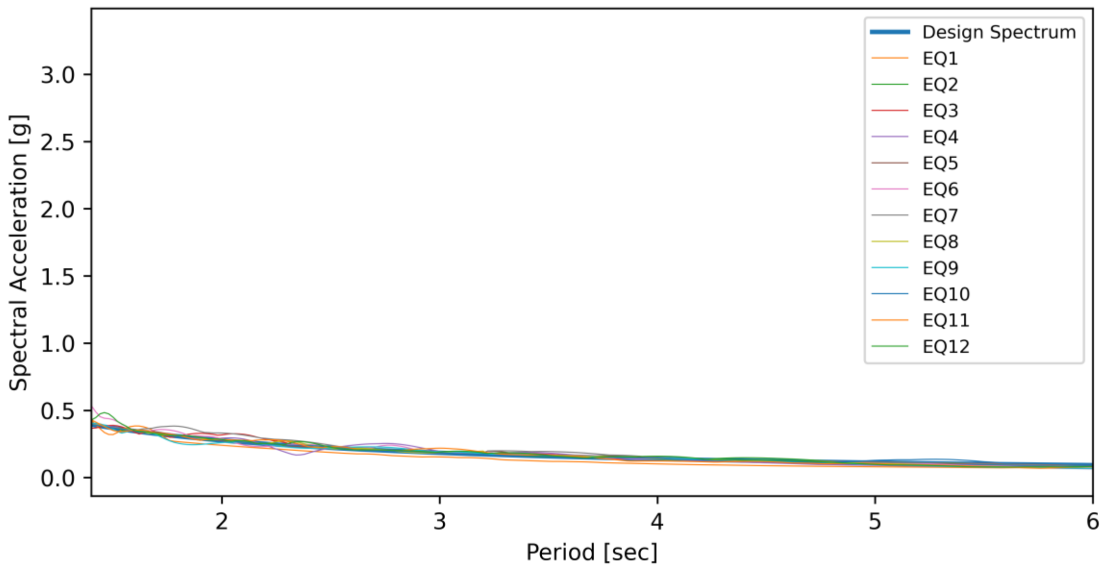


Figure 2.7 Close look matched Spectral Acceleration for all Earthquake

Table 2.3 Ground motion parameters for unmatched accelerograms

Ground Motion Parameter for Original Accelerograms												
Accelerogram	1	2	3	4	5	6	7	8	9	10	11	12
Max Aceleration (g)	0.08376	0.10838	0.05426	0.361	0.3513	0.1948	0.3152	0.3447	0.349	0.5683	0.23573	0.82243
Max Velocity (cm/sec)	7.27379	17.08519	4.84319	21.54766	22.01953	12.35471	31.49599	27.67793	62.18167	51.82672	58.08495	62.10125
Max Displacement (cm)	5.54122	2.89623	1.51534	21.88302	4.0671	4.30014	14.12637	9.69435	51.30239	9.0347	32.11539	13.55936
Vmax/Amax (sec)	0.08853	0.1607	0.09099	0.06084	0.06389	0.06465	0.10186	0.08185	0.18162	0.09296	0.25118	0.07697
Acceleration RMS (g)	0.01366	0.01432	0.0065	0.02148	0.03733	0.02046	0.04559	0.05174	0.04954	0.06667	0.04352	0.05311
Velocity RMS (cm/sec)	1.58103	2.33691	0.71355	4.08563	2.87789	2.732	6.56596	6.30432	17.19039	7.274	10.44089	7.72856
Displacement RMS (cm)	2.50511	0.5949	0.21039	6.46829	0.83609	1.14019	5.18814	2.29461	15.00798	2.38022	5.13369	2.85096
Arias Intensity	0.06537	0.33178	0.0799	0.37522	0.78025	0.25754	1.2646	1.68744	1.32244	2.7321	2.41567	2.43008
Characteristic Intensity	0.00761	0.01756	0.00581	0.02287	0.04348	0.01849	0.06116	0.07527	0.0652	0.10872	0.0826	0.09152
Specific Energy Density (cm2/sec)	56.81689	573.4207	62.43773	881.1901	300.8952	298.1053	1702.485	1625.944	10333.97	2110.622	9024.036	3338.939
Cum. Abs. Velocity (cm/sec)	194.8873	677.5817	382.8608	500.1236	557.1354	458.6146	891.5995	1161.368	991.3535	1292.805	2189.896	1165.445
Acc Spectrum Intensity (g*sec)	0.06598	0.09822	0.04977	0.15579	0.30148	0.16194	0.3366	0.32993	0.21397	0.52434	0.15777	0.47956
Vel Spectrum Intensity (cm)	18.56124	80.12688	25.0747	80.72922	93.48024	56.81163	139.6276	153.5786	168.0304	212.5725	264.1482	255.4487
Housner Intensity (cm)	16.75999	73.51774	22.4872	73.31293	73.07337	51.60288	124.0143	141.6449	176.1751	184.0054	269.1029	237.1019
Sustained Max.Acceleration (g)	0.05328	0.10425	0.04551	0.19	0.2628	0.0712	0.2717	0.2664	0.2046	0.4121	0.22221	0.33321
Sustained Max.Velocity (cm/sec)	4.64224	13.23406	4.0712	14.67576	14.06116	9.0664	23.10157	23.63425	40.54963	32.69281	42.75458	26.32703
Effective Design Acceleration (g)	0.07795	0.10603	0.05323	0.22432	0.32878	0.19825	0.33328	0.32884	0.32705	0.59429	0.22967	0.78601
A95 parameter (g)	0.00008	0.00011	0.00005	0.23176	0.24134	0.14376	0.23514	0.22785	0.23174	0.41088	0.17067	0.65877
Predominant Period (sec)	0	0	0	0	0	0	0	0	0	0	0.9	0
Significant Duration (sec)	9.19	20.59	27.27	11.78	4.24	16.53	8.92	12.86	15.62	9.06	38.02	9.35

Table 2.4 Ground motion parameters for matched accelerograms

Ground Motion Parameter for Matched Accelerograms												
Accelerogram	1	2	3	4	5	6	7	8	9	10	11	12
Max Aceleration (g)	1.03933	0.13913	0.68403	0.92872	0.93916	0.83966	0.7005	0.48103	0.20728	0.54363	0.19159	0.72803
Max Velocity (cm/sec)	90.25864	39.13579	62.40637	60.4348	75.72411	57.28178	65.93892	50.64314	38.93431	63.60308	48.78211	57.02457
Max Displacement (cm)	68.75962	23.18455	42.60773	60.40607	148.5187	37.68838	29.0631	93.87589	27.74894	227.1141	22.73659	121.7577
Vmax/Amax (sec)	0.08853	0.28673	0.093	0.06633	0.08219	0.06954	0.09595	0.10732	0.19148	0.11926	0.25955	0.07984
Acceleration RMS (g)	0.16952	0.02439	0.08121	0.05722	0.09798	0.09088	0.09486	0.07547	0.03169	0.06723	0.03206	0.0519
Velocity RMS (cm/sec)	19.61855	7.23586	10.67018	12.74746	11.84806	15.19197	14.63354	16.17242	10.96517	11.9202	9.2005	12.64193
Displacement RMS (cm)	31.08522	5.70287	5.91772	17.21362	90.67396	21.34777	13.12498	56.25012	10.01777	131.1372	6.09185	71.26817
Arias Intensity	10.06501	0.96289	12.4621	2.66353	5.37403	5.08302	5.47624	3.59084	0.54118	2.77869	1.31078	2.31993
Characteristic Intensity	0.33275	0.03904	0.25627	0.09945	0.18485	0.17314	0.18361	0.13262	0.03336	0.11011	0.05222	0.08839
Specific Energy Density (cm2/sec)	8748.491	5497.55	13961.75	8578.249	5099.876	9217.99	8456.406	10699.9	4204.615	5668.017	7007.264	8933.844
Cum. Abs. Velocity (cm/sec)	2418.054	1543.021	4731.231	1445.718	1490.271	2077.495	1879.933	1785.698	645.3177	1306.594	1671.887	1467.305
Acc Spectrum Intensity (g*sec)	0.8187	0.12406	0.62166	0.40378	0.77891	0.6996	0.71192	0.46837	0.12651	0.5178	0.11888	0.42326
Vel Spectrum Intensity (cm)	230.3216	137.1995	312.1866	209.8993	253.5204	254.6178	261.5799	195.0182	127.8504	215.7006	164.0383	235.7832
Housner Intensity (cm)	207.9705	142.7059	290.9	196.5347	218.6295	240.6011	228.8583	183.42	137.3222	196.4173	164.4677	234.9426
Sustained Max.Acceleration (g)	0.66109	0.12677	0.58421	0.51531	0.65213	0.31208	0.58433	0.40254	0.13213	0.44726	0.13314	0.1875
Sustained Max.Velocity (cm/sec)	57.60433	30.54071	60.12241	40.35156	39.48643	52.88832	48.98421	45.64708	23.93374	36.10406	30.09603	39.28817
Effective Design Acceleration (g)	0.96724	0.13791	0.67413	0.57122	0.88233	0.8548	0.73902	0.45732	0.19423	0.56961	0.18828	0.69523
A95 parameter (g)	0.00104	0.00014	0.00068	0.58324	0.63769	0.60959	0.50226	0.33239	0.12457	0.40881	0.11361	0.56277
Predominant Period (sec)	0.14	0	0	0	0.26	0	0.14	0	0	0	0.92	0
Significant Duration (sec)	9.19	46.28	26.65	15.77	4.58	17.09	9.37	16.04	14.77	9.09	38.61	19.72

CHAPTER 3

TIME HISTORY ANALYSIS FOR BUILDING WITHOUT ISOLATOR

3.1 Earthquake Load Analysis

This section presents the results of the time history analysis performed using Openseespy for the building defined in the Example model section. These results will be compared with the optimization of the isolator structure to be made later, and the results will be examined and interpreted in detail. Analyzes were carried out in the time domain, and structure analysis was performed using the Newmark-Beta method. Alpha and beta coefficients were chosen as 0.5 and 0.25, respectively, in accordance with the average acceleration method. The structure is modeled as a 3D moment frame. Additionally, analyzes were made by taking into account PDelta effects, which expresses the effect of increasing bending moment due to horizontal displacement. The structure, whose 3D view is shown in Figure 3.1, was subjected to time history analysis using 12 different earthquake ground motions.

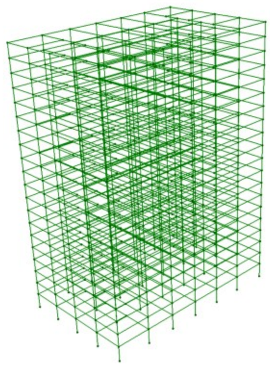


Figure 3.1 3D view of the structure

The modal properties of the structure are presented for the first 20 modes in Table 3.1 Modal properties of which include natural frequency, cyclic frequency, and period. Additionally, the modal participation factor for the first 20 modes in the horizontal (MX and MY), vertical (MZ) and rotational (RMX, RMY and RMZ) directions is shown in Table 3.2.

Table 3.1 Modal properties of uncontrolled building

Mode	Lambda	Omega	Frequency [Hz]	Period [sec]
1	5.874	2.424	0.386	2.593
2	7.334	2.708	0.431	2.320
3	11.165	3.341	0.532	1.880
4	40.322	6.350	1.011	0.989
5	52.484	7.245	1.153	0.867
6	76.621	8.753	1.393	0.718
7	103.607	10.179	1.620	0.617
8	122.897	11.086	1.764	0.567
9	124.279	11.148	1.774	0.564
10	124.579	11.162	1.776	0.563
11	138.117	11.752	1.870	0.535
12	149.571	12.230	1.946	0.514
13	166.611	12.908	2.054	0.487
14	175.414	13.244	2.108	0.474
15	215.239	14.671	2.335	0.428
16	233.999	15.297	2.435	0.411
17	269.235	16.408	2.611	0.383
18	297.799	17.257	2.747	0.364
19	330.945	18.192	2.895	0.345
20	384.050	19.597	3.119	0.321

Table 3.2, where the horizontal participation factor corresponds to the modal participation due to a unit excitation along the horizontal direction. Similarly, the vertical and rotational participation factors are obtained for unit vertical and rotational excitations, respectively. Among the first 20 modal responses, it is expected that modes 1, 2, 4, 5, 8, 11, 12, 14, 16, 18, 19 will have a larger vibrational contribution during horizontal excitations.

Based on Figure 3.2 and Table 3.2, we can conclude that the horizontal mode shape is dominant in the first, second, fourth and fifth modes. This conclusion is supported by the fact that the horizontal modal participation factor is larger than the vertical modal participation factor in these modes. On the other hand, the vertical mode shape is observed to be dominant in the 10th, 13th and 20th modes. Also, rotational mode shapes are dominant in the 3rd, 6th, 9th, 15th and 17th.

Table 3.2 Modal participation factors

Modal Participation Factors						
Mode	MX	MY	MZ	RMX	RMY	RMZ
1	4195.11	0	0	0	55947.6	0
2	0	4164.99	0	-57572.1	0	9.56E-08
3	0	0	0	0	0	90451.8
4	1668.36	0	0	0	-71033.4	0
5	0	1729.41	0	70762.6	0	0
6	0	0	0	0	0	-35545.1
7	928.093	0	0	0	-33026.9	0
8	0	51.9358	0	1673.48	0	0
9	0	0	0	0	0	7132.93
10	0	0	75.1231	0	0	0
11	421.74	0	0	0	-12951.9	0
12	0	1034.29	0	35303.1	0	0
13	0	0	54.406	0	0	0
14	-502.85	0	0	0	17243.2	0
15	0	0	0	0	0	-21674.9
16	610.119	0	0	0	-28615.4	0
17	0	0	0	0	0	-2644.61
18	0	-775.753	0	-32296.4	0	0
19	-458.366	0	0	0	13046.6	0
20	0	0	-2625.93	0	0	0

The structure is simulated with respect to twelve scaled horizontal earthquake records, and the maximum drift ratios are indicated in Table 3.3. The largest drift ratio occurs due to earthquake 3, the maximum drift ratio due to each earthquake is different, and they are not close to each other. Further, the maximum story shear force is given in Table 3.4. The largest maximum story shear force is 8,674 tf, while the smallest is 5,039 tf. As a conclusion, scaling the earthquake data does not result in the same order of structural responses.

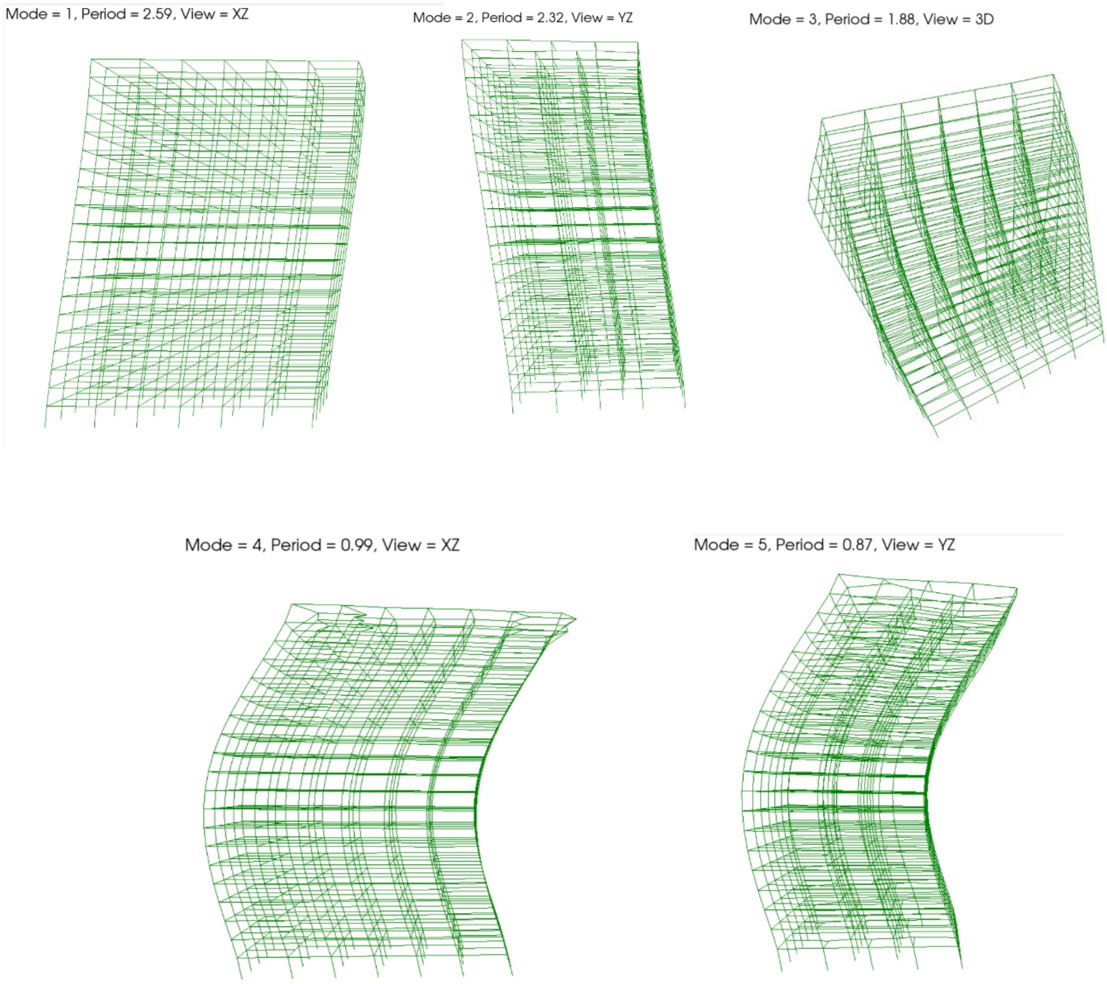


Figure 3.2 First 5 mode shapes for uncontrolled building

Table 3.3 Maximum drift ratios for uncontrolled building in each earthquake data

DRIFT RATIOS												
	EQ DATA											
STORY	1	2	3	4	5	6	7	8	9	10	11	12
1	0.39%	0.50%	0.67%	0.54%	0.63%	0.46%	0.39%	0.50%	0.40%	0.54%	0.49%	0.53%
2	0.57%	0.79%	1.06%	0.86%	0.99%	0.72%	0.62%	0.79%	0.64%	0.85%	0.77%	0.84%
3	0.63%	0.89%	1.19%	0.96%	1.08%	0.81%	0.69%	0.89%	0.73%	0.96%	0.86%	0.95%
4	0.64%	0.91%	1.22%	0.99%	1.05%	0.82%	0.70%	0.91%	0.76%	0.98%	0.89%	0.97%
5	0.66%	0.96%	1.26%	1.03%	1.05%	0.84%	0.71%	0.95%	0.80%	1.03%	0.93%	1.02%
6	0.65%	0.97%	1.24%	1.05%	1.00%	0.84%	0.70%	0.96%	0.81%	1.04%	0.94%	1.03%
7	0.64%	1.01%	1.22%	1.09%	0.94%	0.86%	0.72%	1.00%	0.84%	1.09%	0.93%	1.08%
8	0.63%	1.00%	1.10%	1.08%	1.01%	0.84%	0.72%	0.99%	0.82%	1.08%	0.88%	1.07%
9	0.62%	0.99%	1.09%	1.07%	1.14%	0.89%	0.73%	0.97%	0.80%	1.06%	0.91%	1.05%
10	0.63%	0.96%	1.04%	1.04%	1.22%	0.91%	0.74%	0.94%	0.76%	1.03%	0.90%	1.02%
11	0.72%	0.99%	1.13%	1.07%	1.35%	1.00%	0.79%	0.97%	0.77%	1.05%	0.94%	1.05%
12	0.80%	0.96%	1.15%	1.05%	1.36%	1.03%	0.79%	0.95%	0.75%	1.04%	0.95%	1.03%
13	0.90%	0.98%	1.27%	1.06%	1.46%	1.10%	0.79%	0.97%	0.76%	1.20%	1.00%	1.04%
14	0.95%	0.95%	1.45%	1.03%	1.51%	1.11%	0.76%	0.95%	0.74%	1.29%	1.00%	1.03%
15	0.98%	0.92%	1.66%	1.03%	1.53%	1.10%	0.74%	0.92%	0.73%	1.37%	1.02%	1.19%
16	0.92%	0.84%	1.76%	1.03%	1.41%	1.03%	0.70%	0.85%	0.69%	1.33%	0.98%	1.26%
17	0.95%	0.80%	1.92%	1.10%	1.31%	1.00%	0.71%	0.82%	0.69%	1.30%	0.98%	1.38%
18	1.03%	0.75%	1.99%	1.14%	1.30%	0.97%	0.73%	0.77%	0.68%	1.28%	1.06%	1.42%
19	1.03%	0.68%	1.92%	1.12%	1.39%	0.90%	0.73%	0.70%	0.64%	1.22%	1.30%	1.38%
20	1.16%	0.65%	2.02%	1.18%	1.60%	1.12%	0.80%	0.68%	0.68%	1.25%	1.62%	1.47%
MAX DRIFT RATIO	1.16%	1.01%	2.02%	1.18%	1.60%	1.12%	0.80%	1.00%	0.84%	1.37%	1.62%	1.47%

Table 3.4 Story shears for uncontrolled building in each earthquake data

STORY SHEARS [tf]												
	EQ DATA											
STORY	1	2	3	4	5	6	7	8	9	10	11	12
1	5,308	6,401	8,674	6,970	8,082	5,962	5,039	6,398	5,134	6,883	6,498	6,811
2	4,713	6,335	8,652	6,882	8,088	5,848	5,005	6,311	5,198	6,819	6,359	6,742
3	4,579	6,247	8,639	6,768	7,861	5,703	4,943	6,228	5,230	6,726	6,305	6,648
4	4,498	6,132	8,552	6,628	7,356	5,527	4,792	6,117	5,203	6,602	6,290	6,524
5	4,399	5,989	8,311	6,463	6,962	5,320	4,532	5,970	5,111	6,443	6,242	6,369
6	4,140	5,817	7,863	6,272	6,351	5,085	4,252	5,788	4,955	6,252	6,025	6,185
7	3,754	5,615	7,180	6,051	5,563	4,822	4,016	5,569	4,748	6,027	5,563	5,969
8	3,427	5,383	6,293	5,800	5,479	4,535	3,981	5,314	4,504	5,769	4,982	5,722
9	3,225	5,120	5,834	5,521	6,089	4,554	3,856	5,028	4,230	5,480	4,990	5,442
10	3,247	4,826	5,467	5,212	6,445	4,599	3,827	4,724	3,930	5,159	4,889	5,132
11	3,431	4,505	5,176	4,874	6,503	4,600	3,744	4,410	3,612	4,809	4,533	4,793
12	3,616	4,161	5,135	4,511	6,239	4,530	3,529	4,084	3,298	4,617	4,334	4,429
13	3,726	3,788	5,126	4,117	6,134	4,369	3,166	3,746	3,014	4,834	4,157	4,034
14	3,700	3,398	5,491	3,702	5,931	4,105	2,789	3,396	2,759	4,922	3,701	3,920
15	3,505	2,983	5,843	3,612	5,518	3,731	2,476	3,013	2,499	4,808	3,499	4,221
16	3,084	2,548	5,886	3,436	4,802	3,265	2,186	2,595	2,221	4,408	3,166	4,276
17	2,687	2,087	5,591	3,183	3,835	2,763	1,937	2,141	1,925	3,707	2,693	4,053
18	2,519	1,608	4,917	2,826	3,162	2,275	1,757	1,665	1,606	3,125	2,657	3,538
19	2,040	1,100	3,778	2,222	2,865	1,944	1,417	1,155	1,245	2,374	2,813	2,717
20	1,227	600	2,193	1,320	1,978	1,337	869	637	742	1,363	2,045	1,596
MAX STORY SHEAR	5,308	6,401	8,674	6,970	8,088	5,962	5,039	6,398	5,230	6,883	6,498	6,811

CHAPTER 4

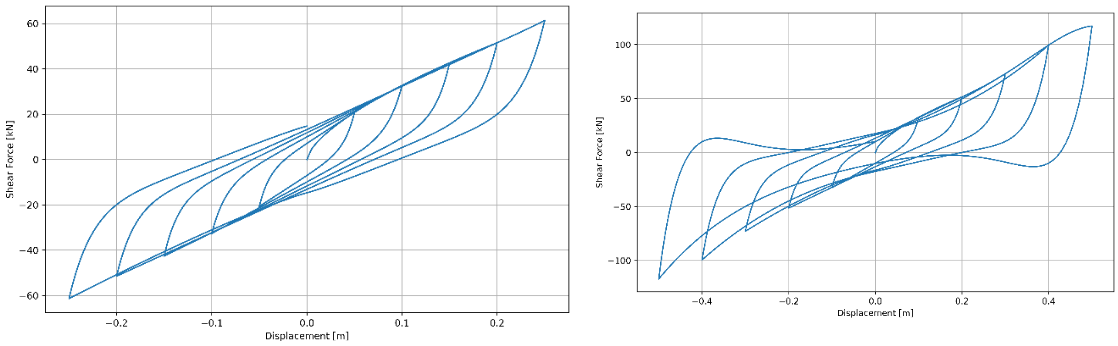
IMPROVEMENTS WITH INTERSTORY ISOLATION

4.1 Example Model

In this section, we will provide an overview of the 20-storey building that is planned to be optimized with isolators. Additionally, we will outline the key features of the isolators and provide information on how to determine the optimal location and parameters for the isolators. This will involve adjusting the isolator parameters and modifying the vertical position of the isolator to ensure that the isolator parameters are optimized as efficiently as possible.

Special materials called isolators are utilized to enhance the structural stability of buildings during earthquakes. These isolators shift the period of the building, separating it from the earthquake's dominant period, and aim to decrease the earthquake's effects by its internal damping. The seismic isolator material utilized in this study was high damping rubber (HDR), known as "KikuchiAikenHDR" which displays a nonlinear hysteresis behavior and was employed in Openseespy for the isolator's horizontal behavior. For the isolator's vertical behavior, an "Elastic" material was used.

The performance of HDR seismic isolators is impacted by the level of shear stress they encounter. In particular, the load history of elastomer bearings affects their mechanical properties. Under low displacements or low shear stresses the stiffness is more or less homogeneous as can be seen in Figure 4.1.a. In the case of high shear stresses in Figure 4.1.b, the stiffness of elastomeric bearings reduces and becomes highly nonlinear (Kikuchi and Aiken 1997). At each cycle of deformation, the energy that is absorbed by the isolator is equivalent to the area under the curve. These graphs were created in Openseespy using the "KikuchiAikenHDR" material.



a) Low shear displacement b) Large shear displacement

Figure 4.1 Shear force – displacement graphs for HDR isolator

As part of our efforts to optimize our building's seismic response, we incorporated "HDR seismic isolators" in various locations throughout our 20-story structure, resulting in 19 distinct models. Each model featured the isolator situated on a different floor, such as the first floor in Model 1, the second floor in Model 2, and so on. To better illustrate these diverse isolator placements, we have included examples. Figure 4.2 displays the isolator on the first floor, while Figure 4.3 showcases it on the third floor. Likewise, Figure 4.4 features the isolator on the eighteenth floor, and Figure 4.5 highlights its placement on the seventeenth floor. In each instance, the isolator was situated on a different level, progressing sequentially from the first floor to the nineteenth floor.

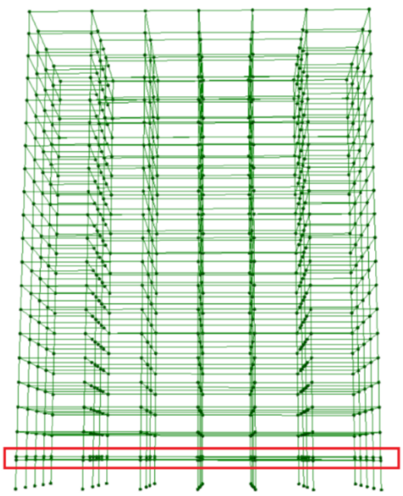


Figure 4.2 Controlled building when isolator is at the 1st floor

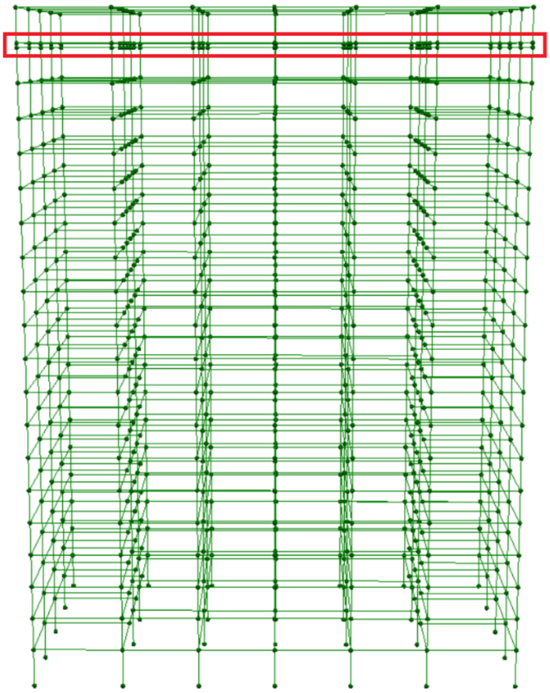


Figure 4.3 Controlled building when isolator at 19th floor

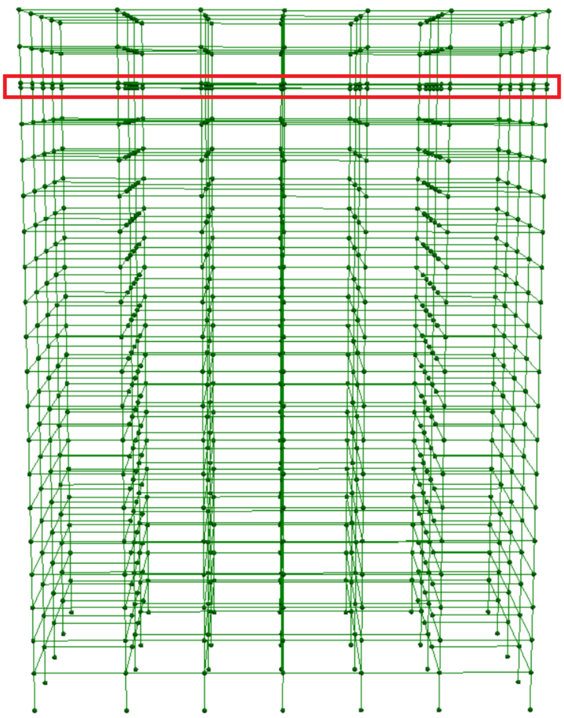


Figure 4.4 Controlled building when isolator at 18th floor

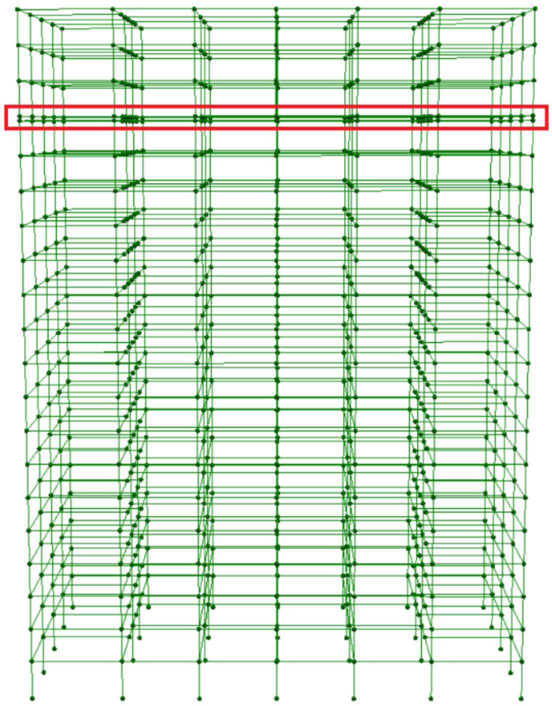


Figure 4.5 Controlled building when isolator at 17th floor

During the optimization of each model, the impact of "EQ12" was considered. The goal was to optimize the isolator parameters. Two distinct methods were employed for isolator optimization. For this purpose, first model (Figure 4.2, Figure 4.3, Figure 4.4, Figure 4.5) taken from the article (Medina and Mathiasson 2014) was used in the same way. The isolator parameters were derived from this optimization by only using “EQ12”. Later, the aforementioned earthquakes were applied to each model using these optimized parameters, and the simulation results were documented. In the second model, shear walls were added below the isolator floors to the structural model (Figure 4.6) which taken from the article and tried to determine optimum isolator parameter that would lead to the lowest story drift ratio. These isolator parameters were then employed to conduct a structural analysis using 12 different earthquakes. The results of the analysis, which included story shear forces and drift ratio, were presented in between and Table A2.24.

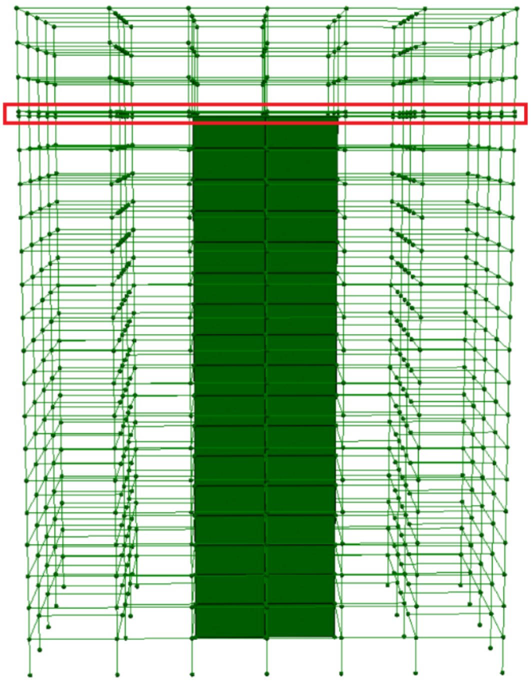


Figure 4.6 Controlled building with shear wall when isolator at 17th floor

4.2 Optimization with First Model

In this section, we have implemented earthquake excitation to the first model with the aim of determining the optimal isolator parameters that would effectively reduce the maximum story drift ratio. The isolator design parameters consist of the elastomer thickness (hr), isolator area (ar), and isolator axial stiffness. The parameters that have been presented in this section were chosen from the Bridgestone catalog, which is cited in section 1.2. Using this catalog is provided to ensure that all results are precise and more accurate for our work.

The objective was to decrease the maximum relative story drift ratio of the building floors (as stated in Equation 4.1), except for the isolator floor. Furthermore, we aimed for the drift ratio of the isolator layer to remain below 200% (as expressed in Equation 4.2), and story drift of the isolator layer remain below isolator radius length

($d_{isolator}$) (as expressed in Equation 4.3). With these parameters in mind, our goal was to discover the most efficient and effective values elastomer thickness, isolator area, and isolator axial stiffness.

$$\text{Minimize} \rightarrow f(X) = \left(\frac{\Delta_i}{h_i}\right)_{max} \quad 4.1$$

$$\text{Constrains} \rightarrow g_1(X) = \left(\frac{\Delta_{isolator}}{h_{isolator}}\right) \leq 200\% \quad 4.2$$

$$g_2(X) = \Delta_{isolator} \leq d_{isolator} \quad 4.3$$

The isolator parameters obtained from this optimization process are detailed in Table 4.1. Upon examining the table, it can be inferred that the optimal isolator parameters for each story are, in fact, not identical. We have observed that the isolator parameters at all levels between stories 13-14 are consistent with one another. Similarly, we have noted that isolator parameters between stories 15-16 are also identical.

Table 4.1 Optimized isolator parameters

Isolator Location	Isolator Model	Product	Cross sectional Area [m^2]	Rubber Height [m]
1	24	HH070X6R	0.3847	0.202
2	9	HH070X4S	0.3847	0.202
3	39	HL070X4S	0.3847	0.167
4	69	HT160X4S	0.6359	0.252
5	27	HH085X6R	0.5671	0.2
6	3	HM080X3R	0.5023	0.1564
7	14	HH095X4S	0.7085	0.198
8	44	HL090X4S	0.7085	0.168
9	30	HH100X6R	0.7849	0.201
10	72	HT100X6R	0.948	0.252
11	85	HS095X4S	0.948	0.222
12	57	HL100X6R	0.948	0.166
13	32	HH120X6R	1.1286	0.2
14	32	HH120X6R	1.1286	0.2
15	46	HL100X4S	0.948	0.166
16	46	HL100X4S	0.948	0.166
17	86	HS100X4S	1.1286	0.24
18	64	HT110X4S	1.1286	0.248
19	16	HH110X4S	0.948	0.2

The following information presents the optimum isolator parameters with maximum story drift ratio and maximum isolator story drift ratio as shown in Table 4.2. Additionally, Table 3.3 indicates that the maximum story drift ratio for an uncontrolled building is 1.00%. According to the data, placing the isolator on the first floor is recommended as it reduces the maximum story drift ratio more significantly than other stories. Conversely, placing the isolator on the 19th floor is not recommended because the maximum story drift ratio is already 1.00% for the uncontrolled building.

Table 4.2 Optimized isolator parameters with maximum story drift ratios

aIsolator Story	Isolator Model	Isolator Area	Isolator Rubber Height	Max Story Drift Ratio	Max Isolator Drift Ratio
1	24	0.3847	0.202	0.19%	72.21%
2	9	0.3847	0.202	0.20%	65.93%
3	39	0.3847	0.167	0.24%	57.67%
4	69	0.6359	0.252	0.38%	52.11%
5	27	0.5671	0.2	0.49%	49.79%
6	3	0.5023	0.1564	0.65%	48.90%
7	14	0.7085	0.198	0.74%	43.41%
8	44	0.7085	0.168	0.84%	42.84%
9	30	0.7849	0.201	0.84%	49.63%
10	72	0.948	0.252	0.83%	54.85%
11	85	0.948	0.222	0.76%	55.11%
12	57	0.948	0.166	0.72%	48.84%
13	32	1.1286	0.2	0.72%	46.79%
14	32	1.1286	0.2	0.72%	47.99%
15	46	0.948	0.166	0.72%	52.28%
16	46	0.948	0.166	0.69%	54.52%
17	86	1.1286	0.24	0.76%	56.34%
18	64	1.1286	0.248	0.90%	56.13%
19	16	0.948	0.2	1.01%	52.68%

A set of simulation is undertaken in which the optimum isolator dimensions are used at varying isolation levels under the action of the selected twelve earthquakes. The maximum results are tabulated in APPENDIX 1. Minimum responses are picked from the total responses, and they are presented below.

For each earthquake simulation, Table 4.3 presents the minimum drift ratio that occurs due to the optimum isolator placement. By analyzing the data, it is observed that if the isolator is situated on the first floor during EQ7, the maximum story drift ratio in the building will only be 0.14%. This model showcases the least drift ratios when compared to other optimized isolator placements. Further, the optimum isolator floor location is first or second story for each earthquake. Thus, from these outputs it is straight forward to select the isolator floor placement which will be the most beneficial for the building, and optimum isolator location is first 2 story.

Table 4.3 Summary of drift ratios for all EQ data

Minimum Drift Ratios					
		Uncontrolled building	Controlled Building	Location Of Isolator	Reduction
Earthquake Data	EQ1	1.16%	0.21%	1	81%
	EQ2	1.01%	0.23%	4	78%
	EQ3	2.02%	0.35%	2	83%
	EQ4	1.18%	0.23%	2	81%
	EQ5	1.60%	0.25%	1	84%
	EQ6	1.12%	0.26%	2	77%
	EQ7	0.80%	0.14%	1	83%
	EQ8	1.00%	0.16%	2	84%
	EQ9	0.84%	0.27%	2	68%
	EQ10	1.37%	0.17%	1	87%
	EQ11	1.62%	0.19%	1	88%
	EQ12	1.47%	0.19%	1	87%
	Min	0.80%	0.14%		
	Max	2.02%	0.35%		

In the decision making the maximum floor shear forces may be helpful. In this respect Table 4.4 is presented, in which the maximum floor shear forces are listed. The table shows the maximum floor shear forces of the building with isolators under earthquake loads under the title "Min Story Shear Controlled Building". It corresponds to the smallest of the maximum shear floor force values among all 19 isolator placements. The “isolator location” column reveals the corresponding isolator floor level. According to this table, if the isolator is placed above the first floor, the maximum floor shear force will be 1140 tf. This value is lower than the floor shear force values of other building models in which the isolator is placed at different floors. In addition, the time history analysis conducted under EQ12 loading of the structure without isolators results in a maximum floor shear force of 6811 tons. Thus, a reduction of 83% has been achieved.

Table 4.4 Summary of story shear for all EQ data

		Story shear uncontrolled building	Min story shear controlled building	Isolator location	Reduction
Earthquake Data	EQ1	5,308	2,030	1	62%
	EQ2	6,401	1,600	5	75%
	EQ3	8,674	2,067	1	76%
	EQ4	6,970	1,955	1	72%
	EQ5	8,088	1,877	1	77%
	EQ6	5,962	1,297	1	78%
	EQ7	5,039	1,211	1	76%
	EQ8	6,398	1,185	1	81%
	EQ9	5,230	1,701	2	67%
	EQ10	6,883	1,156	1	83%
	EQ11	6,498	3,572	1	45%
	EQ12	6,811	1,140	1	83%

Between Table A1.1 and Table A1.12 provide detailed information on the story drift ratios of building models, with and without isolators. The drift ratio of the isolator floor can be found in the "isolator floor" row of the table. For models with isolators, the "Isolator level" columns display the maximum drift ratios for each floor during an earthquake. It's worth noting that the drift ratios presented in the table do not occur simultaneously. Additionally, the highest drift ratio is listed in the bottom row and can be cross-checked with Table 4.5 for clarity.

In the event of an earthquake scenario 7, the minimum floor drift ratio of each model occurs when the isolator is placed on the 1st floor, and this drift rate is 0.14% for buildings equipped with isolators. The optimal isolator position is determined by

Equation 4.4, which takes into account the drift ratio. "O.I.L" refers to the optimum isolator location, while Δ_i represents floor displacement and h_i denotes floor height.

$$O.I.L_1 = \min_{isolator\ levels} \left\{ \left(\frac{\Delta_i}{h_i} \right)_{\max} \right\} \quad 4.4$$

Displayed in between Table A1.13 and Table A1.24 are the floor shear forces of structures both with and without isolators. To determine the optimal placement of the isolator, Equation 4.5 is utilized, which takes into account the story shear forces. Within this equation, "F_i" denotes the floor shear force of the respective floor.

$$O.I.L_2 = \min_{isolator\ levels} \{ F_{i,\max} \} \quad 4.5$$

In Table 4.5, you can find a comparison of the periods for the first 5 modes of each structure model with and without isolators. The structure without an isolator has a period of 2.59 seconds for its first mode. However, buildings with isolators have longer periods. The highest period value is 3.60 seconds when the isolator is located on the 1st floor, while the lowest period value among models with isolators is 2.74 seconds when the isolator is placed on the 19th floor. Hence, placing the isolator on the upper floors can bring the period of the structure with isolator closer to that of the structure without isolator.

Table 4.5 First 5 periods after optimization for all controlled model

			PERIODS 1	2	3	4	5
PERIOD OF THE STRUCTURES		NONISOLATOR BUILDING	2.59	2.32	1.88	0.99	0.87
	ISOLATOR LEVEL	1	3.60	3.43	2.43	1.26	1.17
		2	3.56	3.39	2.45	1.23	1.13
		3	3.37	3.18	2.33	1.17	1.07
		4	3.28	3.08	2.25	1.13	1.03
		5	3.18	2.97	2.19	1.10	0.99
		6	3.09	2.87	2.19	1.07	0.95
		7	3.01	2.78	2.12	1.04	0.93
		8	2.93	2.69	2.07	1.03	0.91
		9	2.93	2.69	2.06	1.03	0.91
		10	2.92	2.68	2.06	1.04	0.91
		11	2.86	2.61	2.04	1.05	0.93
		12	2.79	2.53	1.99	1.05	0.93
		13	2.78	2.51	1.99	1.06	0.94
		14	2.77	2.50	1.98	1.06	0.95
		15	2.76	2.48	1.99	1.06	0.95
		16	2.75	2.47	1.98	1.06	0.95
		17	2.75	2.47	1.98	1.06	0.95
		18	2.75	2.46	1.99	1.06	0.94
		19	2.74	2.46	1.98	1.05	0.92
		MIN PERIOD (sec)	2.59	2.32	1.88	0.99	0.87
		MAX PERIOD (sec)	3.60	3.43	2.45	1.26	1.17

4.3 Optimization with Second Model

In this section, we have integrated earthquake excitation into the second model, which was taken by adding shear walls to the first model. Our objective is to identify the ideal isolator parameters that can efficiently minimize the maximum story drift ratio. The isolator design parameters we have taken into account are the elastomer thickness (hr), isolator area (ar), and isolator axial stiffness. These parameters have been selected from the Bridgestone catalog, same as the first model, as cited in section 1.2. By utilizing this catalog, we are able to aim to get more accurate results for our research.

Our primary goal was to minimize the maximum relative story drift ratio of all building floors, with the exception of the isolator floor. The EQ12 record is utilized during the optimization process to identify optimum isolator parameters. As outlined in Equation 4.1, this was our primary objective. We also strived to ensure that the drift ratio of the isolator layer did not exceed 200% (as noted in Equation 4.2) and that the story drift of the isolator layer remained below the isolator radius length ($d_{isolator}$) (as detailed in Equation 4.3). With these criteria in mind, our main focus was on identifying the most efficient and effective values for the elastomer thickness, isolator area, and isolator axial stiffness.

The section aimed to optimize the isolation parameters for each model which include shear walls. The isolator parameters that were obtained from the optimization process have been presented in Table 4.6. Upon careful examination of the table, it can be inferred that the optimal isolator parameters for each story are not identical. Nevertheless, it has been observed that the isolator parameters for the 1st, 2nd, 5th, and 6th models are consistent with one another. Similarly, the isolator parameters for the 3rd, 4th, and 7th models are also identical. Furthermore, it can be seen that the 10th and 11th models have the same isolators. Similarly, models 14, 15, and 18 share the same isolators, while models 16 and 17 share a common set of isolators.

Table 4.6 Optimized isolator parameters

Isolator Location	Isolator Model	Product	Cross sectional Area [m^2]	Rubber Height [m]	Compressive ($\times 10^3$kN/m) stiffness
1	9	HH070X4S	0.3847	0.202	2290
2	9	HH070X4S	0.3847	0.202	2290
3	24	HH070X6R	0.3847	0.202	2660
4	24	HH070X6R	0.3847	0.202	2660
5	9	HH070X4S	0.3847	0.202	2290
6	9	HH070X4S	0.3847	0.202	2290
7	24	HH070X6R	0.3847	0.202	2660
8	25	HH075X6R	0.4416	0.2	3090
9	52	HL070X6R	0.4416	0.165	3200
10	26	HH080X6R	0.5023	0.2	3510
11	26	HH080X6R	0.5023	0.2	3510
12	72	HT100X6R	0.948	0.252	4420
13	73	HT110X6R	1.1286	0.248	5240
14	87	HS110X4S	1.3249	0.261	5120
15	87	HS110X4S	1.3249	0.261	5120
16	88	HS120X4S	1.5361	0.279	5650
17	88	HS120X4S	1.5361	0.279	5650
18	87	HS110X4S	1.3249	0.261	5120
19	31	HH110X6R	0.948	0.2	6590

Below, you'll find information on the optimal isolator parameters for maximum story drift ratio and isolator story drift ratio, as presented in Table 4.7. According to Table 3.3, the maximum story drift ratio for an uncontrolled building is 1.47%. Based on this data, it's advised to install the isolator on the fourth floor, as it significantly reduces the maximum story drift ratio compared to other floors. However, it's best to avoid placing the isolator between the 12th and 15th floors, as the maximum story drift ratio is already 1.47% for the uncontrolled building, and maximum drift ratios exceed that of the uncontrolled building.

Table 4.7 Optimized isolator parameters with maximum story drift ratios

Isolator Story	Isolator Model	Isolator Area	Isolator Rubber Height	Max Story Drift Ratio	Max Isolator Drift Ratio
1	9	0.3847	0.202	0.256%	87.23%
2	9	0.3847	0.202	0.273%	84.53%
3	24	0.3847	0.202	0.279%	81.22%
4	24	0.3847	0.202	0.263%	74.18%
5	9	0.3847	0.202	0.283%	67.91%
6	9	0.3847	0.202	0.325%	61.37%
7	24	0.3847	0.202	0.370%	59.31%
8	25	0.4416	0.2	0.597%	53.98%
9	52	0.4416	0.165	0.741%	48.45%
10	26	0.5023	0.2	0.797%	49.67%
11	26	0.5023	0.2	0.734%	49.75%
12	72	0.948	0.252	1.593%	50.94%
13	73	1.1286	0.248	2.228%	58.99%
14	87	1.3249	0.261	2.142%	61.05%
15	87	1.3249	0.261	1.543%	64.72%
16	88	1.5361	0.279	1.338%	61.17%
17	88	1.5361	0.279	1.377%	58.35%
18	87	1.3249	0.261	1.283%	58.28%
19	31	0.948	0.2	0.772%	52.26%

Comprehensive tables (tabulated in APPENDIX 2) illustrates the isolator parameters, story shear, and drift ratio for 12 distinct earthquakes. For each earthquake simulation, Table 4.8 presents the minimum drift ratios that occurs due to the optimum isolator placement. By analyzing the data, it is observed that if the isolator is situated on the fifth floor during EQ8, the maximum story drift ratio in the building will only be 0.17%. This model showcases the least drift ratios when compared to other optimized isolator placements. Further, the optimum isolator floor location varies for each earthquake. Thus, from these outputs it is not straight forward to select the isolator floor placement which will be the most beneficial for the building.

Table 4.8 Summary of drift ratios for all EQ data

Minimum Drift Ratios					
		Uncontrolled building	Controlled Building	Location Of Isolator	Reduction
Earthquake Data	EQ1	1.16%	0.27%	4	77%
	EQ2	1.01%	0.22%	7	78%
	EQ3	2.02%	0.35%	1	83%
	EQ4	1.18%	0.26%	6	78%
	EQ5	1.60%	0.32%	2	80%
	EQ6	1.12%	0.26%	1	77%
	EQ7	0.80%	0.19%	2	76%
	EQ8	1.00%	0.17%	5	83%
	EQ9	0.84%	0.28%	6	67%
	EQ10	1.37%	0.21%	5	85%
	EQ11	1.62%	0.25%	1	85%
	EQ12	1.47%	0.26%	1	83%
	Min	0.80%	0.17%		
	Max	2.02%	0.35%		

When making decisions, it can be beneficial to take into account the maximum floor shear forces. Table 4.9 offers this data by presenting the highest floor shear forces of a structure with isolators under earthquake loads. The table is labeled "Min Story Shear Controlled Building" and exhibits the minimum maximum shear floor force value among all 19 isolator placements. The "Isolator Location" column indicates the corresponding isolator floor level, which can be determined using equation 4.4. According to this table, if the isolator is placed above the first floor, the maximum floor shear force will be 1417 tf. This value is lower than the floor shear force values of other building models in which the isolator is placed at different floors. In addition, the time history analysis conducted under EQ7 loading of the structure without isolators results in a maximum floor shear force of 5039 tons. Thus, a reduction of 72% has been achieved.

Table 4.9 Summary of story shears for all EQ datas

		Story shear uncontrolled building	Min story shear controlled building	Isolator location	Reduction
Earthquake Data	EQ1	5,308	2,579	1	51%
	EQ2	6,401	1,790	6	72%
	EQ3	8,674	2,560	1	70%
	EQ4	6,970	2,621	1	62%
	EQ5	8,088	2,233	1	72%
	EQ6	5,962	1,579	1	74%
	EQ7	5,039	1,417	1	72%
	EQ8	6,398	1,583	3	75%
	EQ9	5,230	2,034	1	61%
	EQ10	6,883	1,934	2	72%
	EQ11	6,498	3,531	1	46%
	EQ12	6,811	1,669	1	75%

Between Table A2.1 and Table A2.12 provide detailed information on the story drift ratios of building models, with and without isolators. The drift ratio of the isolator floor can be found in the "isolator floor" row of the table. For models with isolators, the "Isolator level" columns display the maximum drift ratios for each floor during an earthquake. It's worth noting that the drift ratios presented in the table do not occur simultaneously. Additionally, the highest drift ratio is listed in the bottom row and can be cross-checked with Table 4.8 for clarity.

In the event of an earthquake scenario 8, the minimum floor drift ratio of each model occurs when the isolator is placed on the 5th floor, and this drift rate is 0.17% for buildings equipped with isolators. The optimal isolator position is determined by Equation 4.4, which takes into account the drift ratio. "O.I.L" refers to the optimum isolator location, while Δ_i represents floor displacement and h_i denotes floor height.Table A2.13 and Table A2.24 are the floor shear forces of structures both with and without isolators. To determine the optimal placement of the isolator, Equation 4.5 is utilized, which takes into account the story shear forces. Within this equation, "F_i" denotes the floor shear force of the respective floor.

Table 4.10 displays the periods of the first 5 modes of each structural model with and without an isolator. The fundamental mode of the structure without an isolator has a period of 2.59 seconds, whereas the highest period value is 3.89 seconds when an isolator is placed on the 1st floor. The lowest period of the fundamental mode among models with isolators is 1.59 seconds, which is observed when the isolator is placed on the 19th floor. When the isolator is placed on the mid-floors, the period becomes close to the period of the structure without isolators. This is not helpful to reduce the story drift, because only placing isolator upper floors will making a contribution to the building behaving like have TMD.

Table 4.10 First 5 periods for controlled building

			PERIODS				
			1	2	3	4	5
PERIOD OF THE STRUCTURES		NONISOLATOR BUILDING	2.59	2.32	1.88	0.99	0.87
	ISOLATOR LEVEL	1	3.89	3.73	2.54	1.37	1.28
		2	3.77	3.62	2.48	1.32	1.23
		3	3.64	3.50	2.37	1.27	1.18
		4	3.52	3.40	2.30	1.22	1.13
		5	3.39	3.29	2.27	1.17	1.08
		6	3.26	3.18	2.19	1.12	1.03
		7	3.13	3.06	2.08	1.06	0.98
		8	2.87	2.82	1.93	0.99	0.92
		9	2.60	2.58	1.79	0.91	0.85
		10	2.53	2.52	1.73	0.87	0.81
		11	2.42	2.38	1.65	0.81	0.76
		12	2.12	2.04	1.47	0.73	0.72
		13	1.96	1.82	1.35	0.70	0.67
		14	1.85	1.66	1.26	0.71	0.63
		15	1.77	1.52	1.19	0.71	0.62
		16	1.70	1.38	1.10	0.70	0.62
		17	1.64	1.25	1.04	0.67	0.61
		18	1.61	1.16	0.99	0.63	0.58
		19	1.59	1.10	0.95	0.55	0.50
		MIN PERIOD (sec)	1.59	1.10	0.95	0.55	0.50
		MAX PERIOD (sec)	3.89	3.73	2.54	1.37	1.28

CHAPTER 5

IMPROVEMENTS WITH BASE ISOLATION

In this section, we have effected earthquake excitation into the example model which was introduced in section 4.1 by integrating an isolator to the base (Figure 5.1). The primary objective of this endeavor is to determine the optimal isolator parameters, which will effectively reduce the maximum story drift ratio. The isolator design parameters that we have considered consist of the elastomer thickness (hr), isolator area (ar), and isolator axial stiffness. These parameters have been chosen from the Bridgestone catalog, which we have cited in section 1.2.

Our main objective was to reduce the maximum relative story drift ratio of all building floors, except for the isolator floor. This was stated in Equation 4.1. Additionally, we aimed to keep the drift ratio of the isolator layer below 200% (as per Equation 4.2), and to ensure that the story drift of the isolator layer remained below the isolator radius length ($d_{isolator}$) (as per Equation 4.3). To achieve these goals, we set out to determine the most efficient and effective values for the elastomer thickness, isolator area, and isolator axial stiffness.

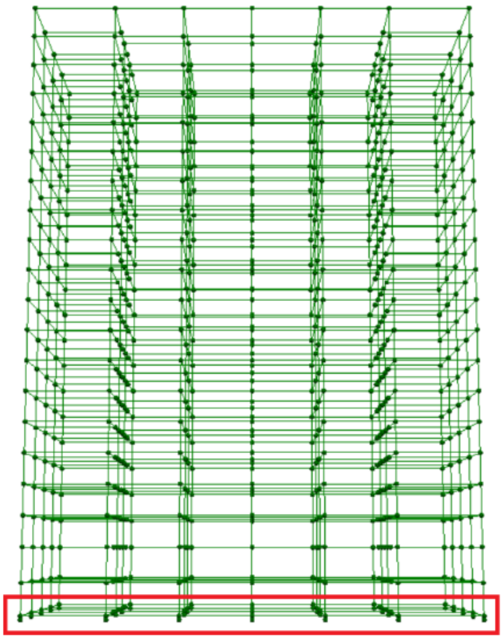


Figure 5.1 Base isolated building

This section aimed to optimize the isolation parameters for the model, which included the base isolator. The isolator parameters obtained from the optimization process have been presented in Table 5.1 and Table 5.2. Based on the results presented in Table 5.2, it can be concluded that the maximum story drift ratio is 0.19% when the isolator is located at the base.

Table 5.1 Optimized isolator parameters

Isolator Location	Isolator Model	Product	Cross sectional Area [m^2]	Rubber Height [m]	Compressive stiffness ($x10^3$kN/m)
Base	24	HH070X6R	0.3847	0.202	2660

Table 5.2 Optimized isolator parameters with maximum story drift ratios

Isolator Story	**Isolator Model**	**Isolator Area**	**Isolator Rubber Height**	**Max Story Drift Ratio**	**Max Isolator Drift Ratio**
Base	**24**	**0.3847**	**0.202**	**0.19%**	**72.73%**

For each earthquake simulation, Table 5.3 presents the minimum drift ratios that occurs due to the optimum isolator parameters. By analyzing the data, it is observed that if the isolator is situated on the fifth floor during EQ8, the minimum story drift ratio in the building will only be 0.14%.

Table 5.3 Summary of drift ratios for all EQ data

DRIFT RATIOS				
		UNCONTROLLED	BASE ISOLATION	Reduction
EARTHQUAKE DATAS	EQ1	1.16%	0.22%	81%
	EQ2	1.01%	0.24%	76%
	EQ3	2.02%	0.36%	82%
	EQ4	1.18%	0.23%	80%
	EQ5	1.60%	0.25%	85%
	EQ6	1.12%	0.26%	76%
	EQ7	0.80%	0.14%	82%
	EQ8	1.00%	0.17%	83%
	EQ9	0.84%	0.28%	67%
	EQ10	1.37%	0.17%	87%
	EQ11	1.62%	0.19%	88%
	EQ12	1.47%	0.19%	87%
	Min	0.80%	0.14%	
	Max	2.02%	0.36%	

When making decisions, it can be beneficial to take into account the maximum floor shear forces. Table 5.4 offers this data by presenting the highest floor shear forces of a structure with isolators under earthquake loads. According to this table, if the isolator is placed above the base floor, the minimum floor shear force will be 962 tf. In addition, the time history analysis conducted under EQ7 loading of the structure without isolators results in a maximum floor shear force of 5039 tons. Thus, a reduction of 81% has been achieved.

Table 5.4 Summary of story shear forces for all EQ data

SHEAR FORCES [tf]				
		UNCONTROLLED	BASE ISOLATION	Reduction
EARTHQUAKE DATAS	EQ1	5,308	1,347	75%
	EQ2	6,401	1,781	72%
	EQ3	8,674	1,918	78%
	EQ4	6,970	1,756	75%
	EQ5	8,088	1,452	82%
	EQ6	5,962	1,223	79%
	EQ7	5,039	962	81%
	EQ8	6,398	1,167	82%
	EQ9	5,230	1,744	67%
	EQ10	6,883	1,201	83%
	EQ11	6,498	1,126	83%
	EQ12	6,811	1,182	83%
	Min	5,039	962	
	Max	8,674	1,918	

The structure is simulated with respect to twelve scaled horizontal earthquake records, and the maximum drift ratios are indicated in Table 5.5. The largest drift ratio occurs due to earthquake 3, the maximum drift ratio due to each earthquake is different, and they are not close to each other. Further, the maximum story shear force is given in Table 5.6. The largest maximum story shear force is 962 tf, while the smallest is 1918 tf.

Table 5.5 Maximum drift ratios for base isolated building for each earthquake data

DRIFT RATIOS												
	EQ DATA											
STORY	1	2	3	4	5	6	7	8	9	10	11	12
ISOLATOR FLOOR	83.52%	105.62%	110.75%	104.60%	89.52%	75.33%	55.61%	71.65%	103.83%	73.95%	68.34%	72.73%
1	0.13%	0.17%	0.19%	0.16%	0.14%	0.12%	0.09%	0.11%	0.17%	0.11%	0.11%	0.11%
2	0.17%	0.24%	0.27%	0.22%	0.19%	0.17%	0.13%	0.15%	0.24%	0.16%	0.16%	0.15%
3	0.17%	0.24%	0.29%	0.22%	0.20%	0.18%	0.13%	0.16%	0.25%	0.16%	0.17%	0.15%
4	0.17%	0.24%	0.29%	0.21%	0.20%	0.19%	0.13%	0.16%	0.25%	0.16%	0.17%	0.14%
5	0.17%	0.24%	0.31%	0.22%	0.20%	0.20%	0.14%	0.16%	0.26%	0.17%	0.18%	0.14%
6	0.17%	0.24%	0.32%	0.21%	0.21%	0.20%	0.14%	0.16%	0.27%	0.17%	0.18%	0.15%
7	0.18%	0.24%	0.34%	0.22%	0.22%	0.22%	0.14%	0.17%	0.28%	0.17%	0.19%	0.16%
8	0.18%	0.23%	0.34%	0.22%	0.22%	0.22%	0.14%	0.16%	0.27%	0.17%	0.19%	0.16%
9	0.18%	0.23%	0.34%	0.22%	0.22%	0.22%	0.14%	0.16%	0.27%	0.17%	0.19%	0.16%
10	0.19%	0.22%	0.33%	0.22%	0.22%	0.21%	0.13%	0.16%	0.26%	0.16%	0.19%	0.17%
11	0.20%	0.22%	0.35%	0.23%	0.23%	0.23%	0.13%	0.16%	0.26%	0.17%	0.19%	0.18%
12	0.21%	0.22%	0.35%	0.22%	0.24%	0.24%	0.13%	0.16%	0.26%	0.16%	0.19%	0.18%
13	0.22%	0.23%	0.36%	0.23%	0.25%	0.25%	0.14%	0.16%	0.26%	0.17%	0.19%	0.19%
14	0.22%	0.22%	0.35%	0.23%	0.24%	0.26%	0.14%	0.15%	0.25%	0.16%	0.18%	0.18%
15	0.22%	0.22%	0.34%	0.23%	0.24%	0.26%	0.14%	0.15%	0.24%	0.16%	0.18%	0.19%
16	0.21%	0.20%	0.32%	0.21%	0.22%	0.25%	0.13%	0.14%	0.22%	0.15%	0.17%	0.19%
17	0.20%	0.20%	0.30%	0.21%	0.21%	0.25%	0.13%	0.13%	0.21%	0.14%	0.17%	0.19%
18	0.19%	0.19%	0.29%	0.20%	0.20%	0.24%	0.13%	0.12%	0.19%	0.15%	0.17%	0.19%
19	0.18%	0.17%	0.26%	0.19%	0.18%	0.22%	0.12%	0.11%	0.17%	0.15%	0.16%	0.18%
20	0.17%	0.16%	0.25%	0.18%	0.20%	0.22%	0.12%	0.11%	0.17%	0.16%	0.17%	0.18%
MAX DRIFT RATIO	0.22%	0.24%	0.36%	0.23%	0.25%	0.26%	0.14%	0.17%	0.28%	0.17%	0.19%	0.19%

Table 5.6 Story shears for base isolated building for each earthquake data

STORY SHEARS [tf]												
	EQ DATA											
STORY	1	2	3	4	5	6	7	8	9	10	11	12
ISOLATOR FLOOR	1,351	1,785	1,906	1,762	1,456	1,223	966	1,171	1,745	1,203	1,126	1,186
1	1,347	1,781	1,902	1,756	1,452	1,223	962	1,167	1,744	1,201	1,125	1,182
2	1,255	1,701	1,900	1,623	1,396	1,209	918	1,108	1,713	1,148	1,126	1,099
3	1,173	1,621	1,912	1,504	1,348	1,202	888	1,064	1,679	1,097	1,124	1,018
4	1,102	1,541	1,918	1,404	1,302	1,199	858	1,024	1,640	1,046	1,111	942
5	1,042	1,460	1,907	1,323	1,259	1,194	827	984	1,595	1,001	1,085	874
6	997	1,380	1,877	1,262	1,223	1,183	794	944	1,544	964	1,051	856
7	966	1,299	1,831	1,212	1,192	1,163	760	902	1,486	925	1,018	842
8	946	1,218	1,774	1,165	1,166	1,132	722	858	1,421	883	990	821
9	933	1,135	1,711	1,115	1,139	1,090	682	811	1,347	838	965	835
10	923	1,050	1,644	1,063	1,110	1,037	639	761	1,265	789	935	838
11	910	986	1,569	1,009	1,076	1,008	596	709	1,175	736	892	820
12	887	930	1,481	951	1,031	994	559	653	1,080	683	833	780
13	851	866	1,379	889	974	968	517	595	977	629	756	721
14	799	792	1,261	821	900	925	480	535	870	572	667	660
15	730	708	1,125	745	807	863	436	471	757	509	581	651
16	648	613	973	659	694	777	394	404	639	440	528	613
17	551	507	805	560	566	668	353	333	517	392	469	545
18	441	393	626	450	444	535	296	257	410	354	390	448
19	312	270	499	322	379	379	219	177	294	281	285	324
20	172	147	303	180	256	209	125	97	169	169	181	179
MAX STORY SHEAR	1,347	1,781	1,918	1,756	1,452	1,223	962	1,167	1,744	1,201	1,126	1,182

CHAPTER 6

CONCLUSIONS

The use of base isolators under buildings is widely used in passive control applications, while interstory isolation is still being investigated. The benefits and obligations of this methodology is not well described in the literature. Researchers explore ways to optimize structures by incorporating isolators on intermediate floors. In this particular study, a 20-story building had isolators installed on its intermediate floors resulting in 19 different models, and two different optimization methods were used to determine the optimal isolator dimensions.

In the first and second model, aimed to minimize the maximum drift ratio of all floors except for the isolator floor which involved HDR isolator parameters from the Bridgestone catalog. Afterward, time-history analysis was conducted using the obtained isolator cross-sectional area and elastomer height under 12 earthquake data. The analysis results included story shear, structure periods, and drift ratios.

It is seen that optimizing a building with isolators in interior floor can reduce building drift ratios. While the extent of the reduction depends on the earthquake excitation, it can be concluded that the midfloor isolation is not always minimized the maximum drift ratio. Because of the catalog is not entirely suitable for midstory isolation.

In the optimization of first model, it was found that 12 earthquake ground motions resulted in a maximum drift ratio of 0.35% and a minimum of 0.14%. The maximum story shear force was 3572 tf while the minimum was 1140 tf. Placing isolators on the lower floors proved to be the optimal approach in achieving minimum story shear force but resulted in a longer fundamental period compared to placing isolators on the upper floors. Also, the installation of isolators in mid-floors can have a beneficial effect on reducing both the maximum story drift ratio and the maximum story shear forces.

In the optimization of second model, a study of 12 earthquake data sets found that the maximum drift ratio was 0.35%, while the minimum was 0.17%. Additionally, placing isolators on the first floors can minimize story shear forces. Across all 12 earthquake scenarios, the maximum story shear force was 3531 tonf, and the minimum was 1417 tonf. In conclusion, if optimal results are desired, isolating first eleven floors will achieve the minimum drift ratio. The second model suggests that placing the isolator on the middle and top floors would not be advantageous, unlike the first model. This is because the isolator would not be able to increase the fundamental period enough or relocate it to a region where earthquake acceleration is lower. As a result, the isolator would not be able to serve its intended purpose.

In the optimization of base isolated model, it was found that 12 earthquake ground motions resulted in a maximum drift ratio of 0.36% and a minimum of 0.14%. The maximum story shear force was 1918 tf while the minimum was 962 tf.

When comparing the two models, it was found that the maximum story drift ratios were similar, but the story shear force was significantly lower in the first model. Therefore, if the objective is to achieve minimum story shear force, optimizing the first model is recommended. However, if minimizing drift ratios is the goal, then there is not much difference between the optimization using the first model and the second model.

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APPENDIX 1

Table A1.1 Drift ratios after optimization for EQ1 data

EARTHQUAKE DATA: EQ 1		DRIFT RATIOS – ISOLATOR LEVEL																				
STORY	UNCONTROLLED BUILDING	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19		
ISOLATOR FLOOR		83.37%	77.30%	68.04%	51.38%	48.25%	45.39%	39.70%	37.10%	36.09%	34.22%	46.30%	43.34%	40.12%	39.20%	38.75%	30.38%	27.68%	29.91%	28.78%		
1	0.39%	0.12%	0.20%	0.27%	0.32%	0.30%	0.25%	0.25%	0.32%	0.35%	0.36%	0.31%	0.30%	0.30%	0.32%	0.33%	0.34%	0.34%	0.35%	0.35%		
2	0.57%	0.14%	0.23%	0.36%	0.42%	0.41%	0.35%	0.35%	0.45%	0.51%	0.52%	0.45%	0.45%	0.46%	0.48%	0.50%	0.52%	0.52%	0.54%	0.54%		
3	0.63%	0.16%	0.15%	0.27%	0.36%	0.36%	0.33%	0.37%	0.45%	0.52%	0.53%	0.48%	0.49%	0.50%	0.52%	0.55%	0.56%	0.56%	0.57%	0.58%		
4	0.64%	0.16%	0.16%	0.16%	0.25%	0.31%	0.31%	0.38%	0.42%	0.46%	0.48%	0.45%	0.48%	0.49%	0.52%	0.54%	0.56%	0.55%	0.56%	0.58%		
5	0.66%	0.16%	0.17%	0.17%	0.18%	0.23%	0.30%	0.39%	0.42%	0.45%	0.48%	0.43%	0.47%	0.50%	0.53%	0.55%	0.57%	0.56%	0.58%	0.60%		
6	0.65%	0.17%	0.17%	0.18%	0.19%	0.18%	0.23%	0.36%	0.41%	0.44%	0.46%	0.42%	0.43%	0.48%	0.53%	0.55%	0.56%	0.56%	0.59%	0.60%		
7	0.64%	0.17%	0.19%	0.18%	0.21%	0.21%	0.20%	0.28%	0.37%	0.41%	0.47%	0.47%	0.45%	0.46%	0.54%	0.57%	0.59%	0.58%	0.61%	0.63%		
8	0.63%	0.18%	0.19%	0.18%	0.22%	0.22%	0.23%	0.23%	0.27%	0.34%	0.43%	0.52%	0.46%	0.43%	0.49%	0.56%	0.58%	0.57%	0.60%	0.61%		
9	0.62%	0.18%	0.20%	0.18%	0.22%	0.22%	0.23%	0.26%	0.25%	0.26%	0.38%	0.52%	0.53%	0.43%	0.48%	0.53%	0.57%	0.56%	0.60%	0.60%		
10	0.63%	0.18%	0.20%	0.18%	0.22%	0.21%	0.24%	0.29%	0.32%	0.25%	0.28%	0.47%	0.54%	0.50%	0.49%	0.50%	0.53%	0.55%	0.56%	0.57%		
11	0.72%	0.20%	0.21%	0.21%	0.23%	0.24%	0.28%	0.35%	0.40%	0.38%	0.28%	0.38%	0.54%	0.58%	0.52%	0.54%	0.57%	0.58%	0.59%	0.64%		
12	0.80%	0.20%	0.21%	0.22%	0.23%	0.27%	0.31%	0.39%	0.46%	0.47%	0.38%	0.33%	0.44%	0.57%	0.57%	0.55%	0.58%	0.58%	0.59%	0.70%		
13	0.90%	0.21%	0.22%	0.24%	0.25%	0.30%	0.35%	0.44%	0.54%	0.57%	0.47%	0.45%	0.43%	0.49%	0.61%	0.62%	0.60%	0.60%	0.66%	0.80%		
14	0.95%	0.21%	0.22%	0.24%	0.26%	0.31%	0.37%	0.48%	0.59%	0.63%	0.52%	0.49%	0.52%	0.44%	0.51%	0.63%	0.66%	0.59%	0.70%	0.86%		
15	0.98%	0.21%	0.22%	0.23%	0.26%	0.31%	0.38%	0.51%	0.63%	0.68%	0.55%	0.51%	0.55%	0.52%	0.44%	0.53%	0.67%	0.66%	0.76%	0.91%		
16	0.92%	0.20%	0.20%	0.21%	0.24%	0.29%	0.37%	0.50%	0.62%	0.68%	0.55%	0.51%	0.53%	0.53%	0.49%	0.41%	0.52%	0.63%	0.78%	0.90%		
17	0.95%	0.20%	0.19%	0.19%	0.22%	0.29%	0.38%	0.52%	0.63%	0.71%	0.60%	0.54%	0.54%	0.56%	0.55%	0.49%	0.42%	0.48%	0.78%	0.95%		
18	1.03%	0.19%	0.18%	0.19%	0.27%	0.34%	0.39%	0.52%	0.64%	0.73%	0.63%	0.56%	0.53%	0.56%	0.57%	0.54%	0.48%	0.38%	0.60%	0.92%		
19	1.03%	0.17%	0.17%	0.20%	0.30%	0.35%	0.39%	0.50%	0.61%	0.70%	0.61%	0.55%	0.53%	0.53%	0.56%	0.56%	0.51%	0.43%	0.43%	0.66%		
20	1.16%	0.17%	0.16%	0.24%	0.35%	0.40%	0.43%	0.53%	0.65%	0.74%	0.64%	0.59%	0.58%	0.54%	0.59%	0.63%	0.59%	0.53%	0.56%	0.43%		LOCATION
MAX DRIFT RATIO	1.16%	0.21%	0.23%	0.36%	0.42%	0.41%	0.43%	0.53%	0.65%	0.74%	0.64%	0.59%	0.58%	0.58%	0.61%	0.63%	0.67%	0.66%	0.78%	0.95%	0.21%	1

Table A1.2 Drift ratios after optimization for EQ2 data

EARTHQUAKE DATA: EQ 2		DRIFT RATIOS – ISOLATOR LEVEL																				
STORY	UNCONTROLLED BUILDING	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19		
ISOLATOR FLOOR		105.84%	101.25%	79.70%	52.90%	52.53%	50.75%	47.81%	44.27%	43.68%	42.98%	41.34%	36.08%	34.41%	33.65%	33.45%	31.27%	26.99%	19.57%	13.09%		
1	0.50%	0.11%	0.13%	0.13%	0.13%	0.12%	0.14%	0.14%	0.19%	0.21%	0.23%	0.25%	0.24%	0.23%	0.25%	0.27%	0.31%	0.34%	0.38%	0.42%		
2	0.79%	0.19%	0.18%	0.19%	0.20%	0.19%	0.22%	0.22%	0.29%	0.32%	0.36%	0.38%	0.37%	0.36%	0.39%	0.42%	0.49%	0.55%	0.61%	0.66%		
3	0.89%	0.23%	0.20%	0.19%	0.21%	0.22%	0.24%	0.26%	0.31%	0.35%	0.40%	0.42%	0.40%	0.40%	0.44%	0.47%	0.55%	0.61%	0.68%	0.74%		
4	0.91%	0.23%	0.22%	0.20%	0.18%	0.21%	0.24%	0.27%	0.30%	0.34%	0.40%	0.42%	0.40%	0.41%	0.45%	0.48%	0.56%	0.63%	0.70%	0.76%		
5	0.96%	0.24%	0.23%	0.22%	0.17%	0.19%	0.23%	0.28%	0.32%	0.34%	0.40%	0.42%	0.40%	0.43%	0.47%	0.50%	0.58%	0.65%	0.73%	0.79%		
6	0.97%	0.24%	0.23%	0.23%	0.20%	0.18%	0.20%	0.27%	0.32%	0.32%	0.39%	0.41%	0.40%	0.44%	0.48%	0.51%	0.59%	0.66%	0.73%	0.80%		
7	1.01%	0.24%	0.24%	0.24%	0.21%	0.22%	0.20%	0.24%	0.33%	0.34%	0.38%	0.41%	0.43%	0.47%	0.50%	0.53%	0.61%	0.69%	0.77%	0.83%		
8	1.00%	0.23%	0.23%	0.23%	0.21%	0.23%	0.23%	0.24%	0.28%	0.34%	0.37%	0.39%	0.45%	0.47%	0.50%	0.53%	0.61%	0.68%	0.76%	0.82%		
9	0.99%	0.23%	0.22%	0.23%	0.21%	0.24%	0.24%	0.26%	0.27%	0.29%	0.37%	0.40%	0.46%	0.47%	0.51%	0.52%	0.60%	0.68%	0.75%	0.81%		
10	0.96%	0.22%	0.21%	0.22%	0.21%	0.24%	0.24%	0.26%	0.30%	0.27%	0.32%	0.39%	0.45%	0.47%	0.51%	0.51%	0.60%	0.66%	0.73%	0.79%		
11	0.99%	0.22%	0.22%	0.23%	0.22%	0.25%	0.26%	0.27%	0.32%	0.32%	0.32%	0.36%	0.46%	0.50%	0.55%	0.55%	0.63%	0.68%	0.75%	0.81%		
12	0.96%	0.22%	0.21%	0.22%	0.22%	0.25%	0.26%	0.27%	0.32%	0.33%	0.35%	0.34%	0.40%	0.49%	0.56%	0.57%	0.63%	0.68%	0.74%	0.80%		
13	0.98%	0.23%	0.21%	0.23%	0.23%	0.27%	0.28%	0.28%	0.33%	0.34%	0.37%	0.40%	0.41%	0.45%	0.57%	0.60%	0.65%	0.72%	0.76%	0.83%		
14	0.95%	0.22%	0.21%	0.22%	0.23%	0.27%	0.28%	0.29%	0.32%	0.34%	0.37%	0.40%	0.46%	0.43%	0.49%	0.59%	0.64%	0.71%	0.75%	0.82%		
15	0.92%	0.22%	0.20%	0.22%	0.23%	0.27%	0.28%	0.29%	0.31%	0.34%	0.37%	0.40%	0.46%	0.49%	0.45%	0.51%	0.61%	0.69%	0.74%	0.81%		
16	0.84%	0.20%	0.19%	0.20%	0.21%	0.25%	0.27%	0.27%	0.29%	0.32%	0.35%	0.37%	0.43%	0.46%	0.47%	0.42%	0.49%	0.62%	0.70%	0.77%		
17	0.80%	0.20%	0.18%	0.20%	0.21%	0.25%	0.27%	0.26%	0.28%	0.31%	0.34%	0.36%	0.41%	0.45%	0.47%	0.47%	0.44%	0.49%	0.67%	0.76%		
18	0.75%	0.19%	0.17%	0.19%	0.20%	0.24%	0.26%	0.25%	0.26%	0.30%	0.33%	0.35%	0.39%	0.43%	0.45%	0.45%	0.48%	0.41%	0.55%	0.71%		
19	0.68%	0.17%	0.16%	0.17%	0.18%	0.22%	0.23%	0.23%	0.24%	0.27%	0.30%	0.33%	0.36%	0.39%	0.41%	0.41%	0.44%	0.45%	0.41%	0.52%		
20	0.65%	0.16%	0.15%	0.16%	0.18%	0.22%	0.23%	0.23%	0.24%	0.26%	0.30%	0.33%	0.36%	0.38%	0.41%	0.40%	0.43%	0.47%	0.46%	0.39%		LOCATION
MAX DRIFT RATIO	1.01%	0.24%	0.24%	0.24%	0.23%	0.27%	0.28%	0.29%	0.33%	0.35%	0.40%	0.42%	0.46%	0.50%	0.57%	0.60%	0.65%	0.72%	0.77%	0.83%	0.23%	4

Table A1.3 Drift ratios after optimization for EQ3 data

		DRIFT RATIOS																				
EARTHQUAKE DATA: EQ 3		ISOLATOR LEVEL																				
STORY	UNCONTROLLED BUILDING	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19		
ISOLATOR FLOOR		111.81%	110.00%	99.24%	88.92%	95.81%	93.26%	86.50%	74.32%	67.58%	66.66%	68.04%	52.18%	43.54%	33.93%	39.62%	39.35%	48.46%	47.92%	44.69%		
1	0.67%	0.13%	0.20%	0.27%	0.34%	0.50%	0.58%	0.65%	0.57%	0.69%	0.64%	0.56%	0.42%	0.36%	0.37%	0.34%	0.38%	0.41%	0.44%	0.50%		
2	1.06%	0.21%	0.23%	0.38%	0.46%	0.71%	0.84%	0.98%	0.86%	1.07%	1.01%	0.89%	0.68%	0.55%	0.56%	0.54%	0.58%	0.64%	0.69%	0.79%		
3	1.19%	0.27%	0.24%	0.31%	0.45%	0.67%	0.81%	1.02%	0.92%	1.17%	1.12%	1.00%	0.79%	0.61%	0.60%	0.58%	0.61%	0.70%	0.76%	0.88%		
4	1.22%	0.29%	0.28%	0.28%	0.33%	0.50%	0.65%	0.91%	0.90%	1.13%	1.11%	1.02%	0.83%	0.66%	0.57%	0.56%	0.60%	0.71%	0.76%	0.88%		
5	1.26%	0.31%	0.31%	0.34%	0.28%	0.34%	0.45%	0.75%	0.87%	1.07%	1.11%	1.03%	0.86%	0.71%	0.60%	0.53%	0.61%	0.74%	0.79%	0.89%		
6	1.24%	0.32%	0.33%	0.37%	0.34%	0.33%	0.34%	0.50%	0.77%	0.95%	1.03%	0.98%	0.85%	0.73%	0.65%	0.59%	0.62%	0.74%	0.81%	0.90%		
7	1.22%	0.34%	0.35%	0.40%	0.39%	0.43%	0.40%	0.37%	0.63%	0.83%	0.94%	0.92%	0.85%	0.75%	0.71%	0.65%	0.67%	0.75%	0.85%	0.93%		
8	1.10%	0.34%	0.35%	0.40%	0.41%	0.47%	0.48%	0.33%	0.38%	0.62%	0.74%	0.77%	0.75%	0.74%	0.72%	0.67%	0.71%	0.76%	0.85%	0.92%		
9	1.09%	0.34%	0.34%	0.40%	0.42%	0.48%	0.50%	0.36%	0.34%	0.35%	0.50%	0.58%	0.68%	0.72%	0.71%	0.70%	0.74%	0.80%	0.88%	0.93%		
10	1.04%	0.33%	0.34%	0.39%	0.42%	0.47%	0.48%	0.40%	0.44%	0.40%	0.30%	0.43%	0.61%	0.66%	0.66%	0.68%	0.73%	0.80%	0.89%	0.92%		
11	1.13%	0.35%	0.35%	0.40%	0.43%	0.49%	0.49%	0.47%	0.56%	0.63%	0.50%	0.38%	0.56%	0.64%	0.67%	0.69%	0.76%	0.84%	0.93%	0.94%		
12	1.15%	0.35%	0.34%	0.39%	0.42%	0.46%	0.45%	0.54%	0.69%	0.81%	0.69%	0.47%	0.43%	0.59%	0.64%	0.65%	0.75%	0.84%	0.91%	0.88%		
13	1.27%	0.36%	0.35%	0.40%	0.42%	0.45%	0.45%	0.65%	0.87%	1.02%	0.86%	0.63%	0.50%	0.50%	0.62%	0.65%	0.79%	0.89%	0.92%	0.92%		
14	1.45%	0.35%	0.34%	0.39%	0.40%	0.42%	0.52%	0.74%	1.02%	1.17%	0.98%	0.72%	0.59%	0.46%	0.52%	0.62%	0.78%	0.86%	0.91%	0.94%		
15	1.66%	0.34%	0.33%	0.37%	0.38%	0.42%	0.59%	0.81%	1.15%	1.30%	1.09%	0.79%	0.64%	0.54%	0.43%	0.51%	0.74%	0.79%	0.98%	1.02%		
16	1.76%	0.32%	0.30%	0.34%	0.35%	0.43%	0.61%	0.83%	1.19%	1.33%	1.12%	0.81%	0.67%	0.57%	0.52%	0.42%	0.53%	0.70%	0.97%	1.06%		
17	1.92%	0.30%	0.29%	0.32%	0.34%	0.44%	0.64%	0.86%	1.25%	1.39%	1.19%	0.86%	0.73%	0.63%	0.59%	0.58%	0.51%	0.53%	0.93%	1.11%		
18	1.99%	0.29%	0.27%	0.31%	0.36%	0.43%	0.63%	0.85%	1.24%	1.37%	1.20%	0.88%	0.76%	0.68%	0.64%	0.64%	0.69%	0.51%	0.70%	1.04%		
19	1.92%	0.26%	0.25%	0.30%	0.38%	0.43%	0.59%	0.79%	1.15%	1.27%	1.14%	0.84%	0.74%	0.69%	0.65%	0.64%	0.75%	0.66%	0.48%	0.72%		
20	2.02%	0.26%	0.26%	0.32%	0.43%	0.47%	0.59%	0.79%	1.13%	1.28%	1.18%	0.88%	0.78%	0.76%	0.75%	0.74%	0.85%	0.81%	0.67%	0.53%		LOCATION
MAX DRIFT RATIO	2.02%	0.36%	0.35%	0.40%	0.46%	0.71%	0.84%	1.02%	1.25%	1.39%	1.20%	1.03%	0.86%	0.76%	0.75%	0.74%	0.85%	0.89%	0.98%	1.11%	0.35%	2

Table A1.4 Drift ratios after optimization for EQ4 data

		DRIFT RATIOS																				
EARTHQUAKE DATA: EQ 4		ISOLATOR LEVEL																				
STORY	UNCONTROLLED BUILDING	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19		
ISOLATOR FLOOR		105.03%	101.58%	86.62%	77.95%	76.47%	80.59%	82.94%	80.04%	83.63%	78.45%	68.80%	53.92%	46.83%	43.54%	43.66%	40.43%	39.31%	35.45%	29.77%		
1	0.54%	0.12%	0.15%	0.21%	0.28%	0.30%	0.34%	0.38%	0.41%	0.42%	0.41%	0.39%	0.39%	0.39%	0.37%	0.37%	0.36%	0.38%	0.42%	0.45%		
2	0.86%	0.18%	0.19%	0.29%	0.41%	0.45%	0.51%	0.58%	0.63%	0.65%	0.64%	0.61%	0.61%	0.60%	0.58%	0.57%	0.54%	0.60%	0.66%	0.71%		
3	0.96%	0.21%	0.19%	0.25%	0.39%	0.46%	0.53%	0.63%	0.68%	0.71%	0.71%	0.69%	0.68%	0.66%	0.63%	0.62%	0.60%	0.67%	0.74%	0.80%		
4	0.99%	0.21%	0.21%	0.21%	0.29%	0.38%	0.47%	0.60%	0.67%	0.72%	0.72%	0.70%	0.70%	0.67%	0.64%	0.62%	0.60%	0.69%	0.76%	0.82%		
5	1.03%	0.21%	0.22%	0.23%	0.21%	0.27%	0.39%	0.56%	0.67%	0.73%	0.74%	0.73%	0.73%	0.69%	0.66%	0.64%	0.62%	0.71%	0.80%	0.86%		
6	1.05%	0.21%	0.22%	0.24%	0.24%	0.24%	0.26%	0.47%	0.61%	0.70%	0.74%	0.74%	0.74%	0.71%	0.67%	0.66%	0.63%	0.72%	0.81%	0.87%		
7	1.09%	0.22%	0.23%	0.24%	0.26%	0.29%	0.28%	0.34%	0.54%	0.67%	0.74%	0.76%	0.77%	0.75%	0.72%	0.70%	0.66%	0.75%	0.84%	0.91%		
8	1.08%	0.22%	0.22%	0.24%	0.26%	0.30%	0.34%	0.32%	0.37%	0.56%	0.67%	0.72%	0.75%	0.75%	0.72%	0.70%	0.67%	0.74%	0.83%	0.90%		
9	1.07%	0.22%	0.22%	0.24%	0.26%	0.29%	0.36%	0.39%	0.40%	0.39%	0.56%	0.66%	0.72%	0.74%	0.73%	0.71%	0.68%	0.73%	0.82%	0.89%		
10	1.04%	0.21%	0.22%	0.23%	0.25%	0.28%	0.35%	0.40%	0.47%	0.40%	0.39%	0.55%	0.65%	0.70%	0.72%	0.71%	0.68%	0.71%	0.80%	0.87%		
11	1.07%	0.22%	0.22%	0.24%	0.26%	0.29%	0.37%	0.43%	0.53%	0.51%	0.42%	0.42%	0.58%	0.68%	0.74%	0.75%	0.73%	0.74%	0.82%	0.90%		
12	1.05%	0.22%	0.22%	0.24%	0.26%	0.29%	0.37%	0.44%	0.54%	0.54%	0.50%	0.43%	0.43%	0.58%	0.68%	0.75%	0.74%	0.73%	0.81%	0.88%		
13	1.06%	0.23%	0.23%	0.25%	0.27%	0.30%	0.39%	0.47%	0.58%	0.58%	0.55%	0.53%	0.48%	0.45%	0.62%	0.73%	0.79%	0.79%	0.83%	0.90%		
14	1.03%	0.23%	0.23%	0.24%	0.27%	0.31%	0.40%	0.48%	0.59%	0.58%	0.56%	0.55%	0.57%	0.47%	0.48%	0.64%	0.76%	0.82%	0.81%	0.88%		
15	1.03%	0.23%	0.23%	0.24%	0.27%	0.31%	0.41%	0.50%	0.61%	0.59%	0.56%	0.56%	0.60%	0.58%	0.47%	0.50%	0.68%	0.81%	0.86%	0.86%		
16	1.03%	0.21%	0.21%	0.23%	0.26%	0.31%	0.41%	0.48%	0.59%	0.58%	0.55%	0.53%	0.58%	0.59%	0.55%	0.43%	0.51%	0.70%	0.83%	0.88%		
17	1.10%	0.21%	0.21%	0.22%	0.27%	0.32%	0.43%	0.49%	0.59%	0.63%	0.61%	0.53%	0.59%	0.61%	0.57%	0.54%	0.45%	0.52%	0.77%	0.93%		
18	1.14%	0.20%	0.20%	0.22%	0.27%	0.32%	0.43%	0.48%	0.58%	0.64%	0.63%	0.54%	0.58%	0.61%	0.57%	0.54%	0.53%	0.42%	0.58%	0.87%		
19	1.12%	0.19%	0.19%	0.20%	0.25%	0.33%	0.40%	0.44%	0.57%	0.60%	0.61%	0.52%	0.53%	0.57%	0.53%	0.54%	0.51%	0.48%	0.41%	0.60%		
20	1.18%	0.18%	0.19%	0.20%	0.26%	0.36%	0.41%	0.48%	0.62%	0.64%	0.63%	0.56%	0.57%	0.58%	0.53%	0.56%	0.57%	0.54%	0.53%	0.43%		LOCATION
MAX DRIFT RATIO	1.18%	0.23%	0.23%	0.29%	0.41%	0.46%	0.53%	0.63%	0.68%	0.73%	0.74%	0.76%	0.77%	0.75%	0.74%	0.75%	0.79%	0.82%	0.86%	0.93%	0.23%	2

Table A1.5 Drift ratios after optimization for EQ5 data

										DRIFT RATIOS												
EARTHQUAKE DATA: EQ 5		ISOLATOR LEVEL																				
STORY	UNCONTROLLED BUILDING	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19		
ISOLATOR FLOOR		90.63%	90.93%	85.30%	85.56%	87.11%	88.02%	83.17%	75.69%	75.80%	68.66%	57.98%	62.60%	67.85%	68.12%	66.08%	63.57%	63.63%	60.30%	44.59%		
1	0.63%	0.11%	0.22%	0.46%	0.61%	0.49%	0.48%	0.40%	0.43%	0.43%	0.49%	0.54%	0.52%	0.47%	0.42%	0.44%	0.42%	0.41%	0.47%	0.47%		
2	0.99%	0.16%	0.22%	0.55%	0.86%	0.73%	0.72%	0.60%	0.65%	0.66%	0.70%	0.80%	0.80%	0.75%	0.67%	0.68%	0.64%	0.63%	0.74%	0.74%		
3	1.08%	0.19%	0.18%	0.37%	0.75%	0.75%	0.73%	0.63%	0.70%	0.72%	0.72%	0.81%	0.84%	0.83%	0.77%	0.72%	0.70%	0.69%	0.81%	0.84%		
4	1.05%	0.20%	0.20%	0.22%	0.44%	0.60%	0.61%	0.64%	0.75%	0.70%	0.72%	0.74%	0.78%	0.80%	0.79%	0.75%	0.70%	0.71%	0.83%	0.86%		
5	1.05%	0.21%	0.22%	0.26%	0.22%	0.35%	0.44%	0.65%	0.82%	0.77%	0.73%	0.74%	0.74%	0.76%	0.79%	0.80%	0.76%	0.75%	0.88%	0.91%		
6	1.00%	0.21%	0.23%	0.27%	0.26%	0.25%	0.32%	0.56%	0.81%	0.79%	0.70%	0.73%	0.72%	0.71%	0.74%	0.80%	0.80%	0.75%	0.89%	0.93%		
7	0.94%	0.22%	0.24%	0.29%	0.29%	0.32%	0.34%	0.38%	0.71%	0.77%	0.69%	0.74%	0.74%	0.72%	0.72%	0.79%	0.85%	0.84%	0.89%	0.98%		
8	1.01%	0.22%	0.24%	0.29%	0.29%	0.34%	0.40%	0.33%	0.45%	0.62%	0.63%	0.72%	0.73%	0.77%	0.75%	0.73%	0.81%	0.86%	0.85%	0.99%		
9	1.14%	0.22%	0.24%	0.30%	0.29%	0.36%	0.42%	0.40%	0.37%	0.41%	0.55%	0.71%	0.78%	0.76%	0.77%	0.75%	0.77%	0.85%	0.88%	0.95%		
10	1.22%	0.22%	0.24%	0.29%	0.29%	0.37%	0.41%	0.40%	0.42%	0.34%	0.41%	0.59%	0.77%	0.79%	0.78%	0.77%	0.74%	0.82%	0.88%	0.89%		
11	1.35%	0.24%	0.25%	0.31%	0.30%	0.38%	0.43%	0.42%	0.45%	0.44%	0.41%	0.44%	0.70%	0.84%	0.86%	0.86%	0.78%	0.86%	0.93%	0.99%		
12	1.36%	0.24%	0.26%	0.31%	0.30%	0.36%	0.42%	0.41%	0.45%	0.54%	0.52%	0.42%	0.47%	0.74%	0.86%	0.90%	0.78%	0.86%	0.96%	1.05%		
13	1.46%	0.25%	0.27%	0.32%	0.32%	0.36%	0.44%	0.43%	0.55%	0.66%	0.61%	0.53%	0.50%	0.54%	0.80%	0.92%	0.91%	0.91%	1.02%	1.16%		
14	1.51%	0.25%	0.26%	0.31%	0.33%	0.36%	0.44%	0.42%	0.65%	0.76%	0.67%	0.57%	0.60%	0.50%	0.59%	0.85%	0.98%	1.02%	1.05%	1.19%		
15	1.53%	0.24%	0.26%	0.30%	0.34%	0.37%	0.45%	0.44%	0.75%	0.85%	0.73%	0.59%	0.62%	0.58%	0.55%	0.64%	0.96%	1.11%	1.16%	1.22%		
16	1.41%	0.22%	0.23%	0.29%	0.33%	0.37%	0.44%	0.48%	0.78%	0.86%	0.75%	0.57%	0.56%	0.53%	0.59%	0.58%	0.69%	1.03%	1.22%	1.27%		
17	1.31%	0.22%	0.23%	0.29%	0.34%	0.46%	0.46%	0.53%	0.82%	0.88%	0.79%	0.58%	0.52%	0.57%	0.71%	0.71%	0.66%	0.76%	1.22%	1.43%		
18	1.30%	0.20%	0.22%	0.29%	0.33%	0.55%	0.47%	0.54%	0.81%	0.86%	0.79%	0.59%	0.51%	0.62%	0.80%	0.77%	0.80%	0.63%	0.93%	1.42%		
19	1.39%	0.19%	0.20%	0.31%	0.34%	0.58%	0.51%	0.53%	0.75%	0.79%	0.75%	0.58%	0.52%	0.60%	0.81%	0.83%	0.82%	0.80%	0.64%	1.00%		
20	1.60%	0.20%	0.23%	0.36%	0.39%	0.68%	0.60%	0.57%	0.73%	0.82%	0.79%	0.63%	0.60%	0.63%	0.88%	0.94%	0.88%	0.95%	0.82%	0.65%		LOCATION
MAX DRIFT RATIO	1.60%	0.25%	0.27%	0.55%	0.86%	0.75%	0.73%	0.65%	0.82%	0.88%	0.79%	0.81%	0.84%	0.84%	0.88%	0.94%	0.98%	1.11%	1.22%	1.43%	0.25%	1

Table A1.6 Drift ratios after optimization for EQ6 data

										DRIFT RATIOS												
EARTHQUAKE DATA: EQ 6		ISOLATOR LEVEL																				
STORY	UNCONTROLLED BUILDING	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19		
ISOLATOR FLOOR		75.31%	73.43%	72.11%	75.05%	70.80%	64.78%	55.83%	48.49%	45.82%	49.30%	53.27%	46.23%	42.09%	41.15%	43.26%	40.82%	43.14%	40.57%	29.33%		
1	0.46%	0.08%	0.12%	0.27%	0.39%	0.41%	0.33%	0.24%	0.31%	0.33%	0.32%	0.29%	0.33%	0.34%	0.32%	0.29%	0.29%	0.31%	0.37%	0.43%		
2	0.72%	0.14%	0.13%	0.32%	0.53%	0.59%	0.51%	0.40%	0.48%	0.52%	0.50%	0.46%	0.52%	0.54%	0.51%	0.45%	0.45%	0.49%	0.58%	0.67%		
3	0.81%	0.17%	0.15%	0.18%	0.44%	0.56%	0.53%	0.45%	0.51%	0.56%	0.54%	0.51%	0.58%	0.61%	0.58%	0.51%	0.50%	0.56%	0.65%	0.75%		
4	0.82%	0.18%	0.18%	0.18%	0.22%	0.40%	0.44%	0.42%	0.49%	0.54%	0.52%	0.51%	0.59%	0.62%	0.59%	0.52%	0.51%	0.57%	0.65%	0.77%		
5	0.84%	0.20%	0.19%	0.22%	0.21%	0.23%	0.32%	0.36%	0.46%	0.52%	0.50%	0.52%	0.60%	0.63%	0.60%	0.54%	0.54%	0.59%	0.66%	0.79%		
6	0.84%	0.20%	0.20%	0.23%	0.24%	0.21%	0.24%	0.30%	0.41%	0.48%	0.45%	0.50%	0.58%	0.62%	0.59%	0.55%	0.55%	0.60%	0.67%	0.79%		
7	0.86%	0.22%	0.21%	0.24%	0.25%	0.23%	0.23%	0.27%	0.35%	0.45%	0.42%	0.49%	0.58%	0.62%	0.59%	0.56%	0.59%	0.62%	0.70%	0.83%		
8	0.84%	0.22%	0.22%	0.25%	0.24%	0.22%	0.24%	0.24%	0.29%	0.37%	0.37%	0.45%	0.54%	0.58%	0.56%	0.58%	0.60%	0.61%	0.69%	0.84%		
9	0.89%	0.22%	0.22%	0.25%	0.23%	0.22%	0.26%	0.25%	0.25%	0.27%	0.32%	0.40%	0.50%	0.55%	0.56%	0.59%	0.60%	0.60%	0.71%	0.84%		
10	0.91%	0.21%	0.22%	0.24%	0.22%	0.23%	0.28%	0.25%	0.29%	0.27%	0.28%	0.34%	0.45%	0.51%	0.54%	0.57%	0.59%	0.58%	0.71%	0.82%		
11	1.00%	0.23%	0.24%	0.25%	0.23%	0.25%	0.31%	0.30%	0.35%	0.36%	0.33%	0.35%	0.44%	0.49%	0.53%	0.59%	0.62%	0.62%	0.75%	0.88%		
12	1.03%	0.24%	0.24%	0.25%	0.24%	0.25%	0.31%	0.33%	0.38%	0.40%	0.39%	0.38%	0.43%	0.49%	0.51%	0.56%	0.60%	0.65%	0.79%	0.92%		
13	1.10%	0.26%	0.26%	0.26%	0.26%	0.25%	0.32%	0.37%	0.44%	0.46%	0.44%	0.45%	0.47%	0.47%	0.55%	0.56%	0.60%	0.71%	0.86%	1.00%		
14	1.11%	0.26%	0.26%	0.26%	0.27%	0.25%	0.32%	0.38%	0.48%	0.49%	0.48%	0.46%	0.52%	0.47%	0.50%	0.55%	0.62%	0.72%	0.88%	1.03%		
15	1.10%	0.27%	0.26%	0.27%	0.27%	0.25%	0.32%	0.38%	0.52%	0.52%	0.52%	0.47%	0.52%	0.54%	0.50%	0.51%	0.62%	0.70%	0.90%	1.06%		
16	1.03%	0.25%	0.25%	0.25%	0.26%	0.24%	0.31%	0.39%	0.52%	0.52%	0.53%	0.45%	0.48%	0.51%	0.54%	0.48%	0.51%	0.62%	0.84%	1.03%		
17	1.00%	0.25%	0.25%	0.25%	0.25%	0.26%	0.30%	0.41%	0.53%	0.53%	0.57%	0.46%	0.47%	0.49%	0.54%	0.58%	0.53%	0.50%	0.78%	1.03%		
18	0.97%	0.24%	0.24%	0.24%	0.24%	0.30%	0.31%	0.42%	0.53%	0.53%	0.59%	0.47%	0.50%	0.49%	0.52%	0.61%	0.60%	0.50%	0.62%	0.96%		
19	0.90%	0.22%	0.22%	0.22%	0.22%	0.31%	0.31%	0.39%	0.49%	0.49%	0.57%	0.45%	0.50%	0.49%	0.50%	0.59%	0.57%	0.56%	0.52%	0.69%		
20	1.12%	0.22%	0.21%	0.22%	0.27%	0.35%	0.36%	0.40%	0.49%	0.50%	0.60%	0.48%	0.54%	0.53%	0.55%	0.61%	0.65%	0.58%	0.62%	0.52%		LOCATION
MAX DRIFT RATIO	1.12%	0.27%	0.26%	0.32%	0.53%	0.59%	0.53%	0.45%	0.53%	0.56%	0.60%	0.52%	0.60%	0.63%	0.60%	0.61%	0.65%	0.72%	0.90%	1.06%	0.26%	2

Table A1.7 Drift ratios after optimization for EQ7 data

		DRIFT RATIOS																				
EARTHQUAKE DATA: EQ 7		ISOLATOR LEVEL																				
STORY	UNCONTROLLED BUILDING	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19		
ISOLATOR FLOOR		55.05%	51.60%	49.40%	52.95%	56.22%	56.25%	58.71%	57.95%	58.41%	52.53%	41.97%	43.89%	42.79%	41.11%	43.35%	39.85%	34.79%	25.35%	16.31%		
1	0.39%	0.07%	0.13%	0.19%	0.21%	0.22%	0.24%	0.24%	0.25%	0.24%	0.24%	0.24%	0.26%	0.27%	0.29%	0.30%	0.30%	0.30%	0.32%	0.36%		
2	0.62%	0.10%	0.14%	0.26%	0.30%	0.31%	0.35%	0.38%	0.39%	0.36%	0.38%	0.38%	0.40%	0.43%	0.45%	0.48%	0.49%	0.48%	0.50%	0.56%		
3	0.69%	0.13%	0.11%	0.20%	0.29%	0.29%	0.35%	0.43%	0.42%	0.41%	0.42%	0.43%	0.46%	0.48%	0.49%	0.53%	0.55%	0.55%	0.57%	0.62%		
4	0.70%	0.13%	0.13%	0.13%	0.22%	0.26%	0.32%	0.43%	0.42%	0.42%	0.42%	0.44%	0.46%	0.49%	0.49%	0.52%	0.57%	0.58%	0.59%	0.63%		
5	0.71%	0.13%	0.13%	0.15%	0.17%	0.22%	0.30%	0.41%	0.42%	0.43%	0.45%	0.44%	0.48%	0.50%	0.50%	0.52%	0.59%	0.62%	0.64%	0.67%		
6	0.70%	0.13%	0.14%	0.16%	0.19%	0.18%	0.24%	0.35%	0.38%	0.42%	0.45%	0.45%	0.48%	0.49%	0.50%	0.51%	0.58%	0.63%	0.66%	0.69%		
7	0.72%	0.14%	0.14%	0.17%	0.21%	0.22%	0.21%	0.29%	0.33%	0.41%	0.46%	0.47%	0.50%	0.51%	0.53%	0.56%	0.59%	0.65%	0.71%	0.73%		
8	0.72%	0.14%	0.14%	0.16%	0.21%	0.23%	0.25%	0.27%	0.27%	0.36%	0.43%	0.46%	0.48%	0.52%	0.56%	0.58%	0.61%	0.64%	0.70%	0.72%		
9	0.73%	0.13%	0.14%	0.16%	0.21%	0.23%	0.25%	0.31%	0.29%	0.31%	0.39%	0.44%	0.49%	0.53%	0.57%	0.60%	0.63%	0.64%	0.68%	0.71%		
10	0.74%	0.13%	0.14%	0.16%	0.20%	0.22%	0.25%	0.31%	0.33%	0.31%	0.33%	0.41%	0.51%	0.57%	0.55%	0.61%	0.64%	0.65%	0.65%	0.69%		
11	0.79%	0.13%	0.14%	0.17%	0.21%	0.23%	0.25%	0.32%	0.35%	0.38%	0.34%	0.36%	0.53%	0.62%	0.62%	0.63%	0.69%	0.71%	0.71%	0.69%		
12	0.79%	0.13%	0.14%	0.17%	0.21%	0.23%	0.25%	0.30%	0.36%	0.39%	0.39%	0.35%	0.47%	0.61%	0.65%	0.63%	0.70%	0.74%	0.73%	0.72%		
13	0.79%	0.14%	0.15%	0.18%	0.22%	0.23%	0.26%	0.29%	0.39%	0.43%	0.43%	0.42%	0.48%	0.55%	0.68%	0.69%	0.72%	0.78%	0.79%	0.78%		
14	0.76%	0.14%	0.15%	0.18%	0.21%	0.23%	0.26%	0.30%	0.41%	0.44%	0.45%	0.44%	0.54%	0.51%	0.58%	0.68%	0.68%	0.77%	0.81%	0.80%		
15	0.74%	0.14%	0.15%	0.17%	0.21%	0.22%	0.27%	0.32%	0.43%	0.46%	0.46%	0.45%	0.57%	0.59%	0.54%	0.57%	0.65%	0.74%	0.81%	0.82%		
16	0.70%	0.13%	0.14%	0.16%	0.20%	0.25%	0.28%	0.32%	0.43%	0.45%	0.44%	0.43%	0.56%	0.59%	0.61%	0.52%	0.54%	0.63%	0.75%	0.79%		
17	0.71%	0.13%	0.14%	0.16%	0.21%	0.29%	0.32%	0.33%	0.45%	0.46%	0.45%	0.44%	0.57%	0.61%	0.63%	0.61%	0.54%	0.51%	0.68%	0.79%		
18	0.73%	0.13%	0.13%	0.17%	0.25%	0.31%	0.34%	0.34%	0.45%	0.45%	0.44%	0.44%	0.56%	0.60%	0.63%	0.62%	0.60%	0.47%	0.53%	0.74%		
19	0.73%	0.12%	0.12%	0.18%	0.26%	0.29%	0.33%	0.32%	0.43%	0.41%	0.41%	0.41%	0.52%	0.57%	0.59%	0.57%	0.58%	0.52%	0.43%	0.53%		
20	0.80%	0.12%	0.12%	0.20%	0.30%	0.30%	0.35%	0.36%	0.44%	0.40%	0.40%	0.42%	0.54%	0.58%	0.59%	0.57%	0.59%	0.55%	0.51%	0.39%		LOCATION
MAX DRIFT RATIO	0.80%	0.14%	0.15%	0.26%	0.30%	0.31%	0.35%	0.43%	0.45%	0.46%	0.46%	0.47%	0.57%	0.62%	0.68%	0.69%	0.72%	0.78%	0.81%	0.82%	0.14%	1

Table A1.8 Drift ratios after optimization for EQ8 data

		DRIFT RATIOS																				
EARTHQUAKE DATA: EQ 8		ISOLATOR LEVEL																				
STORY	UNCONTROLLED BUILDING	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19		
ISOLATOR FLOOR		71.39%	68.07%	55.86%	49.49%	46.23%	42.68%	37.52%	36.93%	34.46%	33.63%	33.86%	41.83%	38.95%	35.66%	34.01%	28.43%	26.53%	21.35%	15.22%		
1	0.50%	0.08%	8.65E-04	0.12%	0.13%	0.12%	0.13%	0.16%	0.15%	0.16%	0.19%	0.23%	0.25%	0.25%	0.23%	0.24%	0.26%	0.31%	0.37%	0.42%		
2	0.79%	0.13%	0.12%	0.17%	0.21%	0.18%	0.20%	0.25%	0.24%	0.24%	0.29%	0.35%	0.40%	0.39%	0.36%	0.39%	0.42%	0.49%	0.58%	0.66%		
3	0.89%	0.15%	0.13%	0.14%	0.21%	0.20%	0.23%	0.25%	0.26%	0.27%	0.32%	0.39%	0.44%	0.43%	0.41%	0.43%	0.48%	0.56%	0.65%	0.74%		
4	0.91%	0.16%	0.15%	0.13%	0.17%	0.20%	0.22%	0.22%	0.27%	0.28%	0.31%	0.39%	0.44%	0.43%	0.42%	0.44%	0.49%	0.58%	0.66%	0.76%		
5	0.95%	0.16%	0.16%	0.15%	0.17%	0.17%	0.21%	0.23%	0.28%	0.29%	0.30%	0.40%	0.45%	0.43%	0.44%	0.46%	0.52%	0.60%	0.69%	0.79%		
6	0.96%	0.16%	0.16%	0.16%	0.19%	0.17%	0.18%	0.22%	0.28%	0.29%	0.31%	0.40%	0.45%	0.43%	0.45%	0.48%	0.54%	0.62%	0.71%	0.80%		
7	1.00%	0.17%	0.16%	0.17%	0.20%	0.21%	0.19%	0.21%	0.28%	0.30%	0.34%	0.41%	0.46%	0.44%	0.47%	0.51%	0.57%	0.65%	0.74%	0.84%		
8	0.99%	0.16%	0.16%	0.17%	0.20%	0.21%	0.21%	0.21%	0.25%	0.29%	0.34%	0.41%	0.45%	0.43%	0.45%	0.51%	0.58%	0.65%	0.74%	0.84%		
9	0.97%	0.16%	0.16%	0.17%	0.21%	0.21%	0.21%	0.24%	0.24%	0.26%	0.32%	0.39%	0.44%	0.44%	0.44%	0.51%	0.58%	0.65%	0.74%	0.83%		
10	0.94%	0.16%	0.15%	0.16%	0.20%	0.21%	0.21%	0.24%	0.26%	0.23%	0.27%	0.36%	0.41%	0.43%	0.44%	0.49%	0.57%	0.64%	0.73%	0.82%		
11	0.97%	0.16%	0.16%	0.17%	0.21%	0.22%	0.21%	0.24%	0.28%	0.28%	0.27%	0.32%	0.44%	0.49%	0.49%	0.50%	0.59%	0.66%	0.77%	0.85%		
12	0.95%	0.16%	0.15%	0.17%	0.21%	0.22%	0.22%	0.24%	0.28%	0.29%	0.30%	0.28%	0.41%	0.50%	0.51%	0.50%	0.58%	0.66%	0.76%	0.84%		
13	0.97%	0.16%	0.16%	0.17%	0.22%	0.23%	0.22%	0.24%	0.28%	0.31%	0.32%	0.33%	0.43%	0.47%	0.54%	0.55%	0.60%	0.68%	0.78%	0.86%		
14	0.95%	0.15%	0.15%	0.17%	0.21%	0.22%	0.22%	0.24%	0.28%	0.31%	0.32%	0.33%	0.47%	0.45%	0.49%	0.55%	0.58%	0.66%	0.76%	0.84%		
15	0.92%	0.15%	0.15%	0.16%	0.21%	0.22%	0.22%	0.23%	0.28%	0.31%	0.32%	0.32%	0.48%	0.51%	0.47%	0.50%	0.58%	0.65%	0.75%	0.82%		
16	0.85%	0.14%	0.14%	0.15%	0.20%	0.22%	0.21%	0.21%	0.26%	0.29%	0.30%	0.30%	0.45%	0.49%	0.50%	0.44%	0.49%	0.60%	0.69%	0.78%		
17	0.82%	0.13%	0.13%	0.14%	0.20%	0.23%	0.21%	0.20%	0.25%	0.29%	0.30%	0.30%	0.45%	0.49%	0.50%	0.50%	0.45%	0.50%	0.67%	0.78%		
18	0.77%	0.12%	0.12%	0.13%	0.20%	0.23%	0.21%	0.19%	0.24%	0.27%	0.29%	0.29%	0.44%	0.46%	0.47%	0.49%	0.49%	0.41%	0.55%	0.74%		
19	0.70%	0.11%	0.11%	0.12%	0.18%	0.22%	0.20%	0.18%	0.22%	0.25%	0.26%	0.27%	0.40%	0.42%	0.42%	0.44%	0.46%	0.44%	0.41%	0.55%		
20	0.68%	0.11%	0.11%	0.12%	0.19%	0.23%	0.21%	0.19%	0.22%	0.24%	0.26%	0.27%	0.40%	0.42%	0.42%	0.43%	0.46%	0.45%	0.47%	0.41%		LOCATION
MAX DRIFT RATIO	1.00%	0.17%	0.16%	0.17%	0.22%	0.23%	0.23%	0.25%	0.28%	0.31%	0.34%	0.41%	0.48%	0.51%	0.54%	0.55%	0.60%	0.68%	0.78%	0.86%	0.16%	2

Table A1.9 Drift ratios after optimization for EQ9 data

		DRIFT RATIOS																				
EARTHQUAKE DATA: EQ 9		ISOLATOR LEVEL																				
STORY	UNCONTROLLED BUILDING	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19		
ISOLATOR FLOOR		104.48%	104.18%	96.87%	90.14%	84.56%	79.35%	66.96%	62.20%	57.13%	56.74%	60.10%	45.27%	36.88%	32.43%	33.16%	26.56%	25.77%	20.12%	14.97%		
1	0.40%	0.11%	0.12%	0.14%	0.17%	0.23%	0.28%	0.32%	0.29%	0.31%	0.31%	0.29%	0.26%	0.25%	0.25%	0.28%	0.29%	0.31%	0.34%	0.36%		
2	0.64%	0.20%	0.17%	0.22%	0.26%	0.34%	0.43%	0.49%	0.44%	0.48%	0.47%	0.44%	0.40%	0.38%	0.39%	0.44%	0.45%	0.50%	0.55%	0.59%		
3	0.73%	0.24%	0.21%	0.23%	0.28%	0.35%	0.45%	0.52%	0.47%	0.51%	0.52%	0.49%	0.43%	0.42%	0.43%	0.49%	0.52%	0.57%	0.63%	0.67%		
4	0.76%	0.25%	0.24%	0.26%	0.25%	0.34%	0.40%	0.48%	0.45%	0.50%	0.51%	0.48%	0.42%	0.42%	0.44%	0.48%	0.53%	0.60%	0.66%	0.70%		
5	0.80%	0.26%	0.26%	0.30%	0.25%	0.30%	0.35%	0.44%	0.44%	0.50%	0.52%	0.48%	0.42%	0.44%	0.47%	0.49%	0.56%	0.64%	0.70%	0.74%		
6	0.81%	0.27%	0.26%	0.31%	0.28%	0.27%	0.30%	0.38%	0.41%	0.48%	0.51%	0.46%	0.43%	0.46%	0.50%	0.52%	0.58%	0.65%	0.72%	0.76%		
7	0.84%	0.28%	0.27%	0.32%	0.30%	0.33%	0.34%	0.31%	0.39%	0.47%	0.51%	0.46%	0.49%	0.53%	0.55%	0.57%	0.62%	0.68%	0.76%	0.80%		
8	0.82%	0.27%	0.26%	0.31%	0.29%	0.34%	0.39%	0.32%	0.33%	0.41%	0.47%	0.42%	0.51%	0.56%	0.58%	0.59%	0.64%	0.69%	0.76%	0.80%		
9	0.80%	0.27%	0.26%	0.31%	0.28%	0.33%	0.40%	0.37%	0.32%	0.33%	0.42%	0.43%	0.52%	0.58%	0.61%	0.61%	0.65%	0.69%	0.76%	0.80%		
10	0.76%	0.26%	0.25%	0.29%	0.27%	0.32%	0.39%	0.38%	0.36%	0.34%	0.32%	0.42%	0.49%	0.58%	0.62%	0.63%	0.66%	0.69%	0.74%	0.78%		
11	0.77%	0.26%	0.25%	0.30%	0.27%	0.32%	0.40%	0.42%	0.44%	0.44%	0.36%	0.38%	0.50%	0.59%	0.66%	0.69%	0.72%	0.74%	0.77%	0.81%		
12	0.75%	0.26%	0.24%	0.29%	0.26%	0.31%	0.38%	0.43%	0.48%	0.51%	0.44%	0.39%	0.43%	0.54%	0.64%	0.70%	0.74%	0.76%	0.77%	0.79%		
13	0.76%	0.26%	0.24%	0.29%	0.27%	0.32%	0.38%	0.46%	0.54%	0.58%	0.51%	0.47%	0.46%	0.46%	0.61%	0.72%	0.79%	0.79%	0.80%	0.79%		
14	0.74%	0.25%	0.23%	0.28%	0.27%	0.32%	0.36%	0.45%	0.57%	0.61%	0.54%	0.49%	0.53%	0.45%	0.49%	0.67%	0.77%	0.77%	0.78%	0.77%		
15	0.73%	0.24%	0.22%	0.27%	0.27%	0.32%	0.35%	0.44%	0.57%	0.62%	0.57%	0.51%	0.56%	0.54%	0.44%	0.54%	0.72%	0.75%	0.76%	0.75%		
16	0.69%	0.22%	0.20%	0.25%	0.25%	0.30%	0.32%	0.39%	0.53%	0.59%	0.55%	0.50%	0.55%	0.54%	0.49%	0.40%	0.54%	0.67%	0.70%	0.71%		
17	0.69%	0.21%	0.19%	0.25%	0.24%	0.29%	0.33%	0.40%	0.50%	0.57%	0.55%	0.51%	0.56%	0.55%	0.51%	0.45%	0.42%	0.52%	0.67%	0.74%		
18	0.68%	0.19%	0.19%	0.24%	0.24%	0.28%	0.33%	0.39%	0.47%	0.53%	0.53%	0.50%	0.54%	0.54%	0.50%	0.45%	0.47%	0.40%	0.53%	0.71%		
19	0.64%	0.17%	0.17%	0.22%	0.22%	0.26%	0.31%	0.37%	0.42%	0.47%	0.48%	0.47%	0.50%	0.49%	0.46%	0.42%	0.46%	0.45%	0.40%	0.50%		
20	0.68%	0.17%	0.17%	0.22%	0.23%	0.25%	0.31%	0.39%	0.42%	0.47%	0.48%	0.47%	0.50%	0.50%	0.46%	0.42%	0.46%	0.48%	0.50%	0.34%		LOCATION
MAX DRIFT RATIO	0.84%	0.28%	0.27%	0.32%	0.30%	0.35%	0.45%	0.52%	0.57%	0.62%	0.57%	0.51%	0.56%	0.59%	0.66%	0.72%	0.79%	0.79%	0.80%	0.81%	0.27%	2

Table A1.10 Drift ratios after optimization for EQ10 data

		DRIFT RATIOS																				
EARTHQUAKE DATA: EQ 10		ISOLATOR LEVEL																				
STORY	UNCONTROLLED BUILDING	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19		
ISOLATOR FLOOR		73.52%	70.58%	69.76%	64.02%	61.65%	57.72%	47.44%	48.05%	49.58%	46.80%	43.67%	37.70%	44.92%	50.96%	55.31%	55.00%	54.99%	50.54%	39.38%		
1	0.54%	0.07%	0.12%	0.24%	0.29%	0.25%	0.24%	0.21%	0.21%	0.28%	0.27%	0.31%	0.34%	0.32%	0.33%	0.32%	0.31%	0.38%	0.43%	0.47%		
2	0.85%	0.13%	0.12%	0.30%	0.40%	0.37%	0.36%	0.34%	0.33%	0.44%	0.44%	0.49%	0.53%	0.50%	0.52%	0.51%	0.50%	0.60%	0.69%	0.75%		
3	0.96%	0.15%	0.14%	0.19%	0.33%	0.37%	0.37%	0.39%	0.39%	0.49%	0.51%	0.53%	0.58%	0.54%	0.57%	0.57%	0.56%	0.68%	0.78%	0.84%		
4	0.98%	0.16%	0.16%	0.17%	0.20%	0.30%	0.33%	0.38%	0.41%	0.48%	0.54%	0.54%	0.56%	0.53%	0.57%	0.58%	0.58%	0.70%	0.80%	0.87%		
5	1.03%	0.16%	0.17%	0.19%	0.20%	0.20%	0.27%	0.34%	0.42%	0.47%	0.57%	0.57%	0.55%	0.55%	0.58%	0.58%	0.60%	0.73%	0.84%	0.91%		
6	1.04%	0.17%	0.17%	0.20%	0.22%	0.20%	0.23%	0.27%	0.40%	0.48%	0.56%	0.58%	0.55%	0.56%	0.58%	0.57%	0.61%	0.74%	0.85%	0.92%		
7	1.09%	0.17%	0.17%	0.20%	0.23%	0.23%	0.23%	0.24%	0.38%	0.48%	0.54%	0.59%	0.61%	0.61%	0.61%	0.59%	0.63%	0.77%	0.89%	0.96%		
8	1.08%	0.17%	0.17%	0.20%	0.22%	0.23%	0.26%	0.24%	0.28%	0.42%	0.48%	0.58%	0.62%	0.62%	0.62%	0.59%	0.65%	0.75%	0.88%	0.95%		
9	1.06%	0.17%	0.17%	0.19%	0.21%	0.22%	0.26%	0.27%	0.25%	0.31%	0.43%	0.57%	0.62%	0.62%	0.62%	0.60%	0.67%	0.74%	0.86%	0.94%		
10	1.03%	0.16%	0.16%	0.19%	0.21%	0.22%	0.26%	0.27%	0.28%	0.26%	0.33%	0.51%	0.57%	0.61%	0.60%	0.57%	0.67%	0.72%	0.84%	0.91%		
11	1.05%	0.17%	0.16%	0.20%	0.22%	0.22%	0.27%	0.28%	0.31%	0.32%	0.31%	0.41%	0.54%	0.60%	0.62%	0.58%	0.69%	0.77%	0.86%	0.94%		
12	1.04%	0.16%	0.16%	0.20%	0.21%	0.22%	0.27%	0.28%	0.32%	0.37%	0.35%	0.34%	0.44%	0.56%	0.64%	0.63%	0.67%	0.79%	0.86%	0.93%		
13	1.20%	0.17%	0.16%	0.20%	0.22%	0.22%	0.28%	0.29%	0.41%	0.45%	0.39%	0.41%	0.40%	0.50%	0.65%	0.68%	0.70%	0.83%	0.93%	1.03%		
14	1.29%	0.16%	0.16%	0.20%	0.22%	0.22%	0.27%	0.31%	0.47%	0.52%	0.43%	0.42%	0.45%	0.44%	0.54%	0.65%	0.72%	0.85%	0.95%	1.07%		
15	1.37%	0.16%	0.15%	0.20%	0.21%	0.21%	0.26%	0.34%	0.52%	0.60%	0.49%	0.43%	0.48%	0.52%	0.48%	0.53%	0.73%	0.89%	0.99%	1.10%		
16	1.33%	0.15%	0.14%	0.19%	0.19%	0.20%	0.24%	0.34%	0.52%	0.62%	0.53%	0.41%	0.46%	0.52%	0.53%	0.49%	0.58%	0.83%	0.99%	1.08%		
17	1.30%	0.14%	0.14%	0.18%	0.19%	0.20%	0.26%	0.36%	0.54%	0.66%	0.60%	0.49%	0.46%	0.54%	0.56%	0.54%	0.61%	0.66%	1.00%	1.16%		
18	1.28%	0.15%	0.13%	0.17%	0.19%	0.22%	0.27%	0.36%	0.53%	0.65%	0.63%	0.54%	0.49%	0.54%	0.58%	0.53%	0.71%	0.60%	0.80%	1.15%		
19	1.22%	0.15%	0.12%	0.16%	0.20%	0.22%	0.27%	0.34%	0.49%	0.60%	0.63%	0.55%	0.52%	0.51%	0.57%	0.53%	0.71%	0.72%	0.60%	0.85%		
20	1.25%	0.16%	0.14%	0.15%	0.25%	0.24%	0.30%	0.37%	0.53%	0.61%	0.68%	0.61%	0.58%	0.51%	0.60%	0.59%	0.75%	0.81%	0.74%	0.62%		LOCATION
MAX DRIFT RATIO	1.37%	0.17%	0.17%	0.30%	0.40%	0.37%	0.37%	0.39%	0.54%	0.66%	0.68%	0.61%	0.62%	0.62%	0.65%	0.68%	0.75%	0.89%	1.00%	1.16%	0.17%	1

Table A1.11 Drift ratios after optimization for EQ11 data

		DRIFT RATIOS																				
EARTHQUAKE DATA: EQ 11		ISOLATOR LEVEL																				
STORY	UNCONTROLLED BUILDING	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19		
ISOLATOR FLOOR		68.96%	72.27%	95.80%	78.81%	71.25%	58.71%	50.17%	51.53%	45.83%	40.77%	38.28%	32.91%	34.89%	33.47%	34.90%	32.62%	32.47%	28.99%	25.29%		
1	0.49%	0.18%	0.42%	0.63%	0.63%	0.58%	0.40%	0.30%	0.38%	0.52%	0.43%	0.42%	0.40%	0.41%	0.43%	0.42%	0.42%	0.44%	0.48%	0.52%		
2	0.77%	0.12%	0.41%	0.81%	0.93%	0.84%	0.60%	0.48%	0.49%	0.73%	0.63%	0.59%	0.58%	0.60%	0.65%	0.66%	0.62%	0.66%	0.75%	0.77%		
3	0.86%	0.15%	0.13%	0.53%	0.83%	0.77%	0.65%	0.54%	0.48%	0.66%	0.69%	0.59%	0.58%	0.64%	0.69%	0.71%	0.70%	0.70%	0.81%	0.85%		
4	0.89%	0.16%	0.16%	0.19%	0.47%	0.59%	0.56%	0.56%	0.55%	0.51%	0.65%	0.62%	0.59%	0.63%	0.67%	0.69%	0.72%	0.72%	0.79%	0.86%		
5	0.93%	0.17%	0.18%	0.25%	0.21%	0.39%	0.53%	0.52%	0.59%	0.61%	0.62%	0.66%	0.64%	0.64%	0.67%	0.67%	0.72%	0.75%	0.84%	0.88%		
6	0.94%	0.18%	0.18%	0.27%	0.24%	0.20%	0.39%	0.43%	0.53%	0.66%	0.57%	0.65%	0.66%	0.64%	0.66%	0.65%	0.70%	0.75%	0.87%	0.90%		
7	0.93%	0.19%	0.19%	0.29%	0.27%	0.24%	0.23%	0.34%	0.46%	0.67%	0.57%	0.62%	0.68%	0.67%	0.68%	0.66%	0.70%	0.77%	0.88%	0.96%		
8	0.88%	0.18%	0.19%	0.29%	0.27%	0.23%	0.25%	0.24%	0.32%	0.56%	0.59%	0.60%	0.63%	0.65%	0.68%	0.68%	0.70%	0.76%	0.85%	0.95%		
9	0.91%	0.19%	0.19%	0.29%	0.27%	0.24%	0.26%	0.28%	0.28%	0.34%	0.56%	0.57%	0.60%	0.62%	0.66%	0.71%	0.76%	0.79%	0.85%	0.95%		
10	0.90%	0.18%	0.19%	0.28%	0.26%	0.24%	0.26%	0.28%	0.31%	0.28%	0.40%	0.54%	0.58%	0.58%	0.62%	0.70%	0.79%	0.78%	0.85%	0.94%		
11	0.94%	0.19%	0.19%	0.28%	0.27%	0.27%	0.27%	0.32%	0.38%	0.37%	0.31%	0.43%	0.57%	0.67%	0.68%	0.71%	0.86%	0.87%	0.90%	1.00%		
12	0.95%	0.19%	0.18%	0.26%	0.26%	0.29%	0.30%	0.34%	0.41%	0.45%	0.38%	0.32%	0.44%	0.65%	0.74%	0.71%	0.85%	0.89%	0.90%	1.01%		
13	1.00%	0.19%	0.19%	0.25%	0.27%	0.31%	0.33%	0.37%	0.47%	0.52%	0.45%	0.41%	0.36%	0.50%	0.75%	0.81%	0.84%	0.92%	0.95%	1.04%		
14	1.00%	0.18%	0.19%	0.23%	0.27%	0.30%	0.34%	0.37%	0.49%	0.55%	0.49%	0.44%	0.44%	0.37%	0.58%	0.81%	0.86%	0.89%	0.95%	1.00%		
15	1.02%	0.18%	0.18%	0.24%	0.26%	0.29%	0.33%	0.39%	0.51%	0.56%	0.53%	0.49%	0.46%	0.44%	0.43%	0.64%	0.85%	0.91%	0.93%	0.95%		
16	0.98%	0.17%	0.17%	0.24%	0.25%	0.31%	0.34%	0.41%	0.51%	0.54%	0.53%	0.49%	0.44%	0.45%	0.49%	0.43%	0.63%	0.79%	0.92%	1.02%		
17	0.98%	0.17%	0.17%	0.24%	0.29%	0.33%	0.37%	0.46%	0.53%	0.55%	0.56%	0.52%	0.50%	0.48%	0.54%	0.57%	0.48%	0.59%	0.89%	1.11%		
18	1.06%	0.17%	0.17%	0.22%	0.32%	0.34%	0.37%	0.47%	0.52%	0.57%	0.56%	0.54%	0.53%	0.50%	0.57%	0.63%	0.60%	0.47%	0.67%	1.08%		
19	1.30%	0.16%	0.17%	0.22%	0.32%	0.33%	0.35%	0.44%	0.49%	0.54%	0.54%	0.57%	0.53%	0.49%	0.56%	0.64%	0.73%	0.61%	0.50%	0.76%		
20	1.62%	0.17%	0.19%	0.27%	0.36%	0.41%	0.40%	0.48%	0.53%	0.62%	0.62%	0.69%	0.62%	0.55%	0.62%	0.74%	0.94%	0.86%	0.77%	0.55%		LOCATION
MAX DRIFT RATIO	1.62%	0.19%	0.42%	0.81%	0.93%	0.84%	0.65%	0.56%	0.59%	0.73%	0.69%	0.69%	0.68%	0.67%	0.75%	0.81%	0.94%	0.92%	0.95%	1.11%	0.19%	1

Table A1.12 Drift ratios after optimization for EQ12 data

		DRIFT RATIOS																				
EARTHQUAKE DATA: EQ 12		ISOLATOR LEVEL																				
STORY	UNCONTROLLED BUILDING	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19		
ISOLATOR FLOOR		72.21%	65.93%	57.67%	52.11%	49.79%	48.90%	43.41%	42.84%	49.63%	54.85%	55.11%	48.84%	46.79%	47.99%	52.28%	54.52%	56.34%	56.13%	52.68%		
1	0.53%	0.07%	0.09%	0.18%	0.29%	0.35%	0.45%	0.49%	0.49%	0.48%	0.48%	0.42%	0.35%	0.34%	0.33%	0.33%	0.32%	0.38%	0.44%	0.48%		
2	0.84%	0.12%	0.11%	0.23%	0.38%	0.49%	0.65%	0.73%	0.76%	0.76%	0.74%	0.68%	0.56%	0.51%	0.51%	0.51%	0.50%	0.60%	0.70%	0.76%		
3	0.95%	0.14%	0.12%	0.17%	0.29%	0.45%	0.62%	0.74%	0.81%	0.83%	0.81%	0.76%	0.66%	0.58%	0.56%	0.55%	0.56%	0.67%	0.79%	0.86%		
4	0.97%	0.14%	0.14%	0.14%	0.20%	0.31%	0.48%	0.64%	0.75%	0.81%	0.77%	0.76%	0.69%	0.62%	0.58%	0.55%	0.57%	0.69%	0.81%	0.88%		
5	1.02%	0.14%	0.15%	0.15%	0.18%	0.21%	0.33%	0.50%	0.66%	0.77%	0.75%	0.76%	0.72%	0.67%	0.63%	0.59%	0.60%	0.72%	0.85%	0.92%		
6	1.03%	0.15%	0.15%	0.16%	0.20%	0.18%	0.20%	0.32%	0.49%	0.66%	0.70%	0.71%	0.71%	0.70%	0.67%	0.63%	0.60%	0.73%	0.86%	0.94%		
7	1.08%	0.16%	0.17%	0.17%	0.22%	0.21%	0.20%	0.22%	0.31%	0.51%	0.63%	0.66%	0.70%	0.72%	0.72%	0.70%	0.63%	0.76%	0.90%	0.98%		
8	1.07%	0.16%	0.17%	0.18%	0.21%	0.22%	0.22%	0.22%	0.26%	0.32%	0.46%	0.55%	0.62%	0.68%	0.71%	0.72%	0.67%	0.75%	0.89%	0.97%		
9	1.05%	0.16%	0.17%	0.18%	0.21%	0.23%	0.24%	0.28%	0.26%	0.26%	0.34%	0.42%	0.52%	0.60%	0.67%	0.71%	0.69%	0.74%	0.88%	0.96%		
10	1.02%	0.17%	0.17%	0.18%	0.22%	0.25%	0.26%	0.32%	0.35%	0.27%	0.30%	0.37%	0.45%	0.51%	0.59%	0.66%	0.68%	0.72%	0.85%	0.94%		
11	1.05%	0.18%	0.18%	0.20%	0.27%	0.29%	0.31%	0.39%	0.44%	0.42%	0.33%	0.35%	0.46%	0.53%	0.56%	0.63%	0.69%	0.74%	0.88%	0.97%		
12	1.03%	0.18%	0.19%	0.22%	0.29%	0.30%	0.33%	0.44%	0.51%	0.50%	0.47%	0.37%	0.42%	0.52%	0.56%	0.57%	0.65%	0.73%	0.87%	0.95%		
13	1.04%	0.18%	0.20%	0.24%	0.32%	0.32%	0.37%	0.52%	0.60%	0.60%	0.57%	0.53%	0.48%	0.47%	0.57%	0.53%	0.63%	0.75%	0.89%	0.97%		
14	1.03%	0.18%	0.19%	0.23%	0.33%	0.33%	0.42%	0.59%	0.67%	0.66%	0.63%	0.60%	0.62%	0.50%	0.49%	0.46%	0.61%	0.73%	0.87%	0.95%		
15	1.19%	0.19%	0.19%	0.23%	0.37%	0.39%	0.49%	0.66%	0.74%	0.72%	0.69%	0.65%	0.68%	0.66%	0.52%	0.38%	0.59%	0.72%	0.85%	1.01%		
16	1.26%	0.19%	0.18%	0.22%	0.37%	0.43%	0.52%	0.68%	0.75%	0.75%	0.69%	0.65%	0.68%	0.68%	0.65%	0.48%	0.48%	0.65%	0.79%	1.00%		
17	1.38%	0.19%	0.19%	0.23%	0.38%	0.47%	0.57%	0.72%	0.82%	0.82%	0.73%	0.67%	0.70%	0.70%	0.70%	0.63%	0.50%	0.53%	0.74%	1.01%		
18	1.42%	0.19%	0.18%	0.22%	0.37%	0.49%	0.57%	0.71%	0.84%	0.84%	0.77%	0.68%	0.69%	0.69%	0.70%	0.65%	0.60%	0.45%	0.61%	0.95%		
19	1.38%	0.18%	0.17%	0.20%	0.35%	0.46%	0.54%	0.66%	0.79%	0.81%	0.77%	0.66%	0.66%	0.65%	0.65%	0.62%	0.60%	0.56%	0.55%	0.72%		
20	1.47%	0.18%	0.17%	0.22%	0.36%	0.47%	0.55%	0.70%	0.82%	0.84%	0.83%	0.75%	0.72%	0.71%	0.69%	0.66%	0.67%	0.65%	0.73%	0.59%		LOCATION
MAX DRIFT RATIO	1.47%	0.19%	0.20%	0.24%	0.38%	0.49%	0.65%	0.74%	0.84%	0.84%	0.83%	0.76%	0.72%	0.72%	0.72%	0.72%	0.69%	0.76%	0.90%	1.01%	0.19%	1

Table A1.13 Story shears after optimization for EQ1 data

		STORY SHEAR[tf]																				
EARTHQUAKE DATA: EQ 1		ISOLATOR LEVEL																				
STORY	UNCONTROLLED BUILDING	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19		
ISOLATOR FLOOR		1,348	1,252	1,330	1,318	1,303	1,307	1,453	1,539	1,506	1,539	1,991	2,292	2,314	2,282	2,130	1,838	1,658	1,702	1,589		
1	5,308	2,030	2,933	3,810	4,666	4,132	3,354	3,413	4,369	4,775	4,863	4,167	4,046	4,061	4,218	4,400	4,591	4,590	4,736	4,702		
2	4,713	1,270	2,353	3,255	3,695	3,608	3,108	3,006	3,885	4,370	4,455	3,876	3,823	3,842	3,995	4,198	4,336	4,309	4,458	4,462		
3	4,579	1,174	1,197	2,282	2,927	2,822	2,555	2,792	3,396	3,890	3,999	3,567	3,645	3,701	3,837	4,036	4,138	4,090	4,192	4,252		
4	4,498	1,081	1,129	1,212	2,010	2,387	2,338	2,751	3,037	3,400	3,481	3,264	3,425	3,560	3,695	3,851	3,934	3,892	3,926	4,076		
5	4,399	1,020	1,071	1,108	1,268	1,801	2,160	2,680	2,892	3,062	3,339	2,935	3,146	3,377	3,571	3,674	3,737	3,714	3,823	3,962		
6	4,140	979	1,031	1,041	1,204	1,230	1,680	2,423	2,700	2,898	2,984	2,697	2,785	3,097	3,439	3,519	3,571	3,548	3,722	3,839		
7	3,754	950	1,011	998	1,160	1,193	1,251	1,926	2,325	2,540	2,882	2,810	2,655	2,731	3,215	3,367	3,430	3,387	3,580	3,680		
8	3,427	931	1,003	960	1,134	1,157	1,224	1,408	1,793	2,052	2,569	3,034	2,616	2,573	2,813	3,195	3,302	3,231	3,386	3,496		
9	3,225	919	999	927	1,103	1,115	1,192	1,368	1,504	1,610	2,185	2,957	2,942	2,438	2,641	2,896	3,149	3,077	3,264	3,314		
10	3,247	908	987	904	1,065	1,064	1,198	1,463	1,684	1,500	1,683	2,585	2,985	2,727	2,513	2,559	2,889	2,931	3,010	3,072		
11	3,431	893	964	940	1,019	1,112	1,305	1,580	1,888	1,832	1,625	2,044	2,724	2,883	2,530	2,511	2,651	2,718	2,787	3,051		
12	3,616	869	924	959	1,006	1,189	1,395	1,684	2,060	2,121	1,811	2,004	2,271	2,724	2,733	2,457	2,536	2,550	2,735	3,153		
13	3,726	833	868	946	1,038	1,224	1,435	1,771	2,187	2,335	1,967	2,012	2,155	2,326	2,674	2,670	2,492	2,357	2,742	3,298		
14	3,700	782	800	894	1,012	1,190	1,408	1,810	2,248	2,443	2,042	1,984	2,096	2,033	2,354	2,637	2,703	2,333	2,708	3,347		
15	3,505	717	723	803	934	1,088	1,323	1,777	2,217	2,430	2,010	1,866	1,967	1,860	1,835	2,339	2,643	2,527	2,690	3,233		
16	3,084	637	636	678	795	958	1,205	1,652	2,062	2,277	1,862	1,742	1,754	1,704	1,606	1,585	2,273	2,388	2,678	3,008		
17	2,687	541	533	528	631	843	1,086	1,485	1,847	2,061	1,744	1,571	1,501	1,548	1,530	1,400	1,421	1,934	2,466	2,820		
18	2,519	433	412	464	692	843	945	1,264	1,572	1,805	1,547	1,360	1,279	1,308	1,366	1,303	1,184	1,234	1,941	2,517		
19	2,040	308	280	422	639	730	785	960	1,182	1,382	1,215	1,082	1,033	983	1,076	1,084	1,016	945	1,248	1,906		
20	1,227	171	176	280	426	468	491	570	681	802	722	665	654	568	639	687	658	601	740	827		LOCATION
MAX STORY SHEAR	5,308	2,030	2,933	3,810	4,666	4,132	3,354	3,413	4,369	4,775	4,863	4,167	4,046	4,061	4,218	4,400	4,591	4,590	4,736	4,702	2,030	1

Table A1.14 Story shears after optimization for EQ2 data

		STORY SHEAR[tf]																				
EARTHQUAKE DATA: EQ 2		ISOLATOR LEVEL																				
STORY	UNCONTROLLED BUILDING	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19		
ISOLATOR FLOOR		1,789	1,687	1,586	1,341	1,378	1,420	1,628	1,724	1,689	1,763	1,858	2,037	2,107	2,079	1,946	1,868	1,631	1,315	984		
1	6,401	1,793	1,704	1,645	1,652	1,588	1,876	1,798	2,530	2,713	3,021	3,218	3,090	2,910	3,199	3,431	3,980	4,442	4,948	5,371		
2	6,335	1,707	1,697	1,626	1,643	1,600	1,838	1,771	2,409	2,631	2,931	3,126	2,999	2,881	3,158	3,377	3,930	4,379	4,883	5,303		
3	6,247	1,626	1,604	1,606	1,568	1,554	1,753	1,843	2,249	2,512	2,825	3,006	2,886	2,831	3,105	3,311	3,862	4,299	4,796	5,213		
4	6,132	1,545	1,522	1,508	1,433	1,506	1,636	1,876	2,055	2,356	2,701	2,861	2,745	2,758	3,037	3,233	3,773	4,199	4,685	5,097		
5	5,989	1,464	1,440	1,434	1,258	1,440	1,512	1,845	2,023	2,173	2,555	2,693	2,577	2,696	2,953	3,145	3,666	4,082	4,551	4,954		
6	5,817	1,383	1,360	1,364	1,206	1,297	1,424	1,744	2,011	1,974	2,381	2,511	2,420	2,658	2,856	3,047	3,543	3,952	4,400	4,790		
7	5,615	1,302	1,280	1,295	1,164	1,237	1,296	1,598	1,931	1,965	2,178	2,314	2,403	2,600	2,744	2,939	3,406	3,810	4,233	4,605		
8	5,383	1,220	1,201	1,228	1,118	1,220	1,236	1,512	1,790	1,912	2,055	2,099	2,399	2,523	2,678	2,820	3,258	3,656	4,054	4,405		
9	5,120	1,136	1,121	1,161	1,078	1,199	1,206	1,410	1,619	1,792	2,004	2,099	2,390	2,454	2,606	2,711	3,114	3,490	3,861	4,188		
10	4,826	1,051	1,039	1,091	1,035	1,170	1,181	1,323	1,531	1,597	1,893	2,054	2,332	2,418	2,579	2,621	3,042	3,311	3,655	3,955		
11	4,505	978	955	1,018	986	1,133	1,152	1,244	1,447	1,514	1,665	1,957	2,214	2,342	2,532	2,532	2,939	3,124	3,434	3,705		
12	4,161	924	870	943	933	1,086	1,115	1,167	1,359	1,430	1,568	1,713	2,060	2,236	2,454	2,474	2,792	3,003	3,200	3,450		
13	3,788	860	790	862	873	1,030	1,067	1,098	1,259	1,338	1,465	1,595	1,872	2,146	2,339	2,381	2,595	2,837	2,950	3,204		
14	3,398	788	725	788	808	963	1,005	1,027	1,147	1,235	1,353	1,467	1,716	1,896	2,195	2,245	2,359	2,620	2,724	2,944		
15	2,983	705	650	705	734	883	926	935	1,021	1,118	1,226	1,317	1,535	1,680	1,814	2,069	2,096	2,352	2,477	2,662		
16	2,548	611	565	611	647	786	827	824	883	983	1,081	1,146	1,322	1,462	1,550	1,651	1,894	2,047	2,183	2,361		
17	2,087	506	469	507	547	672	707	695	733	828	914	993	1,094	1,231	1,268	1,348	1,521	1,757	1,903	2,040		
18	1,608	392	366	394	433	538	567	550	574	654	738	812	880	973	977	1,040	1,170	1,267	1,613	1,704		
19	1,100	269	252	272	317	381	401	386	400	458	527	586	629	681	691	714	803	881	891	1,347		
20	600	146	138	148	197	230	227	218	220	251	293	328	350	373	388	384	430	476	471	576		LOCATION
MAX STORY SHEAR	6,401	1,793	1,704	1,645	1,652	1,600	1,876	1,876	2,530	2,713	3,021	3,218	3,090	2,910	3,199	3,431	3,980	4,442	4,948	5,371	1,600	5

Table A1.15 Story shears after optimization for EQ3 data

								STORY SHEAR[tf]														
EARTHQUAKE DATA: EQ 3										ISOLATOR LEVEL												
STORY	UNCONTROLLED BUILDING	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19		
ISOLATOR FLOOR		1,930	1,886	2,139	1,925	2,348	2,804	2,635	2,672	2,282	2,314	2,565	2,612	2,430	2,091	2,160	2,152	2,324	2,262	2,072		
1	8,674	2,067	2,965	3,772	4,900	6,757	7,874	8,712	7,622	8,988	8,271	7,119	5,278	4,894	4,831	4,472	5,134	5,369	5,829	6,569		
2	8,652	1,906	2,318	3,409	3,929	6,158	7,205	8,254	7,188	8,883	8,297	7,281	5,507	4,536	4,622	4,424	4,801	5,236	5,658	6,471		
3	8,639	1,913	1,903	2,573	3,435	5,104	6,123	7,642	6,746	8,574	8,164	7,293	5,702	4,406	4,301	4,222	4,433	5,080	5,459	6,313		
4	8,552	1,921	1,935	2,178	2,624	3,639	4,680	6,644	6,407	8,022	7,888	7,135	5,770	4,573	3,900	3,869	4,131	4,923	5,258	6,080		
5	8,311	1,915	1,946	2,202	1,959	2,454	3,092	5,156	5,905	7,212	7,415	6,813	5,686	4,656	3,826	3,506	3,947	4,773	5,118	5,853		
6	7,863	1,888	1,930	2,199	2,042	2,442	2,401	3,247	5,093	6,192	6,705	6,272	5,448	4,602	4,013	3,703	3,823	4,584	5,038	5,621		
7	7,180	1,845	1,889	2,172	2,132	2,520	2,796	2,447	3,944	5,056	5,720	5,497	5,026	4,412	4,095	3,844	3,950	4,334	4,930	5,377		
8	6,293	1,788	1,826	2,123	2,178	2,553	2,779	2,306	2,651	3,777	4,440	4,492	4,392	4,173	4,045	3,836	4,069	4,328	4,808	5,189		
9	5,834	1,723	1,746	2,048	2,167	2,527	2,703	2,101	2,416	2,356	2,914	3,295	3,718	3,950	3,905	3,755	4,003	4,426	4,821	5,072		
10	5,467	1,654	1,656	1,946	2,098	2,435	2,544	2,130	2,451	2,575	1,893	2,363	3,239	3,533	3,575	3,592	3,879	4,345	4,783	4,939		
11	5,176	1,576	1,556	1,824	1,980	2,277	2,311	2,239	2,686	3,057	2,664	2,045	2,788	3,150	3,305	3,361	3,638	4,136	4,590	4,630		
12	5,135	1,489	1,448	1,688	1,825	2,059	2,023	2,410	3,068	3,606	3,122	2,534	2,344	2,872	3,006	3,069	3,445	3,931	4,222	4,086		
13	5,126	1,386	1,329	1,538	1,643	1,802	1,747	2,619	3,528	4,132	3,511	2,633	2,430	2,529	2,770	2,686	3,294	3,748	3,821	3,737		
14	5,491	1,267	1,203	1,375	1,440	1,529	1,940	2,786	3,906	4,502	3,768	2,758	2,292	2,073	2,517	2,458	3,089	3,426	3,549	3,521		
15	5,843	1,130	1,063	1,195	1,225	1,445	2,052	2,844	4,085	4,637	3,866	2,788	2,234	1,947	1,861	2,083	2,736	2,871	3,496	3,586		
16	5,886	977	912	1,007	1,096	1,390	2,019	2,739	3,995	4,477	3,774	2,701	2,213	1,873	1,828	1,819	2,138	2,497	3,374	3,571		
17	5,591	809	748	862	945	1,232	1,832	2,465	3,633	4,036	3,477	2,492	2,102	1,806	1,776	1,780	1,890	1,884	2,923	3,307		
18	4,917	631	658	747	935	1,106	1,519	2,046	3,032	3,344	2,962	2,151	1,863	1,676	1,697	1,628	1,852	1,786	2,238	2,772		
19	3,778	504	516	591	797	886	1,120	1,495	2,213	2,418	2,223	1,648	1,453	1,385	1,390	1,396	1,579	1,505	1,560	2,062		
20	2,193	306	302	367	499	534	650	843	1,237	1,328	1,279	969	870	881	891	885	1,001	965	912	1,062		LOCATION
MAX STORY SHEAR	8,674	2,067	2,965	3,772	4,900	6,757	7,874	8,712	7,622	8,988	8,297	7,293	5,770	4,894	4,831	4,472	5,134	5,369	5,829	6,569	2,067	1

Table A1.16 Story shears after optimization for EQ4 data

								STORY SHEAR[tf]														
EARTHQUAKE DATA: EQ 4										ISOLATOR LEVEL												
STORY	UNCONTROLLED BUILDING	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19		
ISOLATOR FLOOR		1,771	1,694	1,764	1,734	1,843	2,283	2,520	2,912	2,771	2,596	2,586	2,679	2,540	2,430	2,303	2,189	2,048	1,887	1,624		
1	6,970	1,955	2,248	2,910	3,761	4,069	4,594	5,135	5,451	5,513	5,279	5,109	5,176	5,207	4,999	4,900	4,751	4,881	5,382	5,773		
2	6,882	1,637	1,869	2,560	3,542	3,849	4,310	4,850	5,215	5,387	5,194	4,984	5,030	5,000	4,790	4,700	4,542	4,808	5,312	5,706		
3	6,768	1,509	1,567	2,104	2,996	3,475	3,964	4,613	4,980	5,196	5,108	4,937	4,916	4,811	4,605	4,523	4,348	4,717	5,223	5,617		
4	6,628	1,405	1,459	1,641	2,279	2,758	3,407	4,285	4,757	4,984	4,969	4,838	4,805	4,628	4,427	4,345	4,160	4,607	5,112	5,506		
5	6,463	1,321	1,370	1,532	1,614	1,945	2,657	3,767	4,433	4,774	4,836	4,720	4,699	4,465	4,261	4,170	3,986	4,476	4,979	5,371		
6	6,272	1,258	1,299	1,434	1,529	1,780	1,901	3,042	3,924	4,447	4,618	4,596	4,569	4,395	4,183	4,068	3,885	4,328	4,827	5,214		
7	6,051	1,207	1,239	1,344	1,461	1,717	2,163	2,174	3,213	3,931	4,278	4,404	4,426	4,309	4,119	3,998	3,816	4,163	4,653	5,034		
8	5,800	1,159	1,182	1,268	1,394	1,650	2,063	2,380	2,348	3,214	3,785	4,077	4,228	4,193	4,052	3,925	3,753	3,984	4,458	4,831		
9	5,521	1,109	1,124	1,210	1,329	1,569	1,956	2,260	2,763	2,343	3,099	3,606	3,904	4,017	3,974	3,835	3,676	3,792	4,242	4,605		
10	5,212	1,057	1,065	1,158	1,253	1,462	1,847	2,151	2,646	2,655	2,263	2,960	3,439	3,723	3,835	3,744	3,586	3,589	4,006	4,354		
11	4,874	1,001	1,004	1,097	1,174	1,372	1,742	2,052	2,552	2,566	2,487	2,199	2,840	3,286	3,566	3,649	3,491	3,378	3,753	4,083		
12	4,511	943	942	1,020	1,100	1,291	1,647	1,967	2,467	2,476	2,385	2,446	2,259	2,715	3,144	3,453	3,421	3,301	3,488	3,793		
13	4,117	881	878	939	1,032	1,189	1,566	1,892	2,378	2,365	2,264	2,305	2,509	2,180	2,579	3,063	3,301	3,262	3,207	3,483		
14	3,702	814	812	866	967	1,123	1,498	1,818	2,275	2,233	2,116	2,146	2,348	2,387	2,117	2,509	2,982	3,205	3,122	3,159		
15	3,612	738	739	796	900	1,061	1,436	1,730	2,143	2,071	1,943	1,960	2,170	2,227	2,221	2,020	2,456	2,942	3,097	3,049		
16	3,436	653	657	713	829	995	1,355	1,603	1,964	1,997	1,852	1,748	1,966	2,041	2,000	2,034	1,967	2,443	2,873	3,034		
17	3,183	557	563	611	743	904	1,232	1,416	1,719	1,867	1,766	1,496	1,723	1,807	1,742	1,743	1,849	1,898	2,412	2,817		
18	2,826	447	454	490	625	787	1,045	1,159	1,506	1,599	1,558	1,308	1,414	1,505	1,433	1,423	1,483	1,593	1,872	2,380		
19	2,222	320	327	348	462	656	783	922	1,170	1,195	1,200	1,025	1,015	1,112	1,049	1,134	1,056	1,113	1,302	1,806		
20	1,320	179	184	196	261	405	490	549	687	683	696	608	617	628	650	669	609	601	701	846		LOCATION
MAX STORY SHEAR	6,970	1,955	2,248	2,910	3,761	4,069	4,594	5,135	5,451	5,513	5,279	5,109	5,176	5,207	4,999	4,900	4,751	4,881	5,382	5,773	1,955	1

Table A1.17 Story shears after optimization for EQ5 data

										STORY SHEAR[tf]												
EARTHQUAKE DATA: EQ 5											ISOLATOR LEVEL											
STORY	UNCONTROLLED BUILDING	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19		
ISOLATOR FLOOR		1,476	1,481	1,729	1,865	2,103	2,578	2,527	2,726	2,518	2,361	2,294	3,039	3,302	3,313	3,197	3,080	2,756	2,603	2,069		
1	8,082	1,877	3,523	6,728	8,462	6,611	6,378	5,312	5,670	5,697	6,851	7,340	6,943	6,178	5,536	5,764	5,571	5,461	6,162	6,212		
2	8,088	1,453	2,146	5,073	7,671	6,287	6,160	5,030	5,543	5,506	6,077	6,852	6,788	6,307	5,533	5,710	5,328	5,216	6,057	6,124		
3	7,861	1,397	1,480	2,880	5,913	5,793	5,511	4,660	5,208	5,256	5,277	6,158	6,349	6,212	5,740	5,342	5,101	4,991	5,897	6,079		
4	7,356	1,341	1,432	1,737	3,333	4,525	4,409	4,652	5,375	4,936	5,085	5,398	5,686	5,785	5,703	5,352	4,870	4,927	5,785	5,980		
5	6,962	1,292	1,387	1,695	1,796	2,473	3,186	4,537	5,636	5,200	4,807	4,857	5,063	5,156	5,360	5,421	5,048	4,948	5,738	5,890		
6	6,351	1,250	1,347	1,654	1,718	2,012	2,289	3,851	5,437	5,219	4,432	4,627	4,620	4,604	4,778	5,209	5,182	4,789	5,571	5,773		
7	5,563	1,214	1,311	1,617	1,657	1,948	2,471	2,446	4,545	4,750	4,404	4,294	4,326	4,383	4,267	4,729	5,083	4,997	5,234	5,727		
8	5,479	1,183	1,278	1,582	1,597	1,954	2,384	2,406	2,953	3,776	3,922	4,261	4,246	4,551	4,395	4,199	4,713	4,982	4,846	5,662		
9	6,089	1,155	1,245	1,540	1,529	2,061	2,287	2,283	2,552	2,535	3,114	4,134	4,435	4,273	4,325	4,154	4,292	4,724	4,896	5,284		
10	6,445	1,124	1,208	1,488	1,447	2,063	2,175	2,148	2,386	2,344	2,466	3,402	4,310	4,351	4,254	4,158	4,029	4,434	4,736	4,804		
11	6,503	1,091	1,168	1,426	1,380	1,960	2,046	2,008	2,231	2,187	2,211	2,371	3,590	4,260	4,330	4,311	3,867	4,239	4,578	4,826		
12	6,239	1,047	1,118	1,349	1,319	1,747	1,914	1,868	2,083	2,334	2,376	2,203	2,337	3,587	4,154	4,302	3,617	4,001	4,474	4,879		
13	6,134	991	1,052	1,250	1,264	1,447	1,787	1,737	2,214	2,653	2,502	2,261	2,838	2,495	3,563	4,015	3,862	3,823	4,309	4,883		
14	5,931	918	968	1,126	1,211	1,348	1,678	1,615	2,464	2,907	2,556	2,257	2,650	2,777	2,563	3,478	3,999	4,047	4,121	4,681		
15	5,518	826	861	974	1,147	1,287	1,576	1,545	2,632	3,002	2,547	2,151	2,396	2,349	2,647	2,603	3,638	4,184	4,217	4,349		
16	4,802	713	735	879	1,058	1,210	1,462	1,601	2,616	2,886	2,464	1,943	2,032	1,912	2,116	2,607	2,803	3,797	4,305	4,315		
17	3,835	582	597	780	937	1,380	1,323	1,530	2,387	2,559	2,257	1,661	1,593	1,718	2,169	2,190	2,536	2,914	3,929	4,394		
18	3,162	448	476	710	869	1,446	1,233	1,346	1,977	2,072	1,906	1,436	1,202	1,591	2,105	2,059	2,148	2,311	3,045	3,978		
19	2,865	387	430	670	748	1,295	1,115	1,052	1,424	1,567	1,435	1,145	971	1,212	1,680	1,774	1,683	1,798	1,757	2,963		
20	1,978	260	292	458	470	860	727	635	798	941	907	711	631	799	1,021	1,118	1,019	1,082	956	1,096		LOCATION
MAX STORY SHEAR	8,088	1,877	3,523	6,728	8,462	6,611	6,378	5,312	5,670	5,697	6,851	7,340	6,943	6,307	5,740	5,764	5,571	5,461	6,162	6,212	1,877	1

Table A1.18 Story shears after optimization for EQ6 data

										STORY SHEAR[tf]												
EARTHQUAKE DATA: EQ 6											ISOLATOR LEVEL											
STORY	UNCONTROLLED BUILDING	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19		
ISOLATOR FLOOR		1,222	1,195	1,413	1,686	1,721	1,765	1,806	1,836	1,738	1,915	2,169	2,393	2,379	2,347	2,287	2,200	2,164	2,044	1,605		
1	5,962	1,297	2,082	4,068	5,489	5,486	4,310	3,037	4,072	4,340	4,182	3,733	4,211	4,360	4,145	3,779	3,869	3,986	4,781	5,494		
2	5,848	1,209	1,225	2,981	4,725	5,155	4,360	3,343	3,960	4,253	4,105	3,717	4,209	4,384	4,165	3,642	3,684	3,961	4,725	5,443		
3	5,703	1,203	1,157	1,459	3,493	4,292	4,013	3,389	3,752	4,070	3,930	3,659	4,149	4,349	4,115	3,610	3,513	3,912	4,608	5,348		
4	5,527	1,201	1,163	1,401	1,636	2,935	3,266	3,100	3,444	3,795	3,656	3,541	4,023	4,243	4,002	3,537	3,449	3,838	4,419	5,200		
5	5,320	1,197	1,163	1,385	1,591	1,703	2,174	2,504	3,051	3,453	3,298	3,361	3,836	4,063	3,833	3,452	3,371	3,738	4,169	4,993		
6	5,085	1,187	1,158	1,362	1,498	1,541	1,802	1,920	2,593	3,077	2,871	3,122	3,594	3,815	3,612	3,332	3,320	3,614	4,048	4,727		
7	4,822	1,168	1,146	1,330	1,400	1,370	1,567	1,816	2,092	2,655	2,591	2,833	3,305	3,514	3,353	3,170	3,282	3,466	3,902	4,605		
8	4,535	1,138	1,128	1,289	1,294	1,223	1,383	1,583	1,927	2,156	2,203	2,634	2,984	3,181	3,084	3,163	3,229	3,300	3,754	4,487		
9	4,554	1,096	1,102	1,240	1,178	1,159	1,348	1,380	1,597	1,764	1,760	2,218	2,643	2,858	2,993	3,110	3,158	3,118	3,650	4,327		
10	4,599	1,045	1,067	1,185	1,075	1,165	1,407	1,298	1,575	1,688	1,695	1,809	2,307	2,559	2,805	2,988	3,047	2,934	3,561	4,126		
11	4,600	1,015	1,046	1,127	1,067	1,136	1,415	1,393	1,619	1,705	1,837	1,951	2,145	2,264	2,533	2,789	2,884	2,884	3,434	4,021		
12	4,530	1,003	1,018	1,067	1,051	1,076	1,372	1,482	1,690	1,789	1,822	2,028	2,277	2,258	2,305	2,514	2,664	2,892	3,442	3,996		
13	4,369	977	977	1,005	1,021	991	1,279	1,502	1,766	1,840	1,783	1,874	2,219	2,329	2,325	2,297	2,411	2,871	3,414	3,923		
14	4,105	935	923	945	973	911	1,151	1,443	1,809	1,844	1,799	1,741	2,024	2,151	2,317	2,162	2,341	2,729	3,299	3,791		
15	3,731	872	850	879	903	838	1,068	1,316	1,797	1,797	1,801	1,635	1,792	1,903	2,077	2,177	2,193	2,460	3,078	3,585		
16	3,265	786	759	790	809	745	964	1,273	1,705	1,689	1,754	1,487	1,523	1,631	1,805	1,944	2,102	2,085	2,740	3,291		
17	2,763	676	648	677	692	805	830	1,178	1,526	1,510	1,642	1,333	1,362	1,340	1,514	1,748	1,863	1,943	2,301	2,897		
18	2,275	542	517	541	553	793	778	1,003	1,261	1,256	1,436	1,151	1,246	1,222	1,258	1,517	1,493	1,680	1,979	2,403		
19	1,944	384	365	380	486	651	699	742	912	919	1,105	891	988	980	1,006	1,153	1,158	1,163	1,389	1,862		
20	1,337	212	201	209	335	409	456	415	506	527	645	528	588	591	600	676	776	713	729	876		LOCATION
MAX STORY SHEAR	5,962	1,297	2,082	4,068	5,489	5,486	4,360	3,389	4,072	4,340	4,182	3,733	4,211	4,384	4,165	3,779	3,869	3,986	4,781	5,494	1,297	1

Table A1.19 Story shears after optimization for EQ7 data

		STORY SHEAR[tf]																				
EARTHQUAKE DATA: EQ 7		ISOLATOR LEVEL																				
STORY	CONTROLLED BUILDI	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19		
ISOLATOR FLOOR		959	918	1,015	1,342	1,444	1,545	1,872	2,102	2,044	1,990	1,875	2,310	2,403	2,345	2,289	2,166	1,900	1,539	1,126		
1	5,039	1,211	2,067	2,726	2,794	2,993	3,161	3,163	3,201	3,137	3,183	3,192	3,343	3,522	3,804	3,966	3,926	3,859	4,169	4,644		
2	5,005	909	1,415	2,354	2,586	2,730	3,052	3,095	3,174	2,957	3,116	3,130	3,274	3,460	3,674	3,919	3,955	3,860	4,049	4,521		
3	4,943	880	888	1,615	2,220	2,225	2,673	3,119	3,034	2,968	3,011	3,110	3,256	3,405	3,505	3,806	3,973	3,915	4,005	4,380		
4	4,792	850	862	983	1,720	1,853	2,226	3,003	2,915	2,929	2,921	3,069	3,176	3,339	3,341	3,607	3,914	3,954	4,032	4,266		
5	4,532	820	830	962	1,256	1,593	2,063	2,686	2,747	2,806	2,890	2,908	3,026	3,214	3,203	3,336	3,755	3,934	4,062	4,216		
6	4,252	788	795	936	1,200	1,375	1,683	2,208	2,415	2,623	2,794	2,811	2,924	3,012	3,022	3,117	3,512	3,825	4,049	4,181		
7	4,016	754	761	904	1,169	1,309	1,477	1,888	1,947	2,377	2,648	2,699	2,824	2,908	3,058	3,178	3,284	3,635	3,966	4,090		
8	3,981	717	726	866	1,129	1,249	1,411	1,817	1,837	2,042	2,435	2,562	2,646	2,904	3,112	3,159	3,308	3,446	3,799	3,936		
9	3,856	677	695	828	1,077	1,192	1,344	1,740	1,918	1,959	2,158	2,397	2,637	2,804	3,061	3,225	3,305	3,315	3,555	3,751		
10	3,827	634	666	795	1,024	1,135	1,271	1,643	1,783	1,952	2,026	2,198	2,667	2,949	2,918	3,187	3,299	3,318	3,285	3,526		
11	3,744	593	637	762	976	1,076	1,187	1,528	1,686	1,863	1,897	1,975	2,573	2,966	2,963	3,039	3,294	3,300	3,245	3,237		
12	3,529	560	605	723	912	1,044	1,086	1,386	1,621	1,786	1,813	1,822	2,415	2,845	2,978	2,859	3,176	3,286	3,192	3,095		
13	3,166	528	566	677	838	1,015	1,000	1,210	1,581	1,718	1,749	1,758	2,197	2,622	2,850	2,862	2,929	3,161	3,153	3,082		
14	2,789	490	522	624	763	893	940	1,114	1,545	1,654	1,684	1,668	2,074	2,217	2,640	2,674	2,569	2,909	3,012	2,985		
15	2,476	444	474	563	689	752	875	1,071	1,491	1,577	1,586	1,536	1,934	2,035	2,155	2,354	2,334	2,540	2,770	2,765		
16	2,186	390	418	492	639	853	944	1,008	1,404	1,459	1,436	1,402	1,771	1,859	1,977	2,044	2,157	2,099	2,413	2,519		
17	1,937	347	353	434	612	862	940	916	1,268	1,280	1,306	1,287	1,561	1,643	1,747	1,772	1,832	1,877	1,983	2,245		
18	1,757	292	281	423	623	770	841	780	1,072	1,041	1,081	1,090	1,294	1,372	1,455	1,446	1,481	1,472	1,550	1,856		
19	1,417	216	218	355	545	583	647	664	798	740	770	799	950	1,020	1,073	1,041	1,065	1,026	1,058	1,381		
20	869	123	132	221	350	377	388	422	453	407	415	458	541	586	610	580	596	557	564	640		LOCATION
MAX STORY SHEAR	5,039	1,211	2,067	2,726	2,794	2,993	3,161	3,163	3,201	3,137	3,183	3,192	3,343	3,522	3,804	3,966	3,973	3,954	4,169	4,644	1,211	1

Table A1.20 Story shears after optimization for EQ8 data

		STORY SHEAR[tf]																				
EARTHQUAKE DATA: EQ 8		ISOLATOR LEVEL																				
STORY	UNCONTROLLED BUILDING	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19		
ISOLATOR FLOOR		1,167	1,121	1,114	1,289	1,267	1,252	1,404	1,535	1,465	1,522	1,648	2,237	2,270	2,153	1,965	1,764	1,614	1,387	1,079		
1	6,398	1,185	1,192	1,700	1,755	1,569	1,751	2,227	2,064	2,148	2,497	2,950	3,277	3,204	2,978	3,138	3,383	4,012	4,740	5,347		
2	6,311	1,107	1,155	1,522	1,740	1,488	1,663	2,071	1,987	2,013	2,431	2,888	3,224	3,156	2,930	3,112	3,377	3,964	4,660	5,261		
3	6,228	1,063	1,060	1,157	1,588	1,452	1,647	1,848	1,896	1,914	2,326	2,800	3,137	3,068	2,860	3,064	3,348	3,920	4,556	5,177		
4	6,117	1,021	1,003	1,040	1,321	1,392	1,563	1,535	1,785	1,874	2,168	2,684	3,017	2,929	2,844	2,988	3,309	3,858	4,429	5,083		
5	5,970	982	961	980	1,223	1,306	1,400	1,450	1,786	1,825	1,976	2,547	2,875	2,765	2,807	2,904	3,275	3,785	4,330	4,959		
6	5,788	942	920	945	1,163	1,219	1,231	1,402	1,735	1,770	1,902	2,411	2,723	2,618	2,727	2,891	3,241	3,706	4,225	4,814		
7	5,569	901	877	909	1,110	1,173	1,200	1,395	1,636	1,705	1,909	2,314	2,582	2,491	2,609	2,843	3,195	3,613	4,107	4,656		
8	5,314	857	834	874	1,077	1,126	1,147	1,332	1,563	1,629	1,858	2,224	2,458	2,341	2,461	2,759	3,127	3,497	3,981	4,486		
9	5,028	810	792	838	1,058	1,085	1,089	1,262	1,425	1,543	1,738	2,097	2,322	2,257	2,289	2,638	3,030	3,359	3,840	4,303		
10	4,724	760	746	799	1,024	1,053	1,027	1,195	1,346	1,373	1,567	1,921	2,154	2,206	2,250	2,486	2,899	3,201	3,690	4,110		
11	4,410	708	696	754	975	1,007	985	1,132	1,270	1,329	1,441	1,703	2,133	2,271	2,246	2,315	2,735	3,028	3,526	3,900		
12	4,084	653	643	703	912	949	936	1,055	1,188	1,276	1,369	1,483	2,172	2,301	2,261	2,189	2,545	2,843	3,319	3,658		
13	3,746	595	589	647	836	881	878	959	1,103	1,208	1,287	1,329	2,014	2,294	2,254	2,164	2,335	2,636	3,064	3,373		
14	3,396	535	533	586	763	803	814	848	1,012	1,123	1,190	1,181	1,807	2,032	2,215	2,124	2,146	2,411	2,773	3,054		
15	3,013	471	471	519	721	724	746	749	909	1,021	1,077	1,042	1,616	1,803	1,897	2,057	2,021	2,167	2,483	2,696		
16	2,595	404	405	446	654	683	672	642	798	904	948	916	1,436	1,578	1,641	1,698	1,898	1,980	2,182	2,423		
17	2,141	333	333	365	562	631	586	526	676	768	800	774	1,237	1,329	1,366	1,411	1,451	1,796	1,918	2,120		
18	1,665	258	258	281	451	543	483	466	542	611	634	635	997	1,047	1,067	1,103	1,143	1,230	1,641	1,793		
19	1,155	177	177	197	329	409	374	357	401	430	445	464	704	726	736	765	804	830	938	1,437		
20	637	97	100	127	190	235	220	208	227	237	245	264	384	397	397	416	446	437	489	624		LOCATION
MAX STORY SHEAR	6,398	1,185	1,192	1,700	1,755	1,569	1,751	2,227	2,064	2,148	2,497	2,950	3,277	3,204	2,978	3,138	3,383	4,012	4,740	5,347	1,185	1

Table A1.21 Story shears after optimization for EQ9 data

STORY SHEAR[tf]																						
EARTHQUAKE DATA: EQ 9		ISOLATOR LEVEL																				
STORY	UNCONTROLLED BUILDING	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19		
ISOLATOR FLOOR		1,758	1,751	2,063	1,947	2,036	2,235	2,069	2,234	2,012	2,084	2,349	2,359	2,198	2,034	1,937	1,695	1,587	1,340	1,071		
1	5,134	1,646	1,572	1,899	2,266	2,980	3,742	4,185	3,861	4,127	4,017	3,749	3,464	3,300	3,329	3,697	3,698	3,964	4,415	4,648		
2	5,198	1,725	1,672	1,822	2,144	2,833	3,587	4,031	3,641	3,930	3,870	3,628	3,303	3,112	3,202	3,609	3,698	4,043	4,494	4,741		
3	5,230	1,689	1,701	1,900	2,072	2,595	3,303	3,768	3,373	3,688	3,708	3,484	3,118	3,015	3,084	3,480	3,696	4,098	4,528	4,787		
4	5,203	1,648	1,644	1,990	1,962	2,400	2,881	3,388	3,106	3,458	3,539	3,308	2,908	2,911	2,998	3,311	3,651	4,107	4,516	4,777		
5	5,111	1,602	1,581	1,916	1,853	2,211	2,333	2,917	2,816	3,248	3,356	3,101	2,680	2,806	3,019	3,161	3,585	4,066	4,476	4,725		
6	4,955	1,549	1,515	1,836	1,759	1,926	2,099	2,441	2,563	3,016	3,148	2,869	2,669	2,834	3,033	3,184	3,536	3,978	4,409	4,640		
7	4,748	1,490	1,444	1,749	1,659	1,881	2,214	2,062	2,278	2,733	2,911	2,615	2,831	2,982	3,067	3,203	3,511	3,868	4,312	4,527		
8	4,504	1,424	1,369	1,655	1,553	1,821	2,176	2,015	2,196	2,401	2,635	2,348	2,883	3,103	3,150	3,204	3,484	3,749	4,179	4,388		
9	4,230	1,349	1,288	1,552	1,442	1,733	2,104	1,942	1,965	2,060	2,313	2,342	2,812	3,132	3,229	3,221	3,440	3,633	4,013	4,219		
10	3,930	1,267	1,201	1,442	1,331	1,615	1,991	1,909	1,860	1,959	1,950	2,270	2,616	3,041	3,227	3,252	3,404	3,526	3,816	4,026		
11	3,612	1,177	1,108	1,326	1,215	1,473	1,839	1,912	1,998	2,093	1,872	2,148	2,480	2,828	3,115	3,240	3,381	3,459	3,620	3,800		
12	3,298	1,081	1,012	1,208	1,125	1,320	1,657	1,884	2,128	2,245	1,980	2,122	2,323	2,493	2,883	3,136	3,326	3,382	3,439	3,518		
13	3,014	978	910	1,088	1,057	1,251	1,458	1,801	2,182	2,326	2,041	1,953	2,203	2,228	2,534	2,929	3,190	3,199	3,213	3,185		
14	2,759	871	807	967	979	1,162	1,280	1,657	2,132	2,298	2,033	1,844	2,084	2,090	2,097	2,590	2,943	2,906	2,921	2,844		
15	2,499	757	701	865	879	1,055	1,130	1,454	1,969	2,154	1,949	1,752	1,961	1,962	1,859	2,136	2,561	2,577	2,589	2,524		
16	2,221	639	592	776	761	929	1,025	1,252	1,709	1,904	1,785	1,633	1,800	1,788	1,666	1,599	2,060	2,261	2,263	2,283		
17	1,925	516	522	664	659	785	917	1,103	1,390	1,576	1,541	1,457	1,581	1,558	1,434	1,293	1,436	1,839	1,992	2,136		
18	1,606	417	426	533	561	624	766	906	1,071	1,215	1,233	1,209	1,294	1,269	1,159	1,011	1,187	1,246	1,611	1,847		
19	1,245	301	305	385	417	444	567	668	761	890	870	877	931	911	827	718	875	900	919	1,365		
20	742	172	173	217	236	251	322	383	432	513	481	484	514	504	457	418	492	527	562	588		LOCATION
MAX STORY SHEAR	5,230	1,725	1,701	1,990	2,266	2,980	3,742	4,185	3,861	4,127	4,017	3,749	3,464	3,300	3,329	3,697	3,698	4,107	4,528	4,787	1,701	2

Table A1.22 Story shears after optimization for EQ10 data

STORY SHEAR[tf]																						
EARTHQUAKE DATA: EQ 10		ISOLATOR LEVEL																				
STORY	UNCONTROLLED BUILDING	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19		
ISOLATOR FLOOR		1,197	1,155	1,364	1,512	1,542	1,580	1,620	1,824	1,829	1,857	1,921	2,093	2,475	2,684	2,732	2,719	2,504	2,334	1,918		
1	6,883	1,156	1,951	3,566	4,007	3,567	3,198	2,647	2,892	3,834	3,747	4,098	4,432	4,127	4,341	4,136	4,024	4,855	5,569	6,023		
2	6,819	1,142	1,208	2,772	3,567	3,194	3,028	2,824	2,706	3,670	3,552	4,021	4,391	4,131	4,281	4,163	4,011	4,835	5,537	5,980		
3	6,726	1,091	1,112	1,481	2,638	2,806	2,816	2,906	2,851	3,579	3,700	3,878	4,199	3,955	4,136	4,098	3,966	4,781	5,474	5,909		
4	6,602	1,041	1,068	1,305	1,619	2,175	2,399	2,787	2,987	3,377	3,784	3,769	3,906	3,664	3,935	3,947	3,916	4,693	5,377	5,807		
5	6,443	996	1,023	1,242	1,430	1,500	1,848	2,390	2,900	3,122	3,772	3,710	3,611	3,508	3,712	3,739	3,824	4,571	5,248	5,672		
6	6,252	962	976	1,177	1,345	1,432	1,632	1,750	2,588	3,024	3,610	3,646	3,400	3,442	3,545	3,508	3,662	4,421	5,091	5,505		
7	6,027	924	927	1,111	1,257	1,333	1,490	1,575	2,304	2,839	3,255	3,478	3,490	3,447	3,475	3,322	3,600	4,244	4,907	5,318		
8	5,769	884	878	1,042	1,176	1,242	1,415	1,533	1,817	2,461	2,743	3,277	3,482	3,433	3,421	3,398	3,660	4,043	4,698	5,104		
9	5,480	839	829	971	1,092	1,160	1,352	1,443	1,680	1,926	2,440	3,099	3,324	3,350	3,314	3,328	3,656	3,828	4,467	4,859		
10	5,159	791	778	931	1,026	1,084	1,291	1,395	1,582	1,721	1,995	2,744	3,017	3,186	3,153	3,068	3,564	3,708	4,215	4,587		
11	4,809	739	725	888	974	1,010	1,226	1,350	1,527	1,639	1,758	2,232	2,645	2,904	2,948	2,731	3,351	3,718	3,947	4,292		
12	4,617	684	670	840	913	936	1,153	1,280	1,492	1,630	1,667	1,821	2,324	2,700	2,987	2,889	3,047	3,622	3,912	4,075		
13	4,834	630	610	783	844	857	1,066	1,196	1,674	1,835	1,587	1,721	1,952	2,527	2,839	2,831	2,846	3,417	3,848	4,211		
14	4,922	572	548	719	767	775	969	1,212	1,822	2,024	1,587	1,620	1,869	2,158	2,534	2,532	2,811	3,265	3,637	4,127		
15	4,808	509	486	650	682	690	857	1,212	1,862	2,146	1,704	1,495	1,758	1,946	2,180	2,269	2,686	3,189	3,454	3,838		
16	4,408	441	419	579	588	603	794	1,160	1,777	2,124	1,773	1,368	1,587	1,756	1,831	2,109	2,387	2,951	3,345	3,548		
17	3,707	391	347	490	520	608	782	1,055	1,582	1,938	1,737	1,409	1,354	1,543	1,570	1,596	2,225	2,490	3,080	3,388		
18	3,125	353	298	388	486	580	694	883	1,298	1,603	1,572	1,336	1,263	1,286	1,365	1,251	1,843	2,037	2,568	3,079		
19	2,374	280	241	302	449	471	578	699	1,035	1,146	1,251	1,095	1,090	953	1,077	997	1,405	1,516	1,575	2,477		
20	1,363	168	151	204	313	310	364	422	634	688	756	677	692	569	643	630	839	874	837	1,053		LOCATION
MAX STORY SHEAR	6,883	1,156	1,951	3,566	4,007	3,567	3,198	2,906	2,987	3,834	3,784	4,098	4,432	4,131	4,341	4,163	4,024	4,855	5,569	6,023	1,156	1

Table A1.23 Story shears after optimization for EQ11 data

EARTHQUAKE DATA: EQ 11		STORY SHEAR[tf] ISOLATOR LEVEL																				
STORY	UNCONTROLLED BUILDING	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19		
ISOLATOR FLOOR		1,134	1,180	2,034	1,750	1,732	1,607	1,681	1,918	1,739	1,709	1,775	1,930	2,126	2,073	1,997	1,917	1,823	1,668	1,468		
1	6,498	3,572	6,595	9,236	8,610	7,834	5,785	4,458	5,652	7,317	6,356	6,116	5,697	5,595	5,924	5,758	5,842	6,010	6,297	7,044		
2	6,359	1,130	4,369	7,681	8,456	7,376	5,215	4,329	4,476	6,634	5,477	5,266	5,245	5,145	5,576	5,509	5,440	5,545	6,187	6,353		
3	6,305	1,112	1,162	4,451	6,805	5,940	5,040	4,195	3,866	5,328	5,467	4,495	4,583	4,782	5,147	5,319	5,180	5,283	5,963	6,115		
4	6,290	1,100	1,153	1,900	3,599	4,362	4,171	4,254	4,133	3,829	4,738	4,430	4,198	4,531	4,802	4,940	5,104	5,199	5,585	5,903		
5	6,242	1,082	1,134	1,814	1,731	3,159	4,033	3,624	4,244	4,268	4,323	4,535	4,297	4,287	4,559	4,540	4,808	5,054	5,626	5,651		
6	6,025	1,052	1,111	1,747	1,697	1,643	2,989	3,110	3,632	4,494	4,017	4,303	4,351	4,138	4,278	4,237	4,439	4,823	5,582	5,657		
7	5,563	1,018	1,084	1,702	1,638	1,561	1,474	2,378	3,031	4,329	3,682	3,950	4,124	4,072	4,116	3,971	4,130	4,563	5,261	5,660		
8	4,982	984	1,049	1,657	1,563	1,418	1,381	1,600	2,163	3,690	3,609	3,746	3,860	3,849	4,016	3,968	3,950	4,321	4,706	5,469		
9	4,990	954	1,002	1,592	1,481	1,267	1,358	1,527	1,776	2,123	3,355	3,377	3,562	3,698	3,795	4,020	4,155	4,386	4,548	5,015		
10	4,889	921	943	1,486	1,392	1,353	1,339	1,454	1,741	1,716	2,402	3,135	3,260	3,325	3,443	3,847	4,259	4,212	4,436	4,759		
11	4,533	879	874	1,347	1,295	1,336	1,320	1,519	1,881	1,892	1,767	2,385	3,004	3,434	3,384	3,551	4,256	4,213	4,246	4,654		
12	4,334	824	798	1,188	1,179	1,286	1,319	1,544	1,891	2,053	1,844	1,784	2,429	3,291	3,524	3,256	3,970	4,163	4,162	4,486		
13	4,157	753	728	1,036	1,109	1,237	1,326	1,478	1,910	2,159	1,849	1,813	1,714	2,504	3,329	3,412	3,457	3,838	3,988	4,165		
14	3,701	668	669	895	1,017	1,112	1,251	1,401	1,869	2,121	1,906	1,820	1,745	1,857	2,657	3,295	3,358	3,533	3,604	3,691		
15	3,499	579	597	828	898	1,021	1,132	1,377	1,787	1,969	1,897	1,856	1,649	1,671	1,906	2,630	3,117	3,307	3,366	3,132		
16	3,166	523	518	770	823	1,013	1,136	1,388	1,705	1,780	1,754	1,649	1,443	1,549	1,736	1,669	2,469	2,829	3,078	3,287		
17	2,693	467	472	661	816	939	1,061	1,354	1,549	1,576	1,599	1,507	1,440	1,417	1,554	1,675	1,638	2,191	2,726	3,224		
18	2,657	392	408	514	783	810	898	1,167	1,284	1,363	1,375	1,328	1,302	1,257	1,377	1,567	1,610	1,492	2,209	2,833		
19	2,813	289	336	483	642	747	755	887	1,007	1,072	1,109	1,213	1,125	1,072	1,182	1,316	1,599	1,440	1,344	2,082		
20	2,045	183	212	357	456	509	479	576	665	742	755	808	742	654	778	920	1,166	1,065	989	865		LOCATION
MAX STORY SHEAR	6,498	3,572	6,595	9,236	8,610	7,834	5,785	4,458	5,652	7,317	6,356	6,116	5,697	5,595	5,924	5,758	5,842	6,010	6,297	7,044	3,572	1

Table A1.24 Story shears after optimization for EQ12 data

EARTHQUAKE DATA: EQ 12		STORY SHEAR[tf] ISOLATOR LEVEL																				
STORY	UNCONTROLLED BUILDING	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19		
ISOLATOR FLOOR		1,178	1,093	1,144	1,329	1,330	1,380	1,533	1,688	1,831	2,044	2,219	2,489	2,539	2,581	2,617	2,703	2,545	2,488	2,304		
1	6,811	1,140	1,376	2,631	4,240	4,774	6,232	6,559	6,435	6,255	6,183	5,392	4,576	4,547	4,444	4,346	4,165	4,858	5,706	6,147		
2	6,742	1,093	1,044	2,080	3,465	4,284	5,580	6,214	6,392	6,267	6,163	5,544	4,559	4,237	4,256	4,210	4,093	4,800	5,645	6,086		
3	6,648	1,011	1,012	1,374	2,371	3,509	4,671	5,596	6,094	6,139	5,932	5,555	4,727	4,166	4,038	4,022	3,968	4,722	5,561	6,004		
4	6,524	934	940	1,068	1,591	2,391	3,517	4,670	5,492	5,844	5,474	5,388	4,806	4,302	3,974	3,838	3,852	4,622	5,452	5,896		
5	6,369	867	882	995	1,270	1,531	2,321	3,463	4,567	5,299	5,065	5,053	4,765	4,410	4,093	3,795	3,736	4,501	5,318	5,762		
6	6,185	860	883	935	1,227	1,261	1,434	2,238	3,343	4,438	4,642	4,560	4,565	4,412	4,203	3,922	3,605	4,359	5,159	5,603		
7	5,969	847	881	937	1,180	1,202	1,281	1,492	2,005	3,236	3,935	3,953	4,185	4,260	4,216	4,047	3,636	4,197	4,976	5,417		
8	5,722	826	872	932	1,129	1,217	1,242	1,487	1,613	1,895	2,878	3,282	3,624	3,912	4,067	4,074	3,750	4,016	4,770	5,205		
9	5,442	829	855	917	1,073	1,275	1,326	1,626	1,840	1,575	1,903	2,440	2,934	3,361	3,720	3,934	3,786	3,818	4,540	4,967		
10	5,132	833	836	891	1,155	1,359	1,420	1,768	2,013	1,997	1,772	1,944	2,280	2,648	3,173	3,590	3,670	3,606	4,288	4,702		
11	4,793	815	839	949	1,285	1,417	1,505	1,900	2,182	2,180	2,190	1,916	2,211	2,456	2,613	3,065	3,366	3,433	4,017	4,413		
12	4,429	777	817	977	1,356	1,394	1,542	2,019	2,340	2,352	2,344	2,318	2,140	2,345	2,440	2,612	2,939	3,206	3,732	4,104		
13	4,034	720	771	957	1,349	1,349	1,509	2,148	2,496	2,505	2,476	2,419	2,590	2,231	2,298	2,198	2,585	2,907	3,428	3,772		
14	3,920	665	702	887	1,275	1,246	1,609	2,285	2,626	2,598	2,542	2,455	2,632	2,593	2,152	1,857	2,215	2,649	3,114	3,583		
15	4,221	655	633	792	1,307	1,373	1,728	2,363	2,659	2,586	2,518	2,408	2,563	2,578	2,522	1,668	2,017	2,379	2,868	3,609		
16	4,276	615	589	766	1,244	1,444	1,760	2,305	2,543	2,567	2,391	2,268	2,378	2,431	2,430	2,282	1,906	2,105	2,517	3,398		
17	4,053	546	521	677	1,094	1,396	1,657	2,088	2,452	2,430	2,165	2,036	2,100	2,146	2,195	2,044	2,056	2,088	2,275	2,981		
18	3,538	450	429	542	890	1,213	1,410	1,732	2,132	2,116	1,972	1,723	1,751	1,757	1,805	1,716	1,611	1,901	2,241	2,600		
19	2,717	325	311	387	649	901	1,031	1,316	1,577	1,601	1,568	1,360	1,332	1,306	1,300	1,252	1,213	1,393	1,823	2,361		
20	1,596	180	173	233	369	500	568	741	869	912	938	856	803	783	753	714	716	874	1,047	1,199		LOCATION
MAX STORY SHEAR	6,811	1,140	1,376	2,631	4,240	4,774	6,232	6,559	6,435	6,267	6,183	5,555	4,806	4,547	4,444	4,346	4,165	4,858	5,706	6,147	1,140	1

APPENDIX 2

Table A2.1 Drift ratios after optimization for EQ1 data

								DRIFT RATIOS														
EARTHQUAKE DATA: EQ 1											ISOLATOR LEVEL											
STORY	UNCONTROLLED BUILDING	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19		
ISOLATOR FLOOR		104.81%	99.45%	92.68%	84.89%	75.47%	72.95%	68.29%	57.93%	51.26%	48.35%	48.04%	43.18%	32.99%	34.95%	37.00%	41.86%	51.09%	50.67%	46.06%		
1	0.39%	0.02%	0.02%	0.04%	0.05%	0.05%	0.06%	0.09%	0.09%	0.12%	0.08%	0.08%	0.07%	0.06%	0.07%	0.06%	0.07%	0.09%	0.11%	0.13%		
2	0.57%	0.16%	0.03%	0.05%	0.08%	0.09%	0.10%	0.15%	0.16%	0.21%	0.14%	0.14%	0.13%	0.10%	0.12%	0.11%	0.13%	0.16%	0.20%	0.24%		
3	0.63%	0.21%	0.16%	0.04%	0.07%	0.09%	0.11%	0.16%	0.19%	0.24%	0.17%	0.16%	0.15%	0.13%	0.13%	0.12%	0.15%	0.19%	0.24%	0.29%		
4	0.64%	0.21%	0.20%	0.15%	0.06%	0.08%	0.11%	0.17%	0.21%	0.26%	0.19%	0.18%	0.17%	0.15%	0.14%	0.13%	0.16%	0.21%	0.27%	0.33%		
5	0.66%	0.21%	0.21%	0.19%	0.15%	0.08%	0.11%	0.17%	0.22%	0.26%	0.20%	0.19%	0.18%	0.17%	0.17%	0.14%	0.17%	0.23%	0.28%	0.36%		
6	0.65%	0.21%	0.21%	0.20%	0.18%	0.14%	0.10%	0.16%	0.22%	0.27%	0.21%	0.20%	0.19%	0.19%	0.19%	0.15%	0.19%	0.25%	0.31%	0.38%		
7	0.64%	0.21%	0.21%	0.21%	0.20%	0.19%	0.14%	0.13%	0.20%	0.26%	0.22%	0.20%	0.19%	0.21%	0.21%	0.17%	0.21%	0.29%	0.34%	0.41%		
8	0.63%	0.21%	0.21%	0.21%	0.21%	0.21%	0.18%	0.14%	0.18%	0.24%	0.22%	0.20%	0.19%	0.23%	0.23%	0.19%	0.24%	0.33%	0.38%	0.44%		
9	0.62%	0.21%	0.21%	0.21%	0.21%	0.21%	0.19%	0.17%	0.15%	0.22%	0.21%	0.19%	0.18%	0.24%	0.25%	0.21%	0.27%	0.36%	0.42%	0.48%		
10	0.63%	0.21%	0.21%	0.21%	0.21%	0.22%	0.19%	0.17%	0.17%	0.16%	0.19%	0.19%	0.18%	0.25%	0.26%	0.23%	0.29%	0.39%	0.46%	0.51%		
11	0.72%	0.23%	0.23%	0.23%	0.23%	0.23%	0.21%	0.18%	0.19%	0.21%	0.17%	0.17%	0.17%	0.25%	0.27%	0.25%	0.31%	0.42%	0.49%	0.55%		
12	0.80%	0.24%	0.24%	0.23%	0.23%	0.24%	0.21%	0.17%	0.19%	0.22%	0.21%	0.17%	0.16%	0.25%	0.27%	0.25%	0.32%	0.44%	0.52%	0.58%		
13	0.90%	0.26%	0.26%	0.25%	0.25%	0.25%	0.23%	0.19%	0.21%	0.24%	0.24%	0.24%	0.28%	0.23%	0.26%	0.26%	0.33%	0.46%	0.55%	0.61%		
14	0.95%	0.27%	0.27%	0.26%	0.25%	0.24%	0.23%	0.21%	0.24%	0.26%	0.29%	0.31%	0.39%	0.31%	0.25%	0.26%	0.33%	0.47%	0.58%	0.63%		
15	0.98%	0.28%	0.28%	0.26%	0.26%	0.24%	0.23%	0.22%	0.26%	0.27%	0.32%	0.36%	0.46%	0.43%	0.37%	0.24%	0.32%	0.48%	0.59%	0.66%		
16	0.92%	0.27%	0.27%	0.25%	0.24%	0.23%	0.22%	0.21%	0.25%	0.26%	0.31%	0.38%	0.49%	0.52%	0.48%	0.40%	0.32%	0.48%	0.60%	0.68%		
17	0.95%	0.28%	0.27%	0.24%	0.24%	0.22%	0.21%	0.20%	0.24%	0.24%	0.29%	0.41%	0.54%	0.62%	0.58%	0.57%	0.51%	0.46%	0.60%	0.68%		
18	1.03%	0.27%	0.26%	0.23%	0.22%	0.21%	0.19%	0.20%	0.24%	0.22%	0.30%	0.41%	0.54%	0.66%	0.65%	0.67%	0.64%	0.50%	0.58%	0.68%		
19	1.03%	0.25%	0.23%	0.21%	0.20%	0.19%	0.18%	0.19%	0.25%	0.25%	0.34%	0.38%	0.54%	0.68%	0.67%	0.70%	0.64%	0.64%	0.55%	0.66%		
20	1.16%	0.34%	0.31%	0.27%	0.27%	0.32%	0.32%	0.37%	0.49%	0.58%	0.78%	0.75%	1.07%	1.20%	1.13%	1.12%	1.43%	1.72%	1.51%	0.94%		LOCATION
MAX DRIFT RATIO	1.16%	0.34%	0.31%	0.27%	0.27%	0.32%	0.32%	0.37%	0.49%	0.58%	0.78%	0.75%	1.07%	1.20%	1.13%	1.12%	1.43%	1.72%	1.51%	0.94%	0.27%	4

Table A2.2 Drift ratios after optimization for EQ2 data

								DRIFT RATIOS														
EARTHQUAKE DATA: EQ 2											ISOLATOR LEVEL											
STORY	UNCONTROLLED BUILDING	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19		
ISOLATOR FLOOR		130.43%	122.63%	114.01%	108.71%	101.11%	92.54%	85.98%	61.42%	53.53%	55.10%	55.60%	46.07%	38.48%	35.18%	36.81%	30.29%	25.48%	24.16%	23.84%		
1	0.50%	0.02%	0.02%	0.02%	0.02%	0.02%	0.02%	0.02%	0.02%	0.02%	0.03%	0.03%	0.03%	0.04%	0.04%	0.04%	0.05%	0.06%	0.07%	0.08%		
2	0.79%	0.24%	0.03%	0.03%	0.03%	0.03%	0.03%	0.04%	0.04%	0.04%	0.06%	0.06%	0.07%	0.08%	0.08%	0.08%	0.10%	0.12%	0.14%	0.16%		
3	0.89%	0.31%	0.23%	0.03%	0.03%	0.03%	0.03%	0.04%	0.05%	0.05%	0.07%	0.07%	0.08%	0.10%	0.11%	0.11%	0.13%	0.15%	0.17%	0.21%		
4	0.91%	0.33%	0.28%	0.21%	0.04%	0.04%	0.04%	0.05%	0.05%	0.06%	0.08%	0.08%	0.10%	0.12%	0.13%	0.13%	0.15%	0.18%	0.21%	0.25%		
5	0.96%	0.34%	0.30%	0.27%	0.21%	0.04%	0.04%	0.05%	0.06%	0.07%	0.09%	0.09%	0.11%	0.14%	0.14%	0.15%	0.17%	0.20%	0.24%	0.29%		
6	0.97%	0.34%	0.31%	0.28%	0.26%	0.20%	0.05%	0.05%	0.06%	0.08%	0.09%	0.09%	0.12%	0.15%	0.16%	0.16%	0.19%	0.22%	0.26%	0.32%		
7	1.01%	0.34%	0.32%	0.29%	0.28%	0.26%	0.19%	0.05%	0.06%	0.08%	0.09%	0.09%	0.13%	0.16%	0.17%	0.17%	0.21%	0.24%	0.28%	0.34%		
8	1.00%	0.34%	0.32%	0.28%	0.27%	0.26%	0.24%	0.18%	0.06%	0.08%	0.10%	0.10%	0.14%	0.17%	0.18%	0.19%	0.22%	0.26%	0.30%	0.37%		
9	0.99%	0.33%	0.31%	0.28%	0.27%	0.26%	0.24%	0.22%	0.16%	0.08%	0.09%	0.10%	0.14%	0.18%	0.19%	0.19%	0.24%	0.27%	0.31%	0.38%		
10	0.96%	0.33%	0.30%	0.26%	0.25%	0.25%	0.23%	0.22%	0.19%	0.17%	0.09%	0.10%	0.15%	0.19%	0.19%	0.20%	0.25%	0.28%	0.32%	0.40%		
11	0.99%	0.34%	0.31%	0.27%	0.26%	0.26%	0.24%	0.22%	0.21%	0.22%	0.19%	0.10%	0.15%	0.19%	0.19%	0.20%	0.25%	0.30%	0.34%	0.41%		
12	0.96%	0.34%	0.30%	0.27%	0.25%	0.25%	0.23%	0.22%	0.21%	0.23%	0.23%	0.18%	0.15%	0.19%	0.19%	0.21%	0.26%	0.31%	0.35%	0.42%		
13	0.98%	0.35%	0.31%	0.28%	0.26%	0.25%	0.23%	0.22%	0.21%	0.24%	0.25%	0.24%	0.30%	0.19%	0.20%	0.21%	0.26%	0.31%	0.36%	0.43%		
14	0.95%	0.34%	0.31%	0.28%	0.25%	0.24%	0.22%	0.21%	0.20%	0.24%	0.24%	0.24%	0.38%	0.36%	0.20%	0.20%	0.27%	0.32%	0.36%	0.44%		
15	0.92%	0.34%	0.30%	0.28%	0.25%	0.23%	0.22%	0.20%	0.20%	0.24%	0.24%	0.23%	0.40%	0.44%	0.40%	0.20%	0.27%	0.32%	0.37%	0.45%		
16	0.84%	0.32%	0.28%	0.26%	0.23%	0.21%	0.20%	0.18%	0.19%	0.23%	0.24%	0.21%	0.38%	0.43%	0.48%	0.41%	0.26%	0.32%	0.37%	0.45%		
17	0.80%	0.31%	0.27%	0.25%	0.22%	0.20%	0.19%	0.17%	0.18%	0.23%	0.25%	0.20%	0.37%	0.44%	0.50%	0.53%	0.44%	0.32%	0.37%	0.45%		
18	0.75%	0.29%	0.26%	0.23%	0.21%	0.19%	0.17%	0.16%	0.18%	0.22%	0.25%	0.20%	0.35%	0.44%	0.48%	0.54%	0.52%	0.41%	0.36%	0.45%		
19	0.68%	0.26%	0.23%	0.21%	0.19%	0.17%	0.15%	0.14%	0.16%	0.21%	0.24%	0.19%	0.32%	0.41%	0.44%	0.50%	0.49%	0.46%	0.40%	0.43%		
20	0.65%	0.33%	0.29%	0.26%	0.24%	0.21%	0.19%	0.19%	0.22%	0.31%	0.39%	0.31%	0.54%	0.62%	0.70%	0.73%	0.81%	0.74%	0.83%	0.69%		LOCATION
MAX DRIFT RATIO	1.01%	0.35%	0.32%	0.29%	0.28%	0.26%	0.24%	0.22%	0.22%	0.31%	0.39%	0.31%	0.54%	0.62%	0.70%	0.73%	0.81%	0.74%	0.83%	0.69%	0.22%	7

Table A2.3 Drift ratios after optimization for EQ3 data

		DRIFT RATIOS																				
EARTHQUAKE DATA: EQ 3		ISOLATOR LEVEL																				
STORY	UNCONTROLLED BUILDING	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19		
ISOLATOR FLOOR		113.39%	113.86%	114.24%	113.11%	110.26%	110.28%	113.75%	107.31%	94.46%	108.68%	103.01%	89.21%	57.34%	70.68%	93.47%	98.34%	80.44%	57.70%	42.01%		
1	0.67%	0.02%	0.02%	0.03%	0.03%	0.05%	0.06%	0.07%	0.08%	0.15%	0.14%	0.16%	0.20%	0.19%	0.16%	0.16%	0.15%	0.12%	0.10%	0.08%		
2	1.06%	0.19%	0.03%	0.03%	0.05%	0.07%	0.10%	0.11%	0.13%	0.27%	0.26%	0.29%	0.38%	0.36%	0.30%	0.31%	0.28%	0.24%	0.20%	0.15%		
3	1.19%	0.25%	0.21%	0.04%	0.05%	0.07%	0.11%	0.12%	0.15%	0.31%	0.31%	0.35%	0.47%	0.44%	0.38%	0.39%	0.36%	0.31%	0.25%	0.19%		
4	1.22%	0.26%	0.26%	0.21%	0.05%	0.07%	0.11%	0.13%	0.16%	0.35%	0.35%	0.40%	0.55%	0.52%	0.45%	0.47%	0.43%	0.37%	0.31%	0.23%		
5	1.26%	0.28%	0.29%	0.29%	0.23%	0.07%	0.11%	0.14%	0.16%	0.36%	0.38%	0.42%	0.61%	0.57%	0.51%	0.53%	0.49%	0.42%	0.34%	0.27%		
6	1.24%	0.28%	0.30%	0.31%	0.30%	0.23%	0.10%	0.13%	0.15%	0.37%	0.39%	0.44%	0.65%	0.61%	0.55%	0.58%	0.53%	0.46%	0.38%	0.31%		
7	1.22%	0.29%	0.32%	0.34%	0.35%	0.32%	0.25%	0.13%	0.15%	0.35%	0.39%	0.45%	0.68%	0.63%	0.59%	0.62%	0.57%	0.49%	0.40%	0.34%		
8	1.10%	0.29%	0.32%	0.35%	0.36%	0.35%	0.32%	0.26%	0.13%	0.34%	0.38%	0.44%	0.68%	0.65%	0.61%	0.65%	0.59%	0.51%	0.42%	0.37%		
9	1.09%	0.28%	0.31%	0.35%	0.37%	0.35%	0.35%	0.34%	0.29%	0.30%	0.36%	0.42%	0.68%	0.64%	0.63%	0.66%	0.61%	0.53%	0.43%	0.40%		
10	1.04%	0.26%	0.31%	0.35%	0.36%	0.35%	0.35%	0.35%	0.38%	0.31%	0.33%	0.40%	0.66%	0.63%	0.63%	0.67%	0.62%	0.54%	0.44%	0.43%		
11	1.13%	0.28%	0.32%	0.36%	0.38%	0.36%	0.37%	0.38%	0.44%	0.43%	0.28%	0.37%	0.64%	0.61%	0.63%	0.66%	0.62%	0.54%	0.44%	0.45%		
12	1.15%	0.28%	0.33%	0.37%	0.37%	0.36%	0.36%	0.38%	0.48%	0.47%	0.32%	0.21%	0.60%	0.59%	0.61%	0.65%	0.62%	0.54%	0.44%	0.47%		
13	1.27%	0.30%	0.34%	0.38%	0.38%	0.36%	0.36%	0.40%	0.52%	0.51%	0.41%	0.39%	0.31%	0.55%	0.60%	0.63%	0.61%	0.54%	0.45%	0.50%		
14	1.45%	0.31%	0.35%	0.38%	0.38%	0.35%	0.35%	0.39%	0.53%	0.50%	0.49%	0.49%	0.50%	0.47%	0.56%	0.61%	0.59%	0.53%	0.46%	0.52%		
15	1.66%	0.31%	0.35%	0.38%	0.37%	0.34%	0.33%	0.38%	0.53%	0.47%	0.57%	0.57%	0.74%	1.12%	0.64%	0.57%	0.58%	0.51%	0.47%	0.53%		
16	1.76%	0.29%	0.33%	0.35%	0.34%	0.31%	0.30%	0.35%	0.49%	0.51%	0.60%	0.61%	0.92%	1.54%	1.16%	0.49%	0.54%	0.50%	0.47%	0.53%		
17	1.92%	0.29%	0.32%	0.34%	0.32%	0.30%	0.29%	0.33%	0.48%	0.57%	0.65%	0.68%	1.14%	1.96%	1.60%	0.84%	0.65%	0.49%	0.47%	0.53%		
18	1.99%	0.27%	0.30%	0.31%	0.30%	0.28%	0.27%	0.31%	0.45%	0.59%	0.65%	0.72%	1.30%	2.18%	1.91%	1.01%	0.95%	0.59%	0.46%	0.53%		
19	1.92%	0.25%	0.26%	0.28%	0.27%	0.27%	0.26%	0.28%	0.40%	0.56%	0.61%	0.70%	1.33%	2.32%	2.03%	1.09%	1.05%	0.76%	0.48%	0.51%		
20	2.02%	0.35%	0.39%	0.46%	0.45%	0.43%	0.44%	0.41%	0.54%	0.82%	0.94%	1.18%	2.22%	4.05%	3.54%	2.14%	2.03%	1.52%	1.20%	0.89%		LOCATION
MAX DRIFT RATIO	2.02%	0.35%	0.39%	0.46%	0.45%	0.43%	0.44%	0.41%	0.54%	0.82%	0.94%	1.18%	2.22%	4.05%	3.54%	2.14%	2.03%	1.52%	1.20%	0.89%	0.35%	1

Table A2.4 Drift ratios after optimization for EQ4 data

		DRIFT RATIOS																				
EARTHQUAKE DATA: EQ 4		ISOLATOR LEVEL																				
STORY	UNCONTROLLED BUILDING	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19		
ISOLATOR FLOOR		119.26%	114.09%	109.88%	106.02%	102.15%	98.02%	93.83%	80.94%	81.03%	83.19%	89.06%	79.31%	76.07%	68.85%	68.88%	60.47%	64.86%	67.09%	57.50%		
1	0.54%	0.02%	0.02%	0.02%	0.03%	0.04%	0.05%	0.06%	0.06%	0.07%	0.09%	0.10%	0.08%	0.08%	0.08%	0.09%	0.10%	0.10%	0.10%	0.10%		
2	0.86%	0.20%	0.03%	0.03%	0.04%	0.06%	0.08%	0.09%	0.10%	0.13%	0.15%	0.17%	0.15%	0.15%	0.16%	0.16%	0.18%	0.19%	0.19%	0.19%		
3	0.96%	0.25%	0.20%	0.03%	0.04%	0.06%	0.08%	0.10%	0.12%	0.15%	0.18%	0.21%	0.18%	0.19%	0.21%	0.21%	0.22%	0.23%	0.23%	0.23%		
4	0.99%	0.26%	0.24%	0.18%	0.04%	0.06%	0.08%	0.10%	0.13%	0.18%	0.20%	0.23%	0.22%	0.23%	0.25%	0.27%	0.27%	0.27%	0.28%	0.28%		
5	1.03%	0.27%	0.25%	0.23%	0.19%	0.06%	0.07%	0.10%	0.14%	0.19%	0.22%	0.25%	0.24%	0.26%	0.28%	0.31%	0.32%	0.31%	0.31%	0.31%		
6	1.05%	0.26%	0.25%	0.24%	0.24%	0.19%	0.07%	0.10%	0.14%	0.20%	0.23%	0.26%	0.26%	0.29%	0.31%	0.34%	0.36%	0.36%	0.35%	0.34%		
7	1.09%	0.27%	0.26%	0.25%	0.25%	0.25%	0.20%	0.09%	0.14%	0.20%	0.23%	0.26%	0.28%	0.31%	0.34%	0.38%	0.40%	0.40%	0.39%	0.37%		
8	1.08%	0.27%	0.26%	0.25%	0.25%	0.25%	0.24%	0.19%	0.13%	0.19%	0.23%	0.25%	0.29%	0.32%	0.36%	0.40%	0.43%	0.43%	0.43%	0.41%		
9	1.07%	0.27%	0.26%	0.25%	0.25%	0.25%	0.25%	0.23%	0.19%	0.18%	0.22%	0.25%	0.29%	0.33%	0.38%	0.43%	0.46%	0.46%	0.46%	0.44%		
10	1.04%	0.27%	0.25%	0.24%	0.24%	0.24%	0.24%	0.24%	0.23%	0.21%	0.21%	0.24%	0.29%	0.34%	0.39%	0.44%	0.48%	0.49%	0.49%	0.48%		
11	1.07%	0.28%	0.26%	0.26%	0.26%	0.25%	0.25%	0.25%	0.25%	0.29%	0.20%	0.23%	0.28%	0.34%	0.39%	0.46%	0.50%	0.51%	0.52%	0.51%		
12	1.05%	0.28%	0.26%	0.25%	0.25%	0.25%	0.24%	0.25%	0.25%	0.30%	0.27%	0.20%	0.27%	0.33%	0.39%	0.46%	0.51%	0.53%	0.54%	0.53%		
13	1.06%	0.29%	0.27%	0.26%	0.26%	0.25%	0.25%	0.26%	0.26%	0.30%	0.30%	0.30%	0.30%	0.32%	0.39%	0.46%	0.52%	0.54%	0.56%	0.56%		
14	1.03%	0.28%	0.27%	0.26%	0.26%	0.25%	0.24%	0.26%	0.26%	0.30%	0.30%	0.31%	0.41%	0.37%	0.38%	0.46%	0.52%	0.55%	0.57%	0.57%		
15	1.03%	0.28%	0.26%	0.26%	0.26%	0.24%	0.24%	0.25%	0.27%	0.30%	0.30%	0.31%	0.43%	0.56%	0.48%	0.44%	0.52%	0.55%	0.57%	0.58%		
16	1.03%	0.26%	0.24%	0.24%	0.24%	0.23%	0.23%	0.23%	0.28%	0.30%	0.28%	0.28%	0.41%	0.59%	0.67%	0.51%	0.50%	0.54%	0.57%	0.59%		
17	1.10%	0.24%	0.23%	0.24%	0.24%	0.23%	0.22%	0.23%	0.28%	0.31%	0.29%	0.30%	0.41%	0.62%	0.75%	0.76%	0.60%	0.52%	0.57%	0.59%		
18	1.14%	0.23%	0.22%	0.23%	0.23%	0.22%	0.21%	0.22%	0.27%	0.31%	0.29%	0.38%	0.41%	0.63%	0.77%	0.80%	0.78%	0.58%	0.55%	0.58%		
19	1.12%	0.20%	0.20%	0.21%	0.21%	0.20%	0.19%	0.19%	0.24%	0.30%	0.31%	0.44%	0.48%	0.60%	0.74%	0.75%	0.77%	0.82%	0.67%	0.56%		
20	1.18%	0.26%	0.26%	0.28%	0.28%	0.26%	0.26%	0.25%	0.35%	0.68%	0.68%	0.86%	0.92%	1.24%	1.48%	1.38%	1.28%	1.62%	1.52%	1.06%		LOCATION
MAX DRIFT RATIO	1.18%	0.29%	0.27%	0.28%	0.28%	0.26%	0.26%	0.26%	0.35%	0.68%	0.68%	0.86%	0.92%	1.24%	1.48%	1.38%	1.28%	1.62%	1.52%	1.06%	0.26%	6

Table A2.5 Drift ratios after optimization for EQ5 data

										DRIFT RATIOS												
EARTHQUAKE DATA: EQ 5												ISOLATOR LEVEL										
STORY	UNCONTROLLED BUILDING	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19		
ISOLATOR FLOOR		87.69%	89.40%	90.71%	91.61%	92.28%	91.63%	92.69%	92.83%	85.58%	89.66%	94.31%	63.19%	60.72%	59.42%	70.49%	70.68%	69.02%	66.69%	64.67%		
1	0.63%	0.02%	0.02%	0.03%	0.06%	0.07%	0.12%	0.15%	0.18%	0.16%	0.17%	0.18%	0.12%	0.13%	0.12%	0.13%	0.15%	0.15%	0.12%	0.13%		
2	0.99%	0.14%	0.03%	0.04%	0.07%	0.11%	0.20%	0.24%	0.31%	0.30%	0.32%	0.33%	0.23%	0.23%	0.22%	0.22%	0.24%	0.25%	0.20%	0.23%		
3	1.08%	0.18%	0.14%	0.03%	0.06%	0.11%	0.20%	0.26%	0.35%	0.36%	0.38%	0.40%	0.29%	0.28%	0.26%	0.26%	0.26%	0.29%	0.24%	0.27%		
4	1.05%	0.19%	0.18%	0.15%	0.05%	0.10%	0.20%	0.27%	0.39%	0.42%	0.44%	0.47%	0.34%	0.33%	0.31%	0.30%	0.27%	0.31%	0.29%	0.30%		
5	1.05%	0.20%	0.20%	0.20%	0.17%	0.09%	0.19%	0.27%	0.40%	0.44%	0.48%	0.51%	0.38%	0.38%	0.37%	0.33%	0.28%	0.32%	0.32%	0.34%		
6	1.00%	0.19%	0.20%	0.21%	0.21%	0.18%	0.16%	0.25%	0.39%	0.46%	0.50%	0.53%	0.40%	0.43%	0.43%	0.37%	0.29%	0.33%	0.35%	0.37%		
7	0.94%	0.20%	0.21%	0.22%	0.24%	0.24%	0.20%	0.22%	0.37%	0.45%	0.51%	0.54%	0.41%	0.47%	0.48%	0.42%	0.30%	0.35%	0.38%	0.40%		
8	1.01%	0.19%	0.21%	0.22%	0.24%	0.25%	0.25%	0.20%	0.33%	0.43%	0.50%	0.54%	0.42%	0.50%	0.52%	0.46%	0.34%	0.37%	0.40%	0.42%		
9	1.14%	0.19%	0.21%	0.23%	0.24%	0.26%	0.26%	0.25%	0.21%	0.39%	0.48%	0.53%	0.43%	0.51%	0.55%	0.50%	0.40%	0.42%	0.45%	0.47%		
10	1.22%	0.19%	0.21%	0.23%	0.24%	0.26%	0.26%	0.26%	0.26%	0.22%	0.44%	0.51%	0.43%	0.52%	0.57%	0.54%	0.45%	0.47%	0.51%	0.54%		
11	1.35%	0.20%	0.22%	0.24%	0.26%	0.27%	0.28%	0.28%	0.29%	0.32%	0.22%	0.47%	0.42%	0.52%	0.57%	0.56%	0.49%	0.51%	0.56%	0.60%		
12	1.36%	0.20%	0.22%	0.24%	0.26%	0.28%	0.28%	0.28%	0.29%	0.34%	0.34%	0.22%	0.40%	0.51%	0.57%	0.57%	0.52%	0.55%	0.60%	0.66%		
13	1.46%	0.21%	0.24%	0.26%	0.28%	0.29%	0.29%	0.29%	0.31%	0.38%	0.39%	0.33%	0.30%	0.47%	0.56%	0.57%	0.53%	0.57%	0.64%	0.71%		
14	1.51%	0.21%	0.24%	0.26%	0.28%	0.29%	0.29%	0.28%	0.31%	0.37%	0.40%	0.35%	0.44%	0.39%	0.52%	0.56%	0.53%	0.58%	0.66%	0.75%		
15	1.53%	0.21%	0.24%	0.26%	0.28%	0.29%	0.29%	0.28%	0.32%	0.37%	0.38%	0.36%	0.54%	0.66%	0.46%	0.53%	0.52%	0.58%	0.67%	0.77%		
16	1.41%	0.20%	0.22%	0.24%	0.26%	0.27%	0.27%	0.26%	0.30%	0.36%	0.33%	0.33%	0.61%	0.82%	0.70%	0.47%	0.50%	0.58%	0.67%	0.78%		
17	1.31%	0.19%	0.21%	0.23%	0.25%	0.26%	0.27%	0.26%	0.31%	0.36%	0.44%	0.32%	0.70%	1.03%	0.91%	0.71%	0.57%	0.56%	0.67%	0.78%		
18	1.30%	0.17%	0.19%	0.21%	0.24%	0.25%	0.26%	0.26%	0.33%	0.34%	0.57%	0.39%	0.81%	1.19%	1.09%	0.90%	0.98%	0.53%	0.64%	0.78%		
19	1.39%	0.17%	0.17%	0.19%	0.21%	0.23%	0.23%	0.25%	0.35%	0.41%	0.65%	0.43%	0.87%	1.26%	1.20%	1.00%	1.15%	0.89%	0.49%	0.75%		
20	1.60%	0.32%	0.32%	0.33%	0.39%	0.43%	0.47%	0.55%	0.73%	0.97%	1.31%	0.85%	1.62%	2.34%	2.46%	2.00%	2.01%	1.68%	1.53%	1.04%		LOCATION
MAX DRIFT RATIO	1.60%	0.32%	0.32%	0.33%	0.39%	0.43%	0.47%	0.55%	0.73%	0.97%	1.31%	0.85%	1.62%	2.34%	2.46%	2.00%	2.01%	1.68%	1.53%	1.04%	0.32%	2

Table A2.6 Drift ratios after optimization for EQ6 data

										DRIFT RATIOS												
EARTHQUAKE DATA: EQ 6												ISOLATOR LEVEL										
STORY	UNCONTROLLED BUILDING	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19		
ISOLATOR FLOOR		86.60%	84.20%	78.98%	73.29%	73.39%	71.19%	72.53%	78.50%	66.38%	60.37%	56.77%	49.86%	41.90%	49.68%	47.65%	44.43%	34.93%	35.18%	29.56%		
1	0.46%	0.01%	0.01%	0.02%	0.04%	0.05%	0.06%	0.09%	0.12%	0.13%	0.12%	0.10%	0.08%	0.09%	0.09%	0.07%	0.06%	0.07%	0.08%	0.09%		
2	0.72%	0.14%	0.02%	0.03%	0.05%	0.07%	0.10%	0.15%	0.20%	0.23%	0.22%	0.18%	0.15%	0.16%	0.16%	0.12%	0.12%	0.12%	0.14%	0.16%		
3	0.81%	0.18%	0.14%	0.02%	0.04%	0.06%	0.10%	0.16%	0.23%	0.27%	0.26%	0.23%	0.19%	0.20%	0.20%	0.16%	0.16%	0.14%	0.16%	0.19%		
4	0.82%	0.18%	0.18%	0.14%	0.03%	0.06%	0.10%	0.16%	0.25%	0.31%	0.30%	0.27%	0.22%	0.23%	0.23%	0.19%	0.19%	0.16%	0.20%	0.22%		
5	0.84%	0.19%	0.19%	0.19%	0.15%	0.04%	0.09%	0.16%	0.25%	0.33%	0.32%	0.29%	0.25%	0.25%	0.26%	0.21%	0.22%	0.18%	0.23%	0.26%		
6	0.84%	0.19%	0.20%	0.21%	0.19%	0.14%	0.07%	0.15%	0.25%	0.34%	0.33%	0.31%	0.27%	0.27%	0.27%	0.24%	0.24%	0.20%	0.26%	0.29%		
7	0.86%	0.19%	0.21%	0.23%	0.22%	0.19%	0.15%	0.13%	0.23%	0.33%	0.33%	0.31%	0.28%	0.28%	0.28%	0.26%	0.26%	0.22%	0.28%	0.32%		
8	0.84%	0.19%	0.21%	0.23%	0.23%	0.21%	0.18%	0.15%	0.21%	0.32%	0.32%	0.31%	0.28%	0.28%	0.29%	0.27%	0.27%	0.24%	0.30%	0.35%		
9	0.89%	0.18%	0.21%	0.23%	0.23%	0.22%	0.20%	0.19%	0.19%	0.28%	0.31%	0.30%	0.27%	0.28%	0.29%	0.28%	0.28%	0.25%	0.32%	0.37%		
10	0.91%	0.18%	0.21%	0.23%	0.23%	0.22%	0.20%	0.19%	0.23%	0.19%	0.28%	0.29%	0.26%	0.28%	0.29%	0.29%	0.29%	0.26%	0.34%	0.40%		
11	1.00%	0.18%	0.21%	0.24%	0.25%	0.24%	0.22%	0.21%	0.26%	0.26%	0.22%	0.27%	0.25%	0.27%	0.29%	0.29%	0.30%	0.27%	0.35%	0.42%		
12	1.03%	0.19%	0.22%	0.24%	0.25%	0.24%	0.23%	0.21%	0.26%	0.28%	0.29%	0.20%	0.23%	0.26%	0.28%	0.30%	0.31%	0.28%	0.37%	0.43%		
13	1.10%	0.19%	0.23%	0.25%	0.26%	0.26%	0.24%	0.22%	0.28%	0.29%	0.34%	0.30%	0.35%	0.24%	0.27%	0.30%	0.31%	0.29%	0.37%	0.45%		
14	1.11%	0.20%	0.23%	0.26%	0.27%	0.26%	0.25%	0.22%	0.28%	0.29%	0.35%	0.35%	0.54%	0.44%	0.26%	0.30%	0.31%	0.30%	0.38%	0.46%		
15	1.10%	0.20%	0.24%	0.27%	0.27%	0.26%	0.25%	0.22%	0.29%	0.29%	0.36%	0.39%	0.67%	0.76%	0.49%	0.29%	0.31%	0.30%	0.38%	0.46%		
16	1.03%	0.19%	0.23%	0.26%	0.26%	0.25%	0.23%	0.21%	0.27%	0.26%	0.34%	0.39%	0.74%	0.92%	0.73%	0.45%	0.30%	0.30%	0.38%	0.46%		
17	1.00%	0.19%	0.22%	0.26%	0.26%	0.24%	0.23%	0.20%	0.26%	0.25%	0.32%	0.40%	0.83%	1.08%	0.91%	0.68%	0.47%	0.29%	0.38%	0.46%		
18	0.97%	0.19%	0.22%	0.25%	0.25%	0.23%	0.22%	0.19%	0.24%	0.25%	0.33%	0.38%	0.87%	1.16%	1.03%	0.78%	0.61%	0.49%	0.37%	0.46%		
19	0.90%	0.18%	0.20%	0.23%	0.23%	0.21%	0.20%	0.17%	0.23%	0.24%	0.31%	0.35%	0.84%	1.14%	1.07%	0.82%	0.66%	0.65%	0.49%	0.45%		
20	1.12%	0.26%	0.27%	0.32%	0.31%	0.30%	0.30%	0.30%	0.41%	0.55%	0.66%	0.59%	1.38%	1.85%	1.85%	1.41%	1.34%	1.56%	1.30%	0.81%		LOCATION
MAX DRIFT RATIO	1.12%	0.26%	0.27%	0.32%	0.31%	0.30%	0.30%	0.30%	0.41%	0.55%	0.66%	0.59%	1.38%	1.85%	1.85%	1.41%	1.34%	1.56%	1.30%	0.81%	0.26%	1

Table A2.7 Drift ratios after optimization for EQ7 data

										DRIFT RATIOS												
EARTHQUAKE DATA: EQ 7											ISOLATOR LEVEL											
STORY	UNCONTROLLED BUILDING	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19		
ISOLATOR FLOOR		68.08%	63.34%	60.11%	55.73%	53.18%	52.48%	52.80%	53.58%	62.10%	59.84%	59.69%	48.20%	41.04%	43.66%	42.40%	42.72%	39.69%	30.72%	23.63%		
1	0.39%	0.01%	0.01%	0.02%	0.03%	0.04%	0.04%	0.05%	0.05%	0.06%	0.07%	0.06%	0.06%	0.08%	0.07%	0.07%	0.06%	0.06%	0.07%	0.08%		
2	0.62%	0.11%	0.02%	0.02%	0.04%	0.06%	0.07%	0.09%	0.09%	0.11%	0.13%	0.11%	0.11%	0.15%	0.14%	0.13%	0.11%	0.11%	0.13%	0.14%		
3	0.69%	0.14%	0.11%	0.02%	0.04%	0.06%	0.08%	0.10%	0.10%	0.12%	0.15%	0.13%	0.14%	0.19%	0.18%	0.17%	0.14%	0.14%	0.15%	0.16%		
4	0.70%	0.14%	0.14%	0.11%	0.03%	0.06%	0.08%	0.11%	0.11%	0.13%	0.17%	0.15%	0.16%	0.22%	0.22%	0.20%	0.17%	0.18%	0.18%	0.19%		
5	0.71%	0.15%	0.15%	0.14%	0.11%	0.05%	0.08%	0.11%	0.12%	0.14%	0.18%	0.16%	0.18%	0.25%	0.25%	0.23%	0.19%	0.21%	0.21%	0.21%		
6	0.70%	0.15%	0.15%	0.15%	0.14%	0.11%	0.07%	0.10%	0.12%	0.14%	0.19%	0.17%	0.19%	0.27%	0.28%	0.25%	0.22%	0.24%	0.25%	0.23%		
7	0.72%	0.16%	0.16%	0.16%	0.15%	0.15%	0.12%	0.10%	0.12%	0.13%	0.19%	0.17%	0.19%	0.28%	0.31%	0.27%	0.25%	0.26%	0.28%	0.27%		
8	0.72%	0.16%	0.16%	0.16%	0.15%	0.15%	0.15%	0.12%	0.11%	0.13%	0.18%	0.17%	0.20%	0.29%	0.32%	0.30%	0.27%	0.29%	0.30%	0.30%		
9	0.73%	0.16%	0.16%	0.15%	0.15%	0.15%	0.15%	0.15%	0.14%	0.13%	0.17%	0.16%	0.20%	0.29%	0.34%	0.32%	0.30%	0.31%	0.33%	0.34%		
10	0.74%	0.16%	0.16%	0.15%	0.14%	0.15%	0.15%	0.15%	0.16%	0.18%	0.16%	0.16%	0.20%	0.29%	0.34%	0.33%	0.31%	0.32%	0.35%	0.36%		
11	0.79%	0.17%	0.16%	0.15%	0.15%	0.16%	0.16%	0.16%	0.18%	0.22%	0.20%	0.14%	0.20%	0.29%	0.35%	0.34%	0.33%	0.34%	0.36%	0.39%		
12	0.79%	0.17%	0.16%	0.15%	0.15%	0.16%	0.16%	0.16%	0.17%	0.23%	0.23%	0.20%	0.19%	0.28%	0.35%	0.34%	0.34%	0.35%	0.38%	0.41%		
13	0.79%	0.17%	0.16%	0.15%	0.15%	0.17%	0.17%	0.16%	0.18%	0.24%	0.27%	0.26%	0.28%	0.27%	0.34%	0.34%	0.35%	0.36%	0.39%	0.43%		
14	0.76%	0.17%	0.16%	0.15%	0.15%	0.17%	0.17%	0.16%	0.19%	0.24%	0.28%	0.28%	0.38%	0.35%	0.33%	0.34%	0.35%	0.36%	0.39%	0.44%		
15	0.74%	0.17%	0.16%	0.15%	0.16%	0.17%	0.17%	0.15%	0.19%	0.23%	0.27%	0.29%	0.42%	0.53%	0.49%	0.33%	0.35%	0.36%	0.40%	0.45%		
16	0.70%	0.16%	0.15%	0.14%	0.15%	0.16%	0.15%	0.14%	0.16%	0.22%	0.25%	0.27%	0.46%	0.65%	0.67%	0.47%	0.34%	0.36%	0.40%	0.45%		
17	0.71%	0.16%	0.15%	0.14%	0.14%	0.15%	0.15%	0.15%	0.18%	0.24%	0.25%	0.27%	0.53%	0.78%	0.76%	0.64%	0.52%	0.35%	0.40%	0.45%		
18	0.73%	0.15%	0.14%	0.14%	0.14%	0.15%	0.16%	0.16%	0.21%	0.29%	0.30%	0.26%	0.56%	0.85%	0.77%	0.66%	0.70%	0.55%	0.38%	0.45%		
19	0.73%	0.14%	0.13%	0.13%	0.12%	0.14%	0.17%	0.18%	0.21%	0.33%	0.34%	0.27%	0.53%	0.83%	0.73%	0.60%	0.72%	0.74%	0.44%	0.44%		
20	0.80%	0.19%	0.19%	0.19%	0.20%	0.25%	0.31%	0.35%	0.40%	0.65%	0.72%	0.53%	0.77%	1.29%	1.10%	1.01%	1.19%	1.37%	1.11%	0.72%		LOCATION
MAX DRIFT RATIO	0.80%	0.19%	0.19%	0.19%	0.20%	0.25%	0.31%	0.35%	0.40%	0.65%	0.72%	0.53%	0.77%	1.29%	1.10%	1.01%	1.19%	1.37%	1.11%	0.72%	0.19%	2

Table A2.8 Drift ratios after optimization for EQ8 data

										DRIFT RATIOS												
EARTHQUAKE DATA: EQ 8											ISOLATOR LEVEL											
STORY	UNCONTROLLED BUILDING	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19		
ISOLATOR FLOOR		86.13%	82.41%	77.82%	73.62%	69.84%	66.17%	60.31%	50.45%	45.45%	44.50%	42.70%	35.95%	26.84%	26.80%	24.09%	27.32%	27.81%	27.99%	28.58%		
1	0.50%	0.01%	9.69E-05	0.01%	0.02%	0.02%	0.02%	0.03%	0.03%	0.04%	0.04%	0.03%	0.04%	0.04%	0.05%	0.05%	0.05%	0.06%	0.07%	0.07%		
2	0.79%	0.13%	0.02%	0.02%	0.02%	0.03%	0.04%	0.05%	0.06%	0.06%	0.06%	0.06%	0.07%	0.08%	0.08%	0.09%	0.09%	0.12%	0.13%	0.14%		
3	0.89%	0.17%	0.14%	0.02%	0.02%	0.03%	0.04%	0.05%	0.07%	0.07%	0.07%	0.07%	0.09%	0.09%	0.10%	0.11%	0.12%	0.15%	0.16%	0.18%		
4	0.91%	0.18%	0.17%	0.13%	0.03%	0.03%	0.04%	0.06%	0.07%	0.08%	0.08%	0.08%	0.10%	0.11%	0.11%	0.13%	0.14%	0.18%	0.19%	0.22%		
5	0.95%	0.19%	0.18%	0.17%	0.13%	0.03%	0.04%	0.06%	0.07%	0.08%	0.08%	0.09%	0.11%	0.12%	0.12%	0.14%	0.16%	0.20%	0.22%	0.25%		
6	0.96%	0.19%	0.19%	0.18%	0.16%	0.13%	0.04%	0.06%	0.07%	0.08%	0.09%	0.10%	0.12%	0.13%	0.13%	0.15%	0.17%	0.22%	0.25%	0.27%		
7	1.00%	0.20%	0.20%	0.19%	0.18%	0.16%	0.13%	0.05%	0.07%	0.08%	0.09%	0.11%	0.13%	0.13%	0.14%	0.16%	0.19%	0.24%	0.27%	0.30%		
8	0.99%	0.20%	0.19%	0.18%	0.18%	0.17%	0.16%	0.12%	0.07%	0.08%	0.09%	0.11%	0.13%	0.14%	0.15%	0.16%	0.20%	0.25%	0.28%	0.32%		
9	0.97%	0.20%	0.19%	0.18%	0.17%	0.17%	0.16%	0.15%	0.14%	0.07%	0.09%	0.11%	0.14%	0.14%	0.16%	0.17%	0.21%	0.26%	0.30%	0.34%		
10	0.94%	0.19%	0.19%	0.18%	0.17%	0.16%	0.16%	0.15%	0.17%	0.15%	0.09%	0.10%	0.14%	0.15%	0.16%	0.18%	0.23%	0.26%	0.31%	0.36%		
11	0.97%	0.20%	0.19%	0.18%	0.17%	0.17%	0.17%	0.16%	0.19%	0.19%	0.16%	0.10%	0.14%	0.15%	0.17%	0.19%	0.24%	0.27%	0.32%	0.38%		
12	0.95%	0.19%	0.19%	0.18%	0.17%	0.17%	0.17%	0.16%	0.19%	0.20%	0.20%	0.17%	0.14%	0.15%	0.17%	0.19%	0.24%	0.28%	0.33%	0.39%		
13	0.97%	0.19%	0.19%	0.18%	0.17%	0.17%	0.17%	0.17%	0.20%	0.21%	0.23%	0.22%	0.25%	0.15%	0.17%	0.20%	0.25%	0.29%	0.34%	0.41%		
14	0.95%	0.19%	0.18%	0.18%	0.17%	0.17%	0.17%	0.17%	0.19%	0.21%	0.23%	0.23%	0.30%	0.27%	0.17%	0.20%	0.25%	0.30%	0.35%	0.41%		
15	0.92%	0.18%	0.18%	0.17%	0.16%	0.16%	0.17%	0.17%	0.19%	0.21%	0.24%	0.22%	0.31%	0.35%	0.32%	0.19%	0.25%	0.30%	0.36%	0.42%		
16	0.85%	0.16%	0.16%	0.16%	0.15%	0.15%	0.15%	0.15%	0.17%	0.21%	0.23%	0.22%	0.30%	0.35%	0.42%	0.32%	0.25%	0.30%	0.36%	0.42%		
17	0.82%	0.15%	0.15%	0.15%	0.15%	0.14%	0.15%	0.15%	0.17%	0.22%	0.23%	0.22%	0.31%	0.40%	0.45%	0.45%	0.46%	0.30%	0.36%	0.42%		
18	0.77%	0.14%	0.14%	0.14%	0.14%	0.13%	0.14%	0.15%	0.16%	0.22%	0.23%	0.22%	0.31%	0.42%	0.46%	0.48%	0.60%	0.47%	0.36%	0.42%		
19	0.70%	0.13%	0.13%	0.13%	0.12%	0.12%	0.13%	0.13%	0.14%	0.21%	0.22%	0.20%	0.30%	0.42%	0.43%	0.47%	0.61%	0.59%	0.45%	0.41%		
20	0.68%	0.18%	0.16%	0.16%	0.16%	0.15%	0.19%	0.22%	0.31%	0.36%	0.46%	0.37%	0.49%	0.67%	0.74%	0.76%	0.96%	0.96%	0.93%	0.83%		LOCATION
MAX DRIFT RATIO	1.00%	0.20%	0.20%	0.19%	0.18%	0.17%	0.19%	0.22%	0.31%	0.36%	0.46%	0.37%	0.49%	0.67%	0.74%	0.76%	0.96%	0.96%	0.93%	0.83%	0.17%	5

Table A2.9 Drift ratios after optimization for EQ9 data

EARTHQUAKE DATA: EQ 9		DRIFT RATIOS – ISOLATOR LEVEL																				
STORY	UNCONTROLLED BUILDING	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19		
ISOLATOR FLOOR		103.17%	104.64%	105.76%	106.21%	105.39%	103.57%	101.58%	93.63%	86.13%	80.41%	84.09%	48.08%	42.13%	34.74%	36.31%	33.39%	36.14%	41.55%	53.60%		
1	0.40%	0.02%	0.01%	0.01%	0.02%	0.02%	0.03%	0.04%	0.04%	0.04%	0.05%	0.06%	0.06%	0.05%	0.05%	0.05%	0.05%	0.06%	0.07%	0.09%		
2	0.64%	0.18%	0.02%	0.02%	0.02%	0.03%	0.04%	0.06%	0.07%	0.08%	0.09%	0.10%	0.11%	0.10%	0.10%	0.10%	0.09%	0.10%	0.13%	0.17%		
3	0.73%	0.25%	0.20%	0.03%	0.03%	0.03%	0.04%	0.06%	0.08%	0.09%	0.10%	0.12%	0.13%	0.12%	0.12%	0.13%	0.13%	0.13%	0.16%	0.23%		
4	0.76%	0.27%	0.25%	0.20%	0.04%	0.04%	0.04%	0.07%	0.09%	0.10%	0.12%	0.14%	0.15%	0.14%	0.14%	0.15%	0.16%	0.16%	0.20%	0.29%		
5	0.80%	0.29%	0.28%	0.26%	0.21%	0.04%	0.04%	0.07%	0.10%	0.11%	0.13%	0.16%	0.17%	0.15%	0.16%	0.17%	0.18%	0.19%	0.23%	0.34%		
6	0.81%	0.30%	0.29%	0.28%	0.26%	0.21%	0.05%	0.07%	0.10%	0.11%	0.14%	0.16%	0.18%	0.17%	0.18%	0.19%	0.21%	0.22%	0.27%	0.38%		
7	0.84%	0.32%	0.31%	0.30%	0.29%	0.27%	0.22%	0.06%	0.09%	0.11%	0.14%	0.17%	0.19%	0.18%	0.20%	0.21%	0.23%	0.24%	0.30%	0.42%		
8	0.82%	0.32%	0.31%	0.30%	0.28%	0.28%	0.27%	0.22%	0.09%	0.11%	0.15%	0.17%	0.19%	0.20%	0.22%	0.23%	0.24%	0.26%	0.33%	0.46%		
9	0.80%	0.32%	0.31%	0.29%	0.28%	0.28%	0.28%	0.27%	0.22%	0.11%	0.14%	0.17%	0.19%	0.21%	0.23%	0.25%	0.26%	0.27%	0.35%	0.49%		
10	0.76%	0.32%	0.30%	0.28%	0.27%	0.27%	0.27%	0.28%	0.28%	0.26%	0.14%	0.16%	0.19%	0.21%	0.24%	0.26%	0.27%	0.29%	0.37%	0.52%		
11	0.77%	0.33%	0.31%	0.29%	0.28%	0.27%	0.28%	0.29%	0.30%	0.34%	0.26%	0.16%	0.18%	0.22%	0.25%	0.27%	0.28%	0.30%	0.39%	0.55%		
12	0.75%	0.33%	0.31%	0.29%	0.27%	0.26%	0.27%	0.28%	0.30%	0.35%	0.32%	0.26%	0.17%	0.22%	0.25%	0.27%	0.29%	0.31%	0.41%	0.57%		
13	0.76%	0.33%	0.31%	0.29%	0.27%	0.26%	0.27%	0.28%	0.30%	0.36%	0.36%	0.35%	0.31%	0.22%	0.26%	0.28%	0.30%	0.32%	0.42%	0.59%		
14	0.74%	0.33%	0.31%	0.28%	0.26%	0.25%	0.26%	0.27%	0.29%	0.35%	0.36%	0.37%	0.41%	0.33%	0.25%	0.28%	0.30%	0.32%	0.43%	0.60%		
15	0.73%	0.31%	0.29%	0.27%	0.25%	0.24%	0.25%	0.26%	0.28%	0.33%	0.35%	0.37%	0.45%	0.45%	0.40%	0.27%	0.30%	0.32%	0.43%	0.61%		
16	0.69%	0.29%	0.27%	0.25%	0.23%	0.22%	0.23%	0.24%	0.26%	0.30%	0.31%	0.34%	0.48%	0.54%	0.53%	0.40%	0.30%	0.32%	0.43%	0.61%		
17	0.69%	0.27%	0.25%	0.23%	0.21%	0.22%	0.22%	0.23%	0.25%	0.29%	0.29%	0.33%	0.52%	0.65%	0.67%	0.53%	0.46%	0.31%	0.43%	0.61%		
18	0.68%	0.25%	0.23%	0.21%	0.20%	0.22%	0.21%	0.21%	0.23%	0.27%	0.26%	0.31%	0.59%	0.72%	0.73%	0.60%	0.60%	0.56%	0.43%	0.61%		
19	0.64%	0.22%	0.21%	0.19%	0.18%	0.21%	0.19%	0.19%	0.20%	0.25%	0.24%	0.29%	0.61%	0.73%	0.74%	0.61%	0.63%	0.73%	0.53%	0.60%		
20	0.68%	0.35%	0.30%	0.25%	0.27%	0.29%	0.28%	0.26%	0.31%	0.45%	0.44%	0.54%	1.02%	1.18%	1.18%	0.91%	1.15%	1.25%	1.38%	1.07%		LOCATION
MAX DRIFT RATIO	0.84%	0.35%	0.31%	0.30%	0.29%	0.29%	0.28%	0.29%	0.31%	0.45%	0.44%	0.54%	1.02%	1.18%	1.18%	0.91%	1.15%	1.25%	1.38%	1.07%	0.28%	6

Table A2.10 Drift ratios after optimization for EQ10 data

EARTHQUAKE DATA: EQ 10		DRIFT RATIOS – ISOLATOR LEVEL																				
STORY	UNCONTROLLED BUILDING	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19		
ISOLATOR FLOOR		103.63%	93.41%	82.22%	72.89%	70.77%	70.08%	69.36%	68.29%	56.36%	53.26%	51.32%	41.07%	52.73%	63.69%	70.10%	61.33%	53.53%	45.24%	39.07%		
1	0.54%	0.02%	0.01%	0.02%	0.03%	0.04%	0.07%	0.07%	0.08%	0.08%	0.08%	0.08%	0.07%	0.08%	0.08%	0.09%	0.10%	0.10%	0.09%	0.09%		
2	0.85%	0.17%	0.02%	0.02%	0.04%	0.06%	0.10%	0.12%	0.14%	0.14%	0.15%	0.14%	0.12%	0.15%	0.15%	0.16%	0.17%	0.18%	0.17%	0.17%		
3	0.96%	0.21%	0.16%	0.02%	0.03%	0.06%	0.11%	0.14%	0.16%	0.17%	0.17%	0.17%	0.15%	0.18%	0.19%	0.18%	0.20%	0.22%	0.22%	0.22%		
4	0.98%	0.22%	0.20%	0.14%	0.03%	0.05%	0.11%	0.14%	0.18%	0.19%	0.19%	0.20%	0.18%	0.21%	0.22%	0.21%	0.23%	0.26%	0.26%	0.26%		
5	1.03%	0.22%	0.21%	0.19%	0.13%	0.05%	0.10%	0.14%	0.18%	0.20%	0.20%	0.22%	0.19%	0.22%	0.24%	0.22%	0.25%	0.28%	0.29%	0.29%		
6	1.04%	0.22%	0.22%	0.20%	0.17%	0.13%	0.08%	0.13%	0.18%	0.21%	0.20%	0.23%	0.21%	0.24%	0.25%	0.23%	0.26%	0.30%	0.32%	0.31%		
7	1.09%	0.22%	0.22%	0.21%	0.18%	0.18%	0.15%	0.11%	0.17%	0.20%	0.19%	0.23%	0.22%	0.25%	0.27%	0.24%	0.28%	0.32%	0.34%	0.34%		
8	1.08%	0.21%	0.22%	0.20%	0.18%	0.18%	0.18%	0.16%	0.15%	0.20%	0.19%	0.23%	0.22%	0.26%	0.28%	0.25%	0.30%	0.33%	0.36%	0.38%		
9	1.06%	0.20%	0.21%	0.20%	0.18%	0.18%	0.19%	0.20%	0.18%	0.18%	0.18%	0.23%	0.22%	0.26%	0.28%	0.27%	0.32%	0.35%	0.38%	0.40%		
10	1.03%	0.18%	0.20%	0.19%	0.17%	0.18%	0.18%	0.20%	0.22%	0.18%	0.17%	0.22%	0.22%	0.26%	0.28%	0.29%	0.34%	0.37%	0.40%	0.43%		
11	1.05%	0.19%	0.20%	0.20%	0.18%	0.18%	0.19%	0.22%	0.24%	0.24%	0.17%	0.20%	0.22%	0.26%	0.27%	0.31%	0.37%	0.40%	0.42%	0.45%		
12	1.04%	0.19%	0.20%	0.19%	0.18%	0.18%	0.19%	0.22%	0.24%	0.25%	0.21%	0.17%	0.21%	0.26%	0.26%	0.32%	0.39%	0.42%	0.44%	0.46%		
13	1.20%	0.19%	0.20%	0.20%	0.18%	0.18%	0.20%	0.23%	0.25%	0.26%	0.24%	0.24%	0.30%	0.24%	0.25%	0.32%	0.40%	0.44%	0.46%	0.48%		
14	1.29%	0.19%	0.19%	0.19%	0.18%	0.18%	0.20%	0.22%	0.24%	0.25%	0.25%	0.27%	0.41%	0.35%	0.23%	0.32%	0.40%	0.45%	0.48%	0.50%		
15	1.37%	0.18%	0.18%	0.19%	0.17%	0.17%	0.19%	0.22%	0.24%	0.26%	0.24%	0.30%	0.57%	0.56%	0.51%	0.31%	0.40%	0.46%	0.49%	0.52%		
16	1.33%	0.17%	0.16%	0.17%	0.16%	0.16%	0.18%	0.21%	0.22%	0.22%	0.23%	0.31%	0.67%	0.66%	0.72%	0.54%	0.40%	0.46%	0.49%	0.53%		
17	1.30%	0.17%	0.17%	0.17%	0.15%	0.15%	0.17%	0.20%	0.22%	0.23%	0.25%	0.37%	0.78%	0.81%	0.81%	0.75%	0.55%	0.45%	0.49%	0.53%		
18	1.28%	0.18%	0.17%	0.16%	0.14%	0.14%	0.16%	0.19%	0.21%	0.25%	0.31%	0.44%	0.83%	0.90%	0.90%	0.77%	0.72%	0.48%	0.48%	0.53%		
19	1.22%	0.17%	0.17%	0.16%	0.14%	0.13%	0.15%	0.17%	0.21%	0.27%	0.34%	0.46%	0.83%	0.94%	0.91%	0.73%	0.80%	0.69%	0.49%	0.51%		
20	1.25%	0.27%	0.28%	0.28%	0.26%	0.21%	0.23%	0.27%	0.40%	0.58%	0.63%	0.94%	1.48%	1.68%	1.46%	1.48%	1.56%	1.64%	1.35%	1.01%		LOCATION
MAX DRIFT RATIO	1.37%	0.27%	0.28%	0.28%	0.26%	0.21%	0.23%	0.27%	0.40%	0.58%	0.63%	0.94%	1.48%	1.68%	1.46%	1.48%	1.56%	1.64%	1.35%	1.01%	0.21%	5

Table A2.11 Drift ratios after optimization for EQ11 data

		DRIFT RATIOS																				
EARTHQUAKE DATA: EQ 11		ISOLATOR LEVEL																				
STORY	UNCONTROLLED BUILDING	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19		
ISOLATOR FLOOR		63.61%	65.52%	67.76%	68.44%	74.16%	83.94%	102.26%	103.09%	93.41%	80.48%	71.62%	48.95%	48.53%	48.77%	44.00%	43.18%	47.03%	55.43%	49.47%		
1	0.49%	0.02%	0.04%	0.08%	0.13%	0.14%	0.13%	0.21%	0.19%	0.20%	0.17%	0.14%	0.14%	0.15%	0.13%	0.12%	0.13%	0.18%	0.23%	0.20%		
2	0.77%	0.10%	0.04%	0.10%	0.18%	0.23%	0.22%	0.35%	0.34%	0.36%	0.31%	0.24%	0.21%	0.24%	0.22%	0.19%	0.21%	0.28%	0.35%	0.32%		
3	0.86%	0.13%	0.11%	0.07%	0.16%	0.23%	0.23%	0.40%	0.39%	0.43%	0.37%	0.30%	0.25%	0.27%	0.26%	0.22%	0.21%	0.29%	0.37%	0.34%		
4	0.89%	0.14%	0.15%	0.11%	0.13%	0.22%	0.24%	0.43%	0.43%	0.50%	0.42%	0.35%	0.30%	0.29%	0.29%	0.26%	0.24%	0.29%	0.37%	0.36%		
5	0.93%	0.15%	0.16%	0.16%	0.12%	0.18%	0.22%	0.42%	0.44%	0.55%	0.45%	0.38%	0.33%	0.31%	0.31%	0.28%	0.26%	0.29%	0.33%	0.37%		
6	0.94%	0.16%	0.17%	0.18%	0.17%	0.13%	0.19%	0.40%	0.44%	0.57%	0.46%	0.39%	0.35%	0.34%	0.33%	0.29%	0.29%	0.33%	0.34%	0.36%		
7	0.93%	0.17%	0.19%	0.19%	0.19%	0.19%	0.15%	0.36%	0.41%	0.57%	0.46%	0.40%	0.36%	0.40%	0.38%	0.30%	0.32%	0.36%	0.34%	0.34%		
8	0.88%	0.17%	0.19%	0.19%	0.19%	0.20%	0.21%	0.19%	0.37%	0.55%	0.44%	0.40%	0.37%	0.45%	0.44%	0.34%	0.34%	0.39%	0.37%	0.33%		
9	0.91%	0.17%	0.19%	0.19%	0.19%	0.20%	0.22%	0.24%	0.24%	0.50%	0.42%	0.38%	0.39%	0.48%	0.49%	0.39%	0.36%	0.41%	0.39%	0.36%		
10	0.90%	0.16%	0.18%	0.19%	0.18%	0.19%	0.21%	0.24%	0.28%	0.19%	0.38%	0.37%	0.39%	0.50%	0.52%	0.43%	0.38%	0.43%	0.41%	0.42%		
11	0.94%	0.17%	0.19%	0.20%	0.19%	0.20%	0.22%	0.26%	0.29%	0.30%	0.21%	0.34%	0.39%	0.51%	0.54%	0.46%	0.42%	0.47%	0.48%	0.48%		
12	0.95%	0.17%	0.20%	0.20%	0.19%	0.19%	0.23%	0.26%	0.29%	0.36%	0.31%	0.22%	0.36%	0.50%	0.55%	0.47%	0.44%	0.50%	0.53%	0.54%		
13	1.00%	0.18%	0.21%	0.21%	0.20%	0.19%	0.24%	0.28%	0.31%	0.41%	0.39%	0.31%	0.30%	0.48%	0.54%	0.48%	0.46%	0.53%	0.57%	0.61%		
14	1.00%	0.19%	0.21%	0.20%	0.20%	0.19%	0.23%	0.27%	0.30%	0.43%	0.41%	0.34%	0.41%	0.38%	0.51%	0.47%	0.47%	0.55%	0.60%	0.66%		
15	1.02%	0.19%	0.21%	0.19%	0.20%	0.19%	0.21%	0.24%	0.29%	0.41%	0.39%	0.33%	0.49%	0.60%	0.51%	0.44%	0.47%	0.55%	0.64%	0.69%		
16	0.98%	0.18%	0.19%	0.17%	0.19%	0.18%	0.19%	0.21%	0.27%	0.34%	0.29%	0.32%	0.57%	0.72%	0.70%	0.42%	0.45%	0.55%	0.65%	0.71%		
17	0.98%	0.17%	0.18%	0.18%	0.18%	0.17%	0.19%	0.24%	0.26%	0.31%	0.28%	0.34%	0.67%	0.84%	0.84%	0.65%	0.55%	0.52%	0.64%	0.72%		
18	1.06%	0.16%	0.17%	0.18%	0.17%	0.16%	0.19%	0.26%	0.28%	0.36%	0.34%	0.39%	0.70%	0.92%	0.91%	0.70%	0.80%	0.66%	0.60%	0.71%		
19	1.30%	0.16%	0.16%	0.17%	0.17%	0.17%	0.18%	0.24%	0.29%	0.41%	0.38%	0.41%	0.70%	0.93%	0.88%	0.77%	0.91%	0.97%	0.55%	0.68%		
20	1.62%	0.25%	0.27%	0.28%	0.29%	0.31%	0.37%	0.43%	0.61%	0.98%	1.04%	0.84%	1.54%	1.63%	1.72%	1.54%	1.95%	2.02%	2.07%	1.65%		LOCATION
MAX DRIFT RATIO	1.62%	0.25%	0.27%	0.28%	0.29%	0.31%	0.37%	0.43%	0.61%	0.98%	1.04%	0.84%	1.54%	1.63%	1.72%	1.54%	1.95%	2.02%	2.07%	1.65%	0.25%	1

Table A2.12 Drift ratios after optimization for EQ12 data

		DRIFT RATIOS																				
EARTHQUAKE DATA: EQ 12		ISOLATOR LEVEL																				
STORY	UNCONTROLLED BUILDING	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19		
ISOLATOR FLOOR		87.23%	84.53%	81.22%	74.18%	67.91%	61.37%	59.31%	53.98%	48.45%	49.67%	49.75%	50.94%	58.99%	61.05%	64.72%	61.17%	58.35%	58.28%	52.26%		
1	0.53%	0.01%	0.01%	0.02%	0.03%	0.04%	0.05%	0.06%	0.09%	0.10%	0.11%	0.12%	0.12%	0.12%	0.11%	0.11%	0.10%	0.09%	0.08%	0.08%		
2	0.84%	0.13%	0.02%	0.02%	0.04%	0.05%	0.07%	0.10%	0.15%	0.17%	0.19%	0.22%	0.22%	0.22%	0.21%	0.20%	0.19%	0.17%	0.15%	0.15%		
3	0.95%	0.17%	0.13%	0.02%	0.03%	0.05%	0.06%	0.10%	0.17%	0.20%	0.23%	0.25%	0.26%	0.27%	0.26%	0.26%	0.23%	0.21%	0.20%	0.20%		
4	0.97%	0.17%	0.16%	0.13%	0.02%	0.04%	0.06%	0.11%	0.18%	0.22%	0.26%	0.29%	0.30%	0.31%	0.31%	0.32%	0.28%	0.25%	0.24%	0.25%		
5	1.02%	0.18%	0.16%	0.16%	0.13%	0.03%	0.05%	0.10%	0.18%	0.23%	0.28%	0.30%	0.34%	0.34%	0.35%	0.36%	0.31%	0.27%	0.28%	0.29%		
6	1.03%	0.18%	0.16%	0.16%	0.16%	0.13%	0.05%	0.09%	0.17%	0.24%	0.29%	0.32%	0.36%	0.36%	0.37%	0.39%	0.33%	0.30%	0.31%	0.32%		
7	1.08%	0.19%	0.17%	0.17%	0.17%	0.17%	0.13%	0.08%	0.15%	0.23%	0.29%	0.32%	0.37%	0.37%	0.39%	0.41%	0.35%	0.31%	0.34%	0.36%		
8	1.07%	0.19%	0.17%	0.16%	0.17%	0.17%	0.16%	0.12%	0.13%	0.21%	0.28%	0.32%	0.38%	0.38%	0.40%	0.43%	0.37%	0.33%	0.36%	0.38%		
9	1.05%	0.19%	0.17%	0.17%	0.17%	0.18%	0.16%	0.15%	0.15%	0.18%	0.26%	0.31%	0.37%	0.38%	0.40%	0.44%	0.37%	0.34%	0.38%	0.40%		
10	1.02%	0.18%	0.17%	0.17%	0.17%	0.17%	0.16%	0.16%	0.18%	0.17%	0.23%	0.29%	0.36%	0.38%	0.40%	0.44%	0.37%	0.35%	0.40%	0.42%		
11	1.05%	0.19%	0.18%	0.19%	0.19%	0.18%	0.18%	0.16%	0.20%	0.23%	0.19%	0.27%	0.35%	0.37%	0.38%	0.43%	0.37%	0.36%	0.41%	0.44%		
12	1.03%	0.19%	0.18%	0.19%	0.20%	0.20%	0.20%	0.19%	0.21%	0.24%	0.23%	0.19%	0.32%	0.35%	0.37%	0.42%	0.36%	0.37%	0.42%	0.45%		
13	1.04%	0.20%	0.19%	0.20%	0.21%	0.22%	0.23%	0.22%	0.25%	0.29%	0.28%	0.25%	0.30%	0.32%	0.35%	0.40%	0.37%	0.38%	0.43%	0.46%		
14	1.03%	0.20%	0.19%	0.20%	0.22%	0.23%	0.24%	0.23%	0.27%	0.30%	0.31%	0.27%	0.42%	0.34%	0.31%	0.38%	0.36%	0.38%	0.44%	0.46%		
15	1.19%	0.20%	0.19%	0.20%	0.21%	0.23%	0.25%	0.23%	0.30%	0.31%	0.32%	0.30%	0.58%	0.69%	0.47%	0.35%	0.36%	0.38%	0.44%	0.47%		
16	1.26%	0.18%	0.18%	0.20%	0.20%	0.22%	0.23%	0.24%	0.32%	0.34%	0.34%	0.32%	0.70%	0.90%	0.77%	0.42%	0.34%	0.38%	0.44%	0.47%		
17	1.38%	0.18%	0.19%	0.21%	0.20%	0.21%	0.24%	0.26%	0.34%	0.39%	0.39%	0.37%	0.82%	1.13%	1.00%	0.68%	0.48%	0.37%	0.44%	0.46%		
18	1.42%	0.18%	0.20%	0.21%	0.20%	0.21%	0.24%	0.26%	0.34%	0.42%	0.43%	0.40%	0.88%	1.28%	1.15%	0.74%	0.69%	0.47%	0.43%	0.46%		
19	1.38%	0.17%	0.19%	0.19%	0.19%	0.19%	0.23%	0.25%	0.32%	0.41%	0.44%	0.41%	0.86%	1.30%	1.20%	0.77%	0.70%	0.63%	0.45%	0.45%		
20	1.47%	0.26%	0.27%	0.28%	0.26%	0.28%	0.32%	0.37%	0.60%	0.74%	0.80%	0.73%	1.59%	2.23%	2.14%	1.54%	1.34%	1.38%	1.28%	0.77%		LOCATION
MAX DRIFT RATIO	1.47%	0.26%	0.27%	0.28%	0.26%	0.28%	0.32%	0.37%	0.60%	0.74%	0.80%	0.73%	1.59%	2.23%	2.14%	1.54%	1.34%	1.38%	1.28%	0.77%	0.26%	1

Table A2.13 Story shears after optimization for EQ1 data

EARTHQUAKE DATA: EQ 1		STORY SHEAR[tf]																				
		ISOLATOR LEVEL																				
STORY	UNCONTROLLED BUILDING	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19		
ISOLATOR FLOOR		1,766	1,650	1,514	1,374	1,225	1,189	1,125	1,149	1,208	1,156	1,151	1,770	1,809	2,132	2,206	2,649	2,984	2,665	2,113		
1	5,308	2,579	3,362	5,175	7,416	6,994	7,884	10,463	11,265	14,934	9,471	9,294	8,035	7,834	8,583	8,236	8,818	10,514	13,070	14,918		
2	4,713	1,651	2,807	4,022	6,701	6,845	7,384	10,569	10,792	14,822	9,473	9,254	8,201	7,645	8,648	8,304	8,764	10,272	12,789	14,915		
3	4,579	1,542	1,540	2,706	4,876	5,674	6,314	9,391	9,850	12,951	8,460	8,213	7,484	6,761	7,818	7,473	7,815	9,303	11,155	13,456		
4	4,498	1,440	1,440	1,389	3,105	4,409	5,456	8,483	9,406	11,504	7,941	7,546	7,035	6,092	7,135	6,878	7,285	8,626	10,052	12,257		
5	4,399	1,344	1,346	1,284	1,293	2,925	4,150	6,839	8,468	9,669	7,174	6,628	6,366	5,756	6,251	6,022	6,645	7,786	9,093	10,747		
6	4,140	1,254	1,260	1,210	1,220	1,187	2,773	4,870	6,984	8,285	6,686	5,729	5,621	5,358	5,273	5,111	6,146	7,281	8,226	9,599		
7	3,754	1,173	1,187	1,154	1,160	1,162	1,100	3,045	4,929	6,580	6,282	5,067	4,911	4,901	4,975	4,488	5,397	6,856	7,603	8,821		
8	3,427	1,104	1,129	1,109	1,116	1,144	1,098	1,035	2,960	4,696	5,497	4,721	4,401	4,979	4,937	4,159	4,621	6,167	7,132	8,294		
9	3,225	1,052	1,088	1,075	1,090	1,128	1,093	1,020	1,025	2,942	4,110	4,263	4,144	5,068	4,940	4,167	5,050	6,599	7,583	8,506		
10	3,247	1,019	1,066	1,052	1,071	1,112	1,068	987	1,011	1,144	2,514	3,274	3,794	4,957	4,891	4,412	5,311	6,923	7,929	8,727		
11	3,431	1,022	1,054	1,039	1,050	1,088	1,025	937	975	1,109	1,057	2,307	3,334	4,479	4,662	4,521	5,416	7,122	8,104	8,791		
12	3,616	1,014	1,043	1,024	1,022	1,042	965	873	915	1,052	1,064	1,065	2,985	3,645	4,145	4,390	5,375	7,272	8,226	8,733		
13	3,726	995	1,026	996	985	970	886	798	862	1,011	1,077	1,042	1,607	3,099	3,352	3,986	5,232	7,375	8,381	8,663		
14	3,700	975	992	951	935	878	818	770	858	1,027	1,152	1,245	1,710	1,652	3,415	3,262	4,931	7,311	8,621	8,782		
15	3,505	933	934	882	868	825	847	757	874	980	1,177	1,348	1,791	1,783	1,865	3,161	4,272	6,831	8,590	9,032		
16	3,084	863	848	787	778	740	797	690	816	892	1,047	1,342	1,738	1,899	1,864	1,923	3,805	5,880	8,092	9,066		
17	2,687	761	732	667	664	627	676	622	662	733	865	1,239	1,664	1,940	1,862	1,848	2,104	4,388	6,810	8,385		
18	2,519	624	588	527	528	485	506	504	632	592	791	1,044	1,415	1,769	1,745	1,798	1,751	1,982	4,889	7,020		
19	2,040	449	413	367	368	344	360	429	566	601	853	850	1,173	1,444	1,522	1,504	1,519	1,728	1,980	4,758		
20	1,227	253	228	201	200	236	238	285	386	438	622	595	798	939	960	932	993	1,275	1,185	1,111		LOCATION
MAX STORY SHEAR	5,308	2,579	3,362	5,175	7,416	6,994	7,884	10,569	11,265	14,934	9,473	9,294	8,201	7,834	8,648	8,304	8,818	10,514	13,070	14,918	2,579	1

Table A2.14 Story shears after optimization for EQ2 data

EARTHQUAKE DATA: EQ 2		STORY SHEAR[tf]																				
		ISOLATOR LEVEL																				
STORY	UNCONTROLLED BUILDING	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19		
ISOLATOR FLOOR		2,428	2,210	1,985	1,856	1,685	1,511	1,392	1,198	1,249	1,261	1,269	1,840	1,984	2,139	2,199	2,177	1,961	1,704	1,421		
1	6,401	2,907	2,218	2,002	1,884	1,748	1,773	2,305	2,800	2,638	3,400	3,757	3,500	4,236	4,453	4,505	5,230	5,984	6,834	7,673		
2	6,335	2,338	2,828	1,996	2,011	1,755	1,790	2,347	2,686	2,597	3,430	3,781	3,525	4,271	4,498	4,538	5,280	6,072	6,972	7,862		
3	6,247	2,247	2,109	2,398	1,871	1,712	1,607	2,162	2,309	2,348	3,150	3,447	3,250	3,950	4,157	4,182	4,877	5,638	6,519	7,408		
4	6,132	2,154	2,006	1,889	2,229	1,703	1,580	2,016	2,051	2,306	2,972	3,256	3,116	3,787	3,978	4,002	4,665	5,408	6,301	7,217		
5	5,989	2,058	1,901	1,794	1,758	1,925	1,532	1,812	1,947	2,220	2,751	2,981	2,986	3,612	3,787	3,817	4,434	5,140	6,034	6,980		
6	5,817	1,959	1,814	1,699	1,661	1,599	1,716	1,551	1,795	2,088	2,578	2,668	2,866	3,432	3,583	3,643	4,191	4,847	5,725	6,700		
7	5,615	1,856	1,734	1,605	1,564	1,514	1,432	1,589	1,593	1,909	2,345	2,294	2,761	3,252	3,378	3,482	3,953	4,537	5,378	6,377		
8	5,383	1,750	1,653	1,510	1,466	1,430	1,351	1,305	1,468	1,690	2,031	1,983	2,653	3,095	3,191	3,321	3,755	4,236	5,009	6,018		
9	5,120	1,674	1,567	1,412	1,366	1,345	1,268	1,217	1,126	1,522	1,642	1,693	2,530	2,955	3,014	3,141	3,596	3,991	4,629	5,627		
10	4,826	1,595	1,474	1,312	1,266	1,256	1,182	1,127	1,054	1,185	1,596	1,490	2,383	2,811	2,832	2,933	3,439	3,833	4,278	5,219		
11	4,505	1,509	1,375	1,237	1,163	1,164	1,092	1,035	982	1,128	1,194	1,557	2,203	2,644	2,620	2,693	3,265	3,708	4,047	4,927		
12	4,161	1,415	1,273	1,171	1,071	1,068	1,000	943	906	1,063	1,116	1,139	2,100	2,454	2,460	2,424	3,062	3,564	3,909	4,695		
13	3,788	1,321	1,194	1,093	998	967	903	849	827	989	1,020	1,024	1,717	2,283	2,309	2,210	2,821	3,377	3,751	4,436		
14	3,398	1,221	1,099	1,002	914	863	804	754	743	911	911	910	1,603	1,809	2,410	2,180	2,545	3,141	3,548	4,135		
15	2,983	1,100	987	896	817	753	700	655	665	827	823	788	1,465	1,621	1,947	2,480	2,390	2,847	3,286	3,770		
16	2,548	959	858	776	708	637	592	554	585	734	760	705	1,293	1,502	1,731	1,918	2,513	2,501	2,967	3,338		
17	2,087	798	711	641	585	517	479	448	504	628	682	609	1,087	1,333	1,462	1,653	1,748	2,286	2,579	2,840		
18	1,608	619	550	495	452	395	363	340	408	511	579	498	851	1,115	1,146	1,342	1,352	1,440	2,209	2,451		
19	1,100	422	373	336	307	270	249	238	290	381	438	376	596	830	805	959	946	937	1,196	2,120		
20	600	228	202	181	166	159	151	139	169	232	287	239	381	484	503	544	604	592	675	722		LOCATION
MAX STORY SHEAR	6,401	2,907	2,828	2,398	2,229	1,925	1,790	2,347	2,800	2,638	3,430	3,781	3,525	4,271	4,498	4,538	5,280	6,072	6,972	7,862	1,790	6

Table A2.15 Story shears after optimization for EQ3 data

EARTHQUAKE DATA: EQ 3		STORY SHEAR[tf]																				
		ISOLATOR LEVEL																				
STORY	UNCONTROLLED BUILDING	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19		
ISOLATOR FLOOR		1,970	1,981	1,991	1,962	1,893	1,893	1,978	2,121	2,325	2,457	2,285	2,883	2,525	3,290	4,066	4,648	3,980	2,883	2,000		
1	8,674	2,560	2,731	3,847	4,853	6,699	7,977	8,409	10,372	17,566	15,929	18,293	21,461	20,103	17,106	16,663	14,401	11,990	10,173	8,800		
2	8,652	1,870	2,781	2,974	4,098	6,057	7,486	7,998	9,756	17,706	16,141	18,329	22,064	20,704	17,612	16,856	14,975	12,501	10,447	8,994		
3	8,639	1,793	1,903	2,690	3,035	4,670	6,414	6,707	8,177	16,065	14,855	16,666	20,783	19,426	16,589	15,552	14,274	11,984	10,007	8,379		
4	8,552	1,737	1,839	1,904	2,756	3,651	5,461	6,024	7,210	14,974	14,016	15,690	20,137	18,749	16,140	15,252	13,978	11,814	9,815	8,063		
5	8,311	1,697	1,806	1,900	1,901	2,668	4,193	5,187	5,971	13,262	12,892	14,358	19,192	17,839	15,502	14,868	13,514	11,495	9,487	7,647		
6	7,863	1,658	1,779	1,906	1,935	1,890	2,892	4,126	4,656	11,250	11,463	12,897	17,934	16,686	14,716	14,430	12,930	11,027	9,053	7,151		
7	7,180	1,606	1,740	1,900	1,953	1,909	1,897	2,823	3,413	8,814	9,704	11,172	16,331	15,381	13,838	13,884	12,263	10,424	8,525	6,526		
8	6,293	1,534	1,681	1,871	1,941	1,896	1,881	1,930	2,996	6,084	7,618	9,211	14,400	13,902	12,889	13,151	11,554	9,712	7,903	6,138		
9	5,834	1,438	1,606	1,816	1,895	1,848	1,857	1,875	1,967	4,217	5,172	6,979	12,155	12,132	11,828	12,151	10,803	8,967	7,196	5,966		
10	5,467	1,319	1,525	1,742	1,819	1,770	1,811	1,804	2,035	2,240	3,857	4,778	9,633	10,143	10,596	10,864	9,919	8,288	6,459	5,765		
11	5,176	1,228	1,454	1,662	1,721	1,670	1,729	1,723	2,122	2,252	2,006	3,861	6,858	8,301	9,145	9,348	8,825	7,600	6,050	5,919		
12	5,135	1,188	1,397	1,582	1,612	1,551	1,611	1,643	2,167	2,252	1,598	1,651	5,918	6,374	7,459	7,871	7,494	6,785	5,834	6,200		
13	5,126	1,152	1,339	1,496	1,498	1,413	1,460	1,567	2,146	2,176	1,695	1,838	2,164	6,408	5,564	5,963	5,893	5,762	5,989	6,292		
14	5,491	1,099	1,261	1,391	1,373	1,271	1,292	1,441	2,046	1,986	1,887	2,036	2,270	3,217	6,641	4,133	4,676	5,183	5,932	6,171		
15	5,843	1,019	1,154	1,258	1,225	1,126	1,116	1,263	1,866	1,674	2,020	2,147	2,840	4,703	3,503	6,795	3,897	4,643	5,592	5,836		
16	5,886	908	1,014	1,094	1,055	969	943	1,050	1,626	1,652	2,018	2,165	3,299	5,882	4,463	3,453	6,863	4,156	4,956	5,268		
17	5,591	766	846	905	865	791	775	891	1,359	1,610	1,866	2,079	3,664	6,351	5,124	3,025	3,653	5,539	4,001	4,456		
18	4,917	600	656	699	663	713	695	714	1,067	1,421	1,570	1,853	3,556	5,982	5,239	2,843	2,790	2,943	3,932	3,486		
19	3,778	445	495	570	545	563	559	533	730	1,068	1,152	1,453	2,882	5,132	4,557	2,519	2,430	1,884	1,998	3,074		
20	2,193	275	312	367	360	338	345	328	395	674	689	903	1,861	3,291	2,949	1,622	1,641	1,178	1,075	1,139		LOCATION
MAX STORY SHEAR	8,674	2,560	2,781	3,847	4,853	6,699	7,977	8,409	10,372	17,706	16,141	18,329	22,064	20,704	17,612	16,856	14,975	12,501	10,447	8,994	2,560	1

Table A2.16 Story shears after optimization for EQ4 data

EARTHQUAKE DATA: EQ 4		STORY SHEAR[tf]																				
		ISOLATOR LEVEL																				
STORY	UNCONTROLLED BUILDING	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19		
ISOLATOR FLOOR		2,120	1,987	1,884	1,794	1,707	1,620	1,536	1,517	1,888	1,775	1,912	2,620	3,059	3,230	3,231	3,302	3,444	3,172	2,449		
1	6,970	2,621	2,396	2,855	3,871	5,486	6,356	7,108	7,556	8,705	10,006	10,656	8,990	8,298	9,085	10,219	10,859	11,007	11,204	11,079		
2	6,882	1,981	2,652	2,410	3,271	4,925	5,838	6,696	7,267	8,675	10,106	10,915	9,244	8,089	8,858	9,993	10,724	10,913	11,163	11,003		
3	6,768	1,853	1,844	2,408	2,588	3,716	4,667	5,552	6,272	7,734	9,232	10,098	8,657	7,668	7,823	8,912	9,617	9,875	10,118	9,980		
4	6,628	1,736	1,708	1,729	2,429	2,843	3,741	4,740	5,630	7,155	8,575	9,589	8,310	7,504	7,816	8,273	8,974	9,280	9,545	9,391		
5	6,463	1,638	1,592	1,591	1,649	2,264	2,870	3,679	4,984	6,623	7,703	8,802	7,821	7,259	7,771	7,773	8,363	8,673	8,923	8,714		
6	6,272	1,556	1,499	1,477	1,531	1,588	2,268	2,924	4,226	5,881	6,756	7,854	7,170	7,115	7,561	7,907	7,903	8,149	8,327	8,043		
7	6,051	1,487	1,425	1,396	1,439	1,490	1,512	2,322	3,319	4,938	5,876	6,701	6,496	6,865	7,262	7,810	7,821	7,795	7,797	7,417		
8	5,800	1,426	1,362	1,333	1,365	1,405	1,413	1,435	2,581	3,771	4,808	5,351	5,934	6,513	6,913	7,578	7,828	7,509	7,405	7,026		
9	5,521	1,370	1,305	1,276	1,299	1,324	1,320	1,346	1,428	2,845	3,631	4,436	5,263	6,018	6,672	7,218	7,701	7,635	7,168	6,784		
10	5,212	1,313	1,247	1,219	1,235	1,242	1,227	1,264	1,364	1,748	2,860	3,374	4,451	5,372	6,250	7,013	7,338	7,589	7,411	6,847		
11	4,874	1,252	1,185	1,159	1,169	1,158	1,135	1,186	1,297	1,638	1,606	3,004	3,486	4,575	5,664	6,623	7,105	7,276	7,413	7,131		
12	4,511	1,182	1,117	1,093	1,097	1,072	1,048	1,110	1,221	1,509	1,515	1,724	3,797	4,019	4,872	6,040	6,710	6,769	7,190	7,165		
13	4,117	1,101	1,039	1,021	1,021	984	965	1,033	1,129	1,342	1,437	1,565	2,289	4,268	4,222	5,200	6,096	6,345	6,701	6,953		
14	3,702	1,009	953	942	940	899	881	944	1,014	1,131	1,326	1,412	1,996	2,708	4,608	4,186	5,270	5,799	6,077	6,489		
15	3,612	902	855	854	852	814	800	836	950	1,001	1,191	1,271	1,731	2,461	2,941	4,842	4,184	4,994	5,538	5,956		
16	3,436	780	744	754	753	722	720	732	922	902	1,041	1,120	1,505	2,253	2,729	2,967	5,057	4,386	5,087	5,546		
17	3,183	645	622	640	641	616	623	637	832	826	886	949	1,274	1,997	2,464	2,653	2,816	5,108	4,649	4,935		
18	2,826	499	487	510	514	493	498	516	670	712	713	922	1,109	1,706	2,095	2,212	2,291	2,678	4,832	4,398		
19	2,222	340	337	359	365	349	346	358	442	732	737	970	1,078	1,398	1,696	1,626	1,666	2,082	2,342	3,905		
20	1,320	183	185	200	205	196	188	184	252	518	510	665	750	914	1,125	1,038	967	1,365	1,357	1,230		LOCATION
MAX STORY SHEAR	6,970	2,621	2,652	2,855	3,871	5,486	6,356	7,108	7,556	8,705	10,106	10,915	9,244	8,298	9,085	10,219	10,859	11,007	11,204	11,079	2,621	1

Table A2.17 Story shears after optimization for EQ5 data

								STORY SHEAR[tf]														
EARTHQUAKE DATA: EQ 5										ISOLATOR LEVEL												
STORY	UNCONTROLLED BUILDING	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19		
ISOLATOR FLOOR		1,423	1,453	1,477	1,494	1,507	1,495	1,515	1,762	2,026	1,925	2,043	2,236	2,619	2,936	3,283	3,646	3,589	3,162	2,675		
1	8,082	2,233	3,485	5,313	8,078	9,888	16,026	18,405	21,148	18,076	19,301	19,268	13,859	15,964	14,801	14,598	19,012	18,154	14,774	17,095		
2	8,088	1,375	2,473	3,709	6,573	8,920	15,153	17,756	21,106	18,892	19,724	19,862	13,618	15,572	14,473	14,320	18,576	18,452	14,509	17,010		
3	7,861	1,336	1,379	2,417	4,105	6,744	12,483	15,023	18,884	17,891	18,390	18,579	12,769	13,766	12,762	12,962	16,016	16,933	12,741	15,192		
4	7,356	1,296	1,312	1,422	2,703	5,002	10,028	12,941	17,171	17,311	17,549	17,814	12,662	12,757	12,154	11,936	14,185	15,618	12,222	14,461		
5	6,962	1,248	1,253	1,362	1,464	2,984	6,926	10,050	14,834	16,031	16,427	16,726	12,208	11,797	11,397	10,611	11,816	13,838	11,130	13,628		
6	6,351	1,187	1,196	1,308	1,418	1,491	3,655	7,188	12,031	14,236	14,920	15,340	11,412	11,195	10,474	9,278	9,586	11,728	10,034	12,504		
7	5,563	1,108	1,148	1,258	1,376	1,460	1,500	3,924	8,616	11,695	12,941	13,772	10,311	10,778	10,173	8,469	7,921	9,667	9,410	10,995		
8	5,479	1,014	1,107	1,214	1,333	1,431	1,481	1,518	4,784	8,494	10,428	11,923	9,315	10,590	10,424	8,719	6,546	7,884	8,565	9,477		
9	6,089	971	1,072	1,177	1,287	1,395	1,459	1,493	1,733	4,483	7,418	9,480	8,588	10,230	10,406	9,295	6,970	6,832	7,695	8,553		
10	6,445	941	1,042	1,144	1,244	1,347	1,425	1,457	1,676	1,894	4,428	6,505	7,464	9,371	10,080	9,639	8,399	7,501	7,524	7,685		
11	6,503	913	1,014	1,112	1,203	1,291	1,373	1,406	1,598	1,774	1,929	4,503	5,815	7,950	9,237	9,595	9,302	8,486	8,528	8,653		
12	6,239	882	982	1,076	1,158	1,225	1,299	1,333	1,477	1,748	1,997	1,869	4,566	6,069	7,777	9,048	9,556	9,641	9,141	9,654		
13	6,134	844	941	1,030	1,103	1,144	1,203	1,232	1,310	1,753	1,957	1,718	2,075	5,122	5,726	7,770	9,401	10,084	9,329	10,198		
14	5,931	791	885	970	1,034	1,047	1,096	1,109	1,113	1,590	1,795	1,573	2,090	2,666	5,424	5,909	8,622	9,765	9,082	10,301		
15	5,518	719	808	887	945	950	1,000	983	1,034	1,291	1,476	1,411	2,138	2,752	2,639	5,303	6,946	8,725	8,380	9,976		
16	4,802	625	706	778	827	847	896	849	955	1,146	1,192	1,211	2,184	2,976	2,662	2,626	5,293	7,026	7,223	9,175		
17	3,835	512	582	644	681	726	771	734	848	991	1,270	983	2,177	3,209	2,705	2,448	2,879	4,865	5,674	7,834		
18	3,162	429	443	491	515	583	619	709	838	873	1,413	950	2,239	3,189	2,775	2,475	2,961	2,640	4,372	6,077		
19	2,865	383	376	381	437	477	530	667	738	1,064	1,486	924	1,908	2,696	2,719	2,276	2,766	2,458	2,133	4,000		
20	1,978	254	252	267	310	326	357	464	533	748	947	624	1,238	1,774	1,858	1,536	1,705	1,924	1,287	1,262		LOCATION
MAX STORY SHEAR	8,088	2,233	3,485	5,313	8,078	9,888	16,026	18,405	21,148	18,892	19,724	19,862	13,859	15,964	14,801	14,598	19,012	18,452	14,774	17,095	2,233	1

Table A2.18 Story shears after optimization for EQ6 data

								STORY SHEAR[tf]														
EARTHQUAKE DATA: EQ 6										ISOLATOR LEVEL												
STORY	UNCONTROLLED BUILDING	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19		
ISOLATOR FLOOR		1,404	1,362	1,278	1,193	1,195	1,164	1,183	1,472	1,508	1,345	1,287	1,930	2,090	2,635	2,570	2,743	2,372	2,138	1,616		
1	5,962	1,579	1,957	3,477	5,263	6,669	8,497	11,323	13,851	14,871	13,095	10,283	7,887	9,514	9,452	6,756	7,394	8,744	9,952	10,682		
2	5,848	1,339	1,716	2,448	4,244	5,922	7,787	10,925	13,676	15,143	13,510	10,859	8,344	9,585	9,592	6,918	7,299	8,695	10,040	10,985		
3	5,703	1,277	1,307	1,595	2,669	4,321	6,179	9,232	12,252	13,841	12,691	10,409	8,262	8,799	8,883	6,487	6,533	7,752	9,163	10,250		
4	5,527	1,216	1,258	1,257	1,690	3,028	4,833	7,965	11,062	12,965	12,118	10,167	8,247	8,389	8,475	6,277	6,034	7,167	8,649	9,865		
5	5,320	1,156	1,216	1,246	1,204	1,666	3,228	6,132	9,481	11,958	11,227	9,686	8,023	7,875	7,970	6,019	5,655	6,404	7,970	9,307		
6	5,085	1,100	1,181	1,241	1,209	1,129	1,857	4,298	7,562	10,532	10,017	8,943	7,585	7,312	7,381	5,825	5,382	5,768	7,199	8,639		
7	4,822	1,047	1,150	1,233	1,209	1,117	1,086	2,222	5,232	8,532	8,481	7,936	6,922	6,681	6,721	5,718	5,081	5,034	6,198	7,697		
8	4,535	995	1,118	1,217	1,200	1,113	1,035	1,114	2,707	6,047	6,661	6,708	6,057	5,982	6,121	5,508	4,753	4,246	5,177	6,604		
9	4,554	941	1,079	1,188	1,181	1,106	1,015	1,053	1,367	3,119	4,593	5,271	5,064	5,214	5,533	5,169	4,411	3,811	4,760	5,344		
10	4,599	881	1,031	1,144	1,152	1,093	1,011	1,000	1,279	1,405	3,045	3,729	4,021	4,387	4,806	4,690	4,166	3,917	4,644	5,207		
11	4,600	817	970	1,086	1,112	1,071	1,001	955	1,213	1,339	1,386	2,587	3,164	3,572	3,936	4,073	4,083	4,062	4,544	5,196		
12	4,530	782	917	1,016	1,062	1,038	979	915	1,165	1,287	1,422	1,175	2,986	2,920	3,327	3,617	4,171	4,405	4,655	5,121		
13	4,369	754	880	978	1,011	994	942	871	1,121	1,223	1,425	1,270	1,865	3,680	2,718	3,182	4,098	4,534	4,940	5,184		
14	4,105	710	832	940	964	937	889	815	1,061	1,130	1,381	1,350	2,228	2,498	4,054	2,696	3,784	4,407	5,125	5,503		
15	3,731	657	771	886	898	864	819	741	975	1,005	1,283	1,382	2,488	3,020	2,632	3,542	3,158	3,976	4,970	5,485		
16	3,265	598	693	810	810	771	729	649	857	856	1,133	1,320	2,595	3,337	2,762	2,221	3,319	3,244	4,507	5,197		
17	2,763	523	596	706	698	656	620	540	711	704	937	1,163	2,523	3,368	2,822	2,172	2,045	2,955	3,669	4,557		
18	2,275	432	480	574	561	527	511	423	602	607	789	939	2,247	3,057	2,718	2,048	1,634	1,822	2,816	3,638		
19	1,944	318	347	409	396	379	372	332	454	575	712	695	1,739	2,385	2,283	1,723	1,457	1,579	1,473	2,732		
20	1,337	189	202	229	221	216	217	223	336	417	483	467	1,110	1,441	1,472	1,120	976	1,125	1,048	873		LOCATION
MAX STORY SHEAR	5,962	1,579	1,957	3,477	5,263	6,669	8,497	11,323	13,851	15,143	13,510	10,859	8,344	9,585	9,592	6,918	7,394	8,744	10,040	10,985	1,579	1

Table A2.19 Story shears after optimization for EQ7 data

		STORY SHEAR[tf]																				
EARTHQUAKE DATA: EQ 7		ISOLATOR LEVEL																				
STORY	UNCONTROLLED BUILDING	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19		
ISOLATOR FLOOR		1,122	1,060	1,020	967	937	929	933	1,088	1,416	1,337	1,335	1,891	2,063	2,437	2,394	2,679	2,563	1,972	1,413		
1	5,039	1,417	1,732	2,551	4,163	5,010	5,410	5,881	6,068	7,511	8,274	7,043	6,591	7,630	7,382	7,320	6,099	6,695	8,293	8,814		
2	5,005	1,055	1,576	1,979	3,666	4,713	5,438	5,904	5,966	7,404	8,414	7,140	6,724	8,041	7,554	7,457	6,193	6,711	8,312	8,894		
3	4,943	995	1,013	1,504	2,610	3,824	4,795	5,303	5,353	6,488	7,674	6,447	6,210	7,801	7,065	6,916	5,740	6,128	7,448	8,069		
4	4,792	942	972	981	1,679	2,947	4,143	4,873	4,866	5,850	7,072	5,990	5,888	7,709	6,866	6,610	5,560	5,776	6,784	7,494		
5	4,532	895	935	944	922	1,740	3,181	4,140	4,249	4,964	6,345	5,473	5,462	7,499	6,846	6,381	5,302	5,363	5,995	6,753		
6	4,252	855	901	908	884	894	1,941	3,180	3,562	4,281	5,659	4,874	4,958	7,143	6,802	6,027	5,043	5,177	5,283	6,027		
7	4,016	835	870	872	845	865	880	1,961	2,780	3,584	4,898	4,238	4,404	6,680	6,654	5,649	4,931	5,036	5,169	5,537		
8	3,981	823	838	833	803	831	850	875	1,925	2,779	3,910	3,641	4,031	6,132	6,384	5,424	4,836	4,949	5,101	5,264		
9	3,856	805	804	791	759	796	822	832	992	2,323	2,701	3,078	3,613	5,537	6,015	5,387	4,859	4,890	5,192	4,991		
10	3,827	780	768	745	712	758	788	788	924	1,324	2,436	2,356	3,076	4,880	5,552	5,213	4,845	4,727	5,140	5,090		
11	3,744	747	726	695	661	721	747	741	859	1,245	1,230	2,159	2,433	4,092	4,990	4,899	4,783	4,621	4,936	5,225		
12	3,529	707	680	640	628	683	700	689	807	1,160	1,176	1,180	2,536	3,224	4,305	4,463	4,648	4,469	4,644	5,236		
13	3,166	659	626	582	596	644	648	633	796	1,058	1,219	1,113	1,689	3,418	3,481	3,905	4,401	4,372	4,461	5,174		
14	2,789	602	572	531	558	601	593	585	760	967	1,173	1,088	1,619	2,012	3,789	3,360	4,012	4,129	4,630	5,049		
15	2,476	544	513	476	509	549	540	538	664	847	1,032	1,017	1,566	2,153	2,525	3,215	3,469	3,690	4,485	4,839		
16	2,186	487	457	414	450	486	475	491	545	726	835	909	1,585	2,361	2,526	2,200	3,712	3,163	4,033	4,726		
17	1,937	418	389	375	381	411	399	442	522	684	699	781	1,607	2,439	2,369	2,033	2,362	3,764	3,229	4,229		
18	1,757	336	309	320	303	334	381	408	515	746	722	638	1,433	2,253	2,013	1,695	2,044	2,119	3,166	3,397		
19	1,417	239	231	240	226	279	351	389	473	728	790	582	1,051	1,756	1,482	1,190	1,581	1,712	1,496	2,374		
20	869	137	139	143	147	183	230	262	328	494	520	378	627	1,014	856	770	940	1,083	863	715		LOCATION
MAX STORY SHEAR	5,039	1,417	1,732	2,551	4,163	5,010	5,438	5,904	6,068	7,511	8,414	7,140	6,724	8,041	7,554	7,457	6,193	6,711	8,312	8,894	1,417	1

Table A2.20 Story shears after optimization for EQ8 data

		STORY SHEAR[tf]																				
EARTHQUAKE DATA: EQ 8		ISOLATOR LEVEL																				
STORY	UNCONTROLLED BUILDING	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19		
ISOLATOR FLOOR		1,395	1,333	1,260	1,198	1,145	1,097	1,022	1,045	1,109	1,097	1,071	1,585	1,598	1,817	1,704	2,046	2,067	1,863	1,583		
1	6,398	1,640	1,305	1,583	2,396	2,548	2,954	3,434	3,921	4,085	4,051	3,893	4,918	4,786	4,928	5,024	5,082	6,296	6,830	7,532		
2	6,311	1,325	1,684	1,292	2,109	2,459	2,834	3,436	3,937	4,139	4,082	3,827	4,859	4,813	4,958	5,131	5,110	6,398	6,913	7,717		
3	6,228	1,255	1,259	1,523	1,499	2,006	2,359	3,023	3,550	3,748	3,705	3,427	4,293	4,386	4,497	4,752	4,680	5,930	6,442	7,261		
4	6,117	1,184	1,186	1,185	1,496	1,564	1,886	2,680	3,223	3,468	3,415	3,205	3,867	4,100	4,176	4,514	4,433	5,684	6,174	7,037		
5	5,970	1,139	1,136	1,123	1,117	1,385	1,506	2,154	2,774	3,037	3,040	2,994	3,380	3,742	3,790	4,209	4,220	5,382	5,881	6,731		
6	5,788	1,106	1,100	1,075	1,053	1,058	1,364	1,719	2,195	2,547	2,597	2,826	3,076	3,352	3,444	3,840	3,992	5,055	5,531	6,354		
7	5,569	1,070	1,061	1,027	997	978	994	1,337	1,768	1,975	2,299	2,650	2,967	2,959	3,089	3,439	3,705	4,690	5,140	5,865		
8	5,314	1,029	1,018	979	945	915	900	925	1,435	1,624	2,067	2,405	2,840	2,703	2,738	3,028	3,441	4,312	4,712	5,362		
9	5,028	981	969	929	892	864	850	835	999	1,504	1,747	2,045	2,639	2,629	2,656	2,764	3,252	3,930	4,368	4,898		
10	4,724	928	914	875	838	816	810	785	950	1,027	1,498	1,617	2,332	2,539	2,602	2,798	3,156	3,689	4,142	4,826		
11	4,410	868	854	817	782	764	766	744	898	968	1,008	1,458	1,960	2,347	2,530	2,802	3,131	3,538	4,074	4,797		
12	4,084	802	789	755	724	709	719	706	842	911	978	990	2,041	2,044	2,382	2,730	3,058	3,432	3,956	4,725		
13	3,746	729	718	689	663	654	668	663	779	851	938	933	1,378	2,007	2,124	2,549	2,923	3,342	3,840	4,624		
14	3,396	652	644	620	598	593	611	612	710	784	886	867	1,201	1,449	2,252	2,265	2,724	3,182	3,710	4,411		
15	3,013	568	564	547	530	526	547	552	633	719	820	782	1,135	1,341	1,673	2,171	2,459	2,942	3,517	4,084		
16	2,595	480	480	469	457	454	474	485	549	684	743	706	1,022	1,238	1,580	1,588	2,570	2,623	3,242	3,641		
17	2,141	388	392	385	378	375	391	414	464	630	652	613	884	1,147	1,416	1,459	1,866	2,507	2,867	3,087		
18	1,665	297	301	298	292	290	313	329	366	540	540	495	718	1,041	1,192	1,262	1,629	1,741	2,508	2,513		
19	1,155	206	204	203	199	202	232	244	322	405	515	407	561	826	888	975	1,255	1,332	1,309	2,101		
20	637	125	114	111	109	112	137	155	218	273	357	271	357	527	568	587	745	776	692	839		LOCATION
MAX STORY SHEAR	6,398	1,640	1,684	1,583	2,396	2,548	2,954	3,436	3,937	4,139	4,082	3,893	4,918	4,813	4,958	5,131	5,110	6,398	6,913	7,717	1,583	3

Table A2.21 Story shears after optimization for EQ9 data

		STORY SHEAR[tf]																				
EARTHQUAKE DATA: EQ 9		ISOLATOR LEVEL																				
STORY	UNCONTROLLED BUILDING	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19		
ISOLATOR FLOOR		1,730	1,762	1,788	1,798	1,779	1,738	1,695	1,780	2,043	1,714	1,795	1,888	2,096	2,124	2,181	2,309	2,419	2,363	2,333		
1	5,134	2,034	1,519	1,797	2,403	3,002	3,730	4,522	4,884	5,139	5,437	6,125	6,092	5,452	5,443	5,267	5,232	6,046	7,004	8,225		
2	5,198	1,742	2,206	1,546	1,942	2,628	3,391	4,278	4,727	5,165	5,415	6,192	6,173	5,451	5,437	5,324	5,209	6,059	6,983	8,331		
3	5,230	1,752	1,758	2,116	1,539	1,924	2,670	3,573	4,217	4,655	4,883	5,692	5,720	5,018	5,006	4,943	4,755	5,540	6,342	7,868		
4	5,203	1,757	1,749	1,754	2,074	1,595	2,116	3,157	3,884	4,325	4,552	5,402	5,470	4,794	4,749	4,771	4,497	5,244	6,012	7,795		
5	5,111	1,753	1,734	1,717	1,736	2,015	1,644	2,592	3,423	3,797	4,145	5,017	5,167	4,526	4,445	4,583	4,269	4,902	5,675	7,705		
6	4,955	1,740	1,710	1,675	1,671	1,704	2,009	1,961	2,860	3,204	3,837	4,583	4,809	4,230	4,190	4,375	4,245	4,535	5,325	7,597		
7	4,748	1,715	1,675	1,624	1,600	1,624	1,657	1,984	2,189	2,669	3,438	4,085	4,384	3,926	3,927	4,168	4,199	4,255	5,162	7,458		
8	4,504	1,677	1,628	1,565	1,522	1,538	1,572	1,613	2,172	2,427	2,987	3,550	3,889	3,846	3,958	4,013	4,118	4,214	5,106	7,290		
9	4,230	1,625	1,569	1,495	1,438	1,445	1,482	1,528	1,667	2,516	2,472	2,964	3,322	3,778	3,976	3,956	4,006	4,189	5,065	7,087		
10	3,930	1,559	1,496	1,414	1,347	1,346	1,386	1,435	1,557	1,863	2,218	2,452	2,898	3,592	3,907	3,888	3,902	4,123	5,035	6,862		
11	3,612	1,477	1,410	1,324	1,249	1,241	1,284	1,335	1,445	1,692	1,659	2,305	2,444	3,288	3,731	3,770	3,827	4,009	4,978	6,636		
12	3,298	1,381	1,311	1,223	1,145	1,131	1,177	1,230	1,332	1,584	1,601	1,602	2,704	2,865	3,433	3,583	3,727	3,847	4,869	6,419		
13	3,014	1,270	1,199	1,113	1,035	1,016	1,063	1,118	1,216	1,458	1,521	1,507	1,825	2,863	3,010	3,303	3,562	3,623	4,681	6,173		
14	2,759	1,145	1,076	995	920	898	946	1,000	1,093	1,302	1,406	1,415	1,752	1,946	2,942	2,915	3,324	3,320	4,398	5,859		
15	2,499	1,005	941	867	799	775	825	873	960	1,119	1,252	1,290	1,691	1,781	1,916	2,896	3,009	2,967	4,014	5,452		
16	2,221	853	796	732	673	710	700	738	817	924	1,057	1,116	1,698	1,926	2,012	1,798	3,067	2,723	3,523	4,935		
17	1,925	689	643	591	566	644	599	597	666	764	829	903	1,575	2,027	2,083	1,719	1,802	3,280	3,099	4,307		
18	1,606	550	484	447	477	538	494	483	510	631	603	687	1,493	1,917	1,954	1,619	1,579	2,077	3,428	3,764		
19	1,245	437	368	321	348	390	360	348	361	503	478	583	1,239	1,552	1,575	1,298	1,329	1,622	1,840	3,415		
20	742	268	228	194	202	218	214	204	234	337	326	375	784	954	960	742	870	994	1,133	1,215		LOCATION
MAX STORY SHEAR	5,230	2,034	2,206	2,116	2,403	3,002	3,730	4,522	4,884	5,165	5,437	6,192	6,173	5,452	5,443	5,324	5,232	6,059	7,004	8,331	2,034	1

Table A2.22 Story shears after optimization for EQ10 data

		STORY SHEAR[tf]																				
EARTHQUAKE DATA: EQ 10		ISOLATOR LEVEL																				
STORY	UNCONTROLLED BUILDING	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19		
ISOLATOR FLOOR		1,740	1,528	1,330	1,188	1,158	1,149	1,139	1,301	1,301	1,233	1,203	1,718	2,399	3,068	3,270	3,331	3,069	2,490	1,915		
1	6,883	2,033	1,635	2,873	4,208	5,650	8,489	9,115	9,660	8,836	9,784	8,745	7,544	8,842	8,900	10,251	10,638	10,547	9,238	9,806		
2	6,819	1,648	1,934	2,101	3,466	5,059	8,057	8,981	9,720	9,186	9,713	8,894	7,617	8,962	9,038	10,168	10,684	10,786	9,473	10,081		
3	6,726	1,563	1,463	1,599	2,259	3,754	6,664	7,780	8,774	8,580	8,735	8,198	7,045	8,246	8,418	9,059	9,666	9,976	8,857	9,379		
4	6,602	1,476	1,400	1,281	1,497	2,767	5,373	6,834	7,960	8,139	8,052	7,813	6,725	7,832	8,077	8,308	8,969	9,427	8,550	8,936		
5	6,443	1,384	1,339	1,230	1,134	1,561	3,746	5,399	6,863	7,386	7,189	7,285	6,326	7,277	7,637	7,349	8,068	8,722	8,103	8,302		
6	6,252	1,291	1,275	1,179	1,082	1,096	1,902	3,850	5,505	6,409	6,205	6,699	5,855	6,665	7,100	6,363	7,107	7,906	7,584	7,693		
7	6,027	1,196	1,207	1,126	1,029	1,036	1,087	1,926	3,867	5,151	5,043	5,914	5,296	6,130	6,523	5,376	6,121	7,001	7,004	7,071		
8	5,769	1,100	1,135	1,071	974	991	1,032	1,112	2,293	3,669	3,899	5,049	4,689	5,539	6,082	4,947	5,362	6,180	6,489	6,407		
9	5,480	1,001	1,061	1,014	916	942	982	1,080	1,232	2,269	2,901	4,106	4,134	4,901	5,499	4,803	5,406	5,796	6,136	5,886		
10	5,159	902	984	954	868	890	933	1,042	1,168	1,244	2,234	3,071	3,477	4,322	4,752	5,094	5,711	5,803	5,982	5,828		
11	4,809	844	904	891	820	834	882	996	1,104	1,188	1,192	2,332	2,757	3,629	4,147	5,245	6,065	6,078	6,003	5,964		
12	4,617	789	821	826	765	774	829	943	1,041	1,123	1,200	1,210	2,970	2,902	3,955	5,202	6,266	6,456	6,142	6,177		
13	4,834	728	736	756	704	710	771	883	970	1,043	1,178	1,220	1,770	3,651	3,516	4,870	6,200	6,686	6,334	6,448		
14	4,922	660	650	682	637	642	706	815	890	1,029	1,093	1,185	1,785	2,403	4,346	4,234	5,792	6,592	6,405	6,651		
15	4,808	586	567	602	564	568	633	737	800	960	956	1,103	2,098	2,408	2,923	4,119	4,983	6,136	6,191	6,668		
16	4,408	519	495	516	484	488	550	646	696	786	806	1,065	2,353	2,369	2,849	2,748	3,945	5,248	5,667	6,361		
17	3,707	493	469	424	397	402	458	541	585	682	744	1,114	2,372	2,471	2,588	2,477	2,572	4,032	4,750	5,705		
18	3,125	435	424	393	333	318	357	423	533	628	795	1,120	2,154	2,374	2,431	2,043	2,046	2,423	3,554	4,724		
19	2,374	336	337	323	287	259	285	324	428	638	731	1,039	1,725	1,998	1,990	1,645	1,783	1,786	1,760	3,251		
20	1,363	205	213	212	190	157	175	204	301	453	490	692	1,119	1,315	1,189	1,104	1,152	1,203	1,150	1,149		LOCATION
MAX STORY SHEAR	6,883	2,033	1,934	2,873	4,208	5,650	8,489	9,115	9,720	9,186	9,784	8,894	7,617	8,962	9,038	10,251	10,684	10,786	9,473	10,081	1,934	2

Table A2.23 Story shears after optimization for EQ11 data

EARTHQUAKE DATA: EQ 11		STORY SHEAR[tf]																				
		ISOLATOR LEVEL																				
STORY	UNCONTROLLED BUILDING	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19		
ISOLATOR FLOOR		1,064	1,088	1,118	1,127	1,206	1,359	1,711	2,011	2,291	1,718	1,542	1,909	2,282	2,606	2,450	2,698	2,843	2,818	2,219		
1	6,498	3,531	6,469	11,931	18,125	18,332	17,007	25,961	22,768	23,350	19,012	19,197	18,784	18,794	16,239	15,602	17,652	24,368	30,501	25,853		
2	6,359	1,007	3,967	9,191	15,880	18,176	16,567	25,371	22,872	23,728	19,675	18,289	18,562	18,491	16,344	15,334	17,468	23,065	30,484	26,493		
3	6,305	968	1,050	4,690	11,384	15,213	14,429	22,396	20,662	21,660	18,373	15,070	15,833	16,701	14,955	13,718	15,455	19,120	26,899	24,653		
4	6,290	945	1,038	1,088	6,237	11,678	11,969	20,304	19,087	20,331	17,393	13,735	13,472	14,739	13,879	12,464	14,036	16,438	24,219	22,847		
5	6,242	940	1,039	1,087	1,117	6,234	8,525	16,622	16,691	19,540	15,820	12,903	11,100	12,075	12,496	11,570	12,133	14,098	20,919	20,821		
6	6,025	940	1,042	1,089	1,120	1,198	4,744	12,305	13,696	18,103	13,754	11,710	10,419	9,984	10,443	10,443	10,184	12,319	17,673	18,758		
7	5,563	935	1,037	1,079	1,113	1,204	1,348	6,632	10,029	15,356	11,462	10,394	9,275	9,426	8,869	8,687	9,208	10,020	14,443	16,155		
8	4,982	909	1,012	1,049	1,078	1,185	1,334	1,667	5,436	11,316	10,106	10,100	9,428	10,093	8,548	7,569	8,370	9,064	11,269	12,907		
9	4,990	865	971	1,000	1,015	1,130	1,285	1,649	1,881	5,963	7,675	9,642	9,572	10,639	9,659	7,403	7,665	8,513	8,959	10,613		
10	4,889	810	919	946	934	1,044	1,205	1,588	1,770	2,031	5,281	7,863	9,081	10,509	10,200	8,399	7,126	7,667	8,660	10,070		
11	4,533	767	878	901	865	945	1,120	1,498	1,673	1,897	1,623	5,154	7,452	9,491	10,016	8,785	8,125	7,908	8,660	10,446		
12	4,334	742	851	863	830	844	1,042	1,405	1,604	1,847	1,813	1,374	4,848	7,580	8,971	8,496	8,629	8,834	9,975	9,914		
13	4,157	725	825	821	784	741	950	1,291	1,523	1,837	1,949	1,473	1,855	5,530	7,050	7,597	8,462	10,010	11,126	10,668		
14	3,701	695	779	759	728	683	826	1,111	1,379	1,762	1,925	1,488	1,900	2,415	5,389	6,502	7,841	10,343	12,352	12,797		
15	3,499	641	703	666	659	617	668	853	1,148	1,529	1,693	1,382	2,085	2,461	2,720	4,974	6,376	9,544	12,458	13,737		
16	3,166	560	598	547	574	541	625	649	919	1,182	1,255	1,270	2,105	2,694	2,820	2,352	5,296	7,819	11,438	13,599		
17	2,693	458	473	477	477	465	593	709	743	835	827	1,029	2,140	2,703	2,730	2,285	2,477	5,586	9,022	12,037		
18	2,657	378	388	408	399	387	513	676	703	834	861	982	1,904	2,543	2,414	1,980	2,402	2,738	6,012	9,203		
19	2,813	286	295	311	331	351	432	557	632	998	1,075	867	1,709	2,050	1,927	1,718	2,042	2,632	2,254	5,813		
20	2,045	193	205	212	221	247	319	408	541	770	743	632	1,138	1,287	1,271	1,206	1,491	1,988	2,000	1,932		LOCATION
MAX STORY SHEAR	6,498	3,531	6,469	11,931	18,125	18,332	17,007	25,961	22,872	23,728	19,675	19,197	18,784	18,794	16,344	15,602	17,652	24,368	30,501	26,493	3,531	1

Table A2.24 Story shears after optimization for EQ12 data

EARTHQUAKE DATA: EQ 12		STORY SHEAR[tf]																				
		ISOLATOR LEVEL																				
STORY	UNCONTROLLED BUILDING	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19		
ISOLATOR FLOOR		1,414	1,368	1,314	1,206	1,119	1,036	1,010	1,094	1,160	1,177	1,178	1,956	2,572	2,986	3,103	3,328	3,235	2,902	2,298		
1	6,811	1,669	1,715	3,166	4,596	5,463	6,267	7,910	11,901	12,132	11,945	14,220	13,781	13,318	12,265	11,698	10,655	9,145	8,315	8,191		
2	6,742	1,307	1,728	2,126	3,620	4,681	5,535	7,275	11,301	11,966	12,101	14,068	13,787	13,473	12,556	11,921	10,980	9,452	8,666	8,362		
3	6,648	1,213	1,261	1,588	2,168	3,312	4,255	6,009	9,644	10,652	11,160	12,593	12,576	12,388	11,771	11,090	10,295	8,902	8,206	7,956		
4	6,524	1,145	1,154	1,210	1,578	2,222	3,240	5,110	8,373	9,884	10,532	11,711	11,843	11,836	11,382	10,676	9,877	8,592	7,949	7,748		
5	6,369	1,091	1,050	1,108	1,107	1,469	2,087	3,858	6,898	8,788	9,711	10,545	11,023	11,120	10,917	10,509	9,310	8,146	7,570	7,348		
6	6,185	1,045	961	1,011	1,019	1,042	1,495	2,662	5,350	7,572	8,746	9,344	10,147	10,337	10,351	10,220	8,640	7,591	7,103	6,850		
7	5,969	1,004	916	927	949	983	955	1,716	3,611	5,975	7,541	8,013	9,288	9,434	9,680	9,762	8,187	6,949	6,514	6,311		
8	5,722	966	894	860	898	941	900	923	2,250	4,212	5,979	6,666	8,247	8,382	8,877	9,135	7,633	6,320	5,928	6,098		
9	5,442	930	867	853	885	910	862	865	1,042	2,522	4,038	5,225	6,980	7,400	7,886	8,345	7,042	5,786	5,667	5,849		
10	5,132	893	856	875	868	880	820	816	998	1,139	2,853	3,776	5,508	6,220	6,669	7,343	6,325	5,381	5,378	5,564		
11	4,793	852	831	874	874	848	799	760	996	1,234	1,208	2,855	3,951	4,779	5,276	6,142	5,431	5,192	5,341	5,404		
12	4,429	808	786	849	877	881	879	856	1,027	1,316	1,336	1,140	4,120	3,310	3,926	4,785	4,940	5,084	5,423	5,576		
13	4,034	758	727	799	854	887	924	908	1,070	1,354	1,411	1,237	2,005	4,882	3,098	4,042	4,510	4,854	5,393	5,762		
14	3,920	700	672	729	802	860	921	901	1,062	1,328	1,408	1,262	2,038	2,515	5,424	3,188	3,937	4,472	5,227	5,852		
15	4,221	633	605	664	720	797	863	831	1,064	1,240	1,326	1,274	2,184	2,760	2,899	5,446	3,174	3,889	4,832	5,730		
16	4,276	556	605	651	648	694	746	786	1,055	1,196	1,175	1,258	2,486	3,311	2,917	2,817	5,324	3,176	4,249	5,337		
17	4,053	521	567	598	583	639	712	757	979	1,189	1,178	1,213	2,554	3,569	3,165	2,554	2,785	4,611	3,414	4,659		
18	3,538	452	486	505	484	540	615	656	832	1,078	1,088	1,105	2,330	3,428	3,101	2,190	2,230	2,478	3,726	3,765		
19	2,717	339	361	371	351	382	449	479	663	853	906	895	1,914	2,818	2,623	1,755	1,648	1,723	1,726	2,881		
20	1,596	196	208	211	198	212	249	275	461	547	598	567	1,281	1,778	1,707	1,194	995	997	1,114	1,164		LOCATION
MAX STORY SHEAR	6,811	1,669	1,728	3,166	4,596	5,463	6,267	7,910	11,901	12,132	12,101	14,220	13,787	13,473	12,556	11,921	10,980	9,452	8,666	8,362	1,669	1