Earthquake Induced Inelastic Demands on Buckling Restrained Braces

by

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Abstract

Buckling restrained braces (BRBs) show an increasing popularity in modern designs due to their high ductility capacity over conventional braces. Non-linear tests on isolated BRBs have shown the symmetrical hysteresis properties of BRBs with roughly equal ultimate forces in both compression and tension. Further research is needed on the behavior of BRBs in braced frames and the system-level behavior of the buckling restrained brace frame (BRBF) system. This paper will investigate the effect of the stiffness and configuration of BRBs for BRBF system with different heights. This paper focuses on the behavior of three-story and six-story BRBF systems with normal yield length and shortened yield length BRBs for a chevron and single diagonal configuration designed for Los Angeles, CA and Riverside, CA. SAP2000 [CSI] and Perform 3D [CSI] were used for design and analysis of the models. Ground motions used in this study are scaled near-field and far-field motions with a 2 percent probability of exceedance in 50 years. The goal of the research is to evaluate the inelastic demands of the BRBs and the behavior of the BRBF systems induced by earthquakes and thus to provide further understanding of the BRBs.

Acknowledgment

I would like to thank Dr. Marshall for his help throughout my study at Auburn University in the last two years. I really appreciate his guidance and assistance in both research and classes, which benefits a lot. His patience and passion has been encouraged me greatly. Also, I would like to thank the rest of my committee, Dr. Davidson and Dr. Hughes for all kinds of help they have been provided.

I also would like to thank my parents for the support and encouragement in my entire life. I also appreciate my friend for the friendship, which makes me really enjoy my living and studying at Auburn.

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Table of Contents

List of Tables

List of Figures

Chapter 1 Introduction

1.1 Motivation for the Research

The concentric braced frame (CBF) system is a traditional seismic resistant system. In past earthquakes, they have shown their disadvantages due to the limited capacity of ductility of those structures. Conventional braces buckle when compressed which shows an asymmetric pattern in the hysteric loops and makes those braces relatively limited in the energy dissipation ability of the braces. The buckling restrained brace frame (BRBF), an advanced type of braced frame system, was developed based on the CBF system. Conventional braces are replaced by buckling restrained braces (BRBs). BRBs have a symmetrical full hysteresis due to the ability to yield in compression because the yielding core is confined by a concrete filled tube. The popularity of BRBs are currently on the rise, which leads to more research interest in the properties and behavior of the BRBs.

Research on inelastic behavior and ductility capacity of BRB components and subassemblies have been conducted by previous researchers [Xie, 2005]. More attention was drawn to the system-level behavior of the BRBF system as the codes defining design requirements have progressed and changed. Thus, further research on the performance of BRBs is needed. However, analytical data of seismic simulation of BRBF is limited. As a lateral force resisting system, the performance and ductility demands of BRBs under strong earthquakes records are of particular interest.

1.2 Scope of work

The purpose of this research is to conduct further study on the behavior of BRBs and the BRBF system. This paper focuses on seismic nonlinear time-history analysis of behavior of BRBF structures with different heights, which are braced by BRBs different in configuration and design. Thus, three-story and six-story BRBF buildings were designed and numerical models were built for time-history analysis. All the prototype structures were designed to be located in either Los Angeles, CA or Riverside, CA. To conduct the comparison, BRBs are used in two configurations, chevron and single diagonal. Considering the effect of structural stiffness, BRBs were also designed with a shortened yield length and the BRBF system was designed with an importance factor of 1.5. The design was based on ASCE 7-10 [ASCE, 2010] using SAP2000 [CSI, 2011]. Numerical modeling and time history analyses were conducted using Perform 3D [CSI, 2011]. BRB modeling parameters were provided by CoreBrace LLC.

Dynamic analyses were completed with scaled ground motion suites. Ductility demands of BRBs were studied and compared based on the various structural parameters. The primary performance metrics of interest included brace ductility demand, brace force demand, and story drift. Several other performance metrics are also reported and discussed.

1.3 Organization of thesis

Chapter 1 is the introduction of this paper with the motivation of the research and scope of the work.

Chapter 2 provides the literature review on previous studies of BRBs and the BRBF system. Previous research on modeling of BRBs is also presented.

Chapter 3 provides the parameters of the prototype buildings and the design coefficients. Designs of the three-story and six-story buildings are presented. The modeling and analysis procedure of the structures using SAP2000 and Perform 3D are introduced. Scaled ground motion suites are also listed.

Chapter 4 presents the non-linear time history data results of all the models analyzed previously. Case study analysis of a selected record is presented and discussed. Statistical analysis of the results for the ground motion suites is conducted. Differences in behavior and ductility demand of BRBs in different BRBF system configurations are discussed.

Chapter 5 is the conclusion of this thesis. Summary of the research conclusions are presented and recommendation for further research are listed.

Chapter 2 Literature Review

2.1 Introduction of BRBs

Since concentric braces shows disadvantages when it buckles in compression, a new concept of brace was developed, by simply restraining the buckling behavior of the brace. The steel core can deform and yield in compression without buckling. This property gives BRBs more ductility and energy dissipating capacity. Figure 2-1 shows the difference between a typical BRB hysteresis and a typical conventional brace hysteresis [Sabelli, 2001].

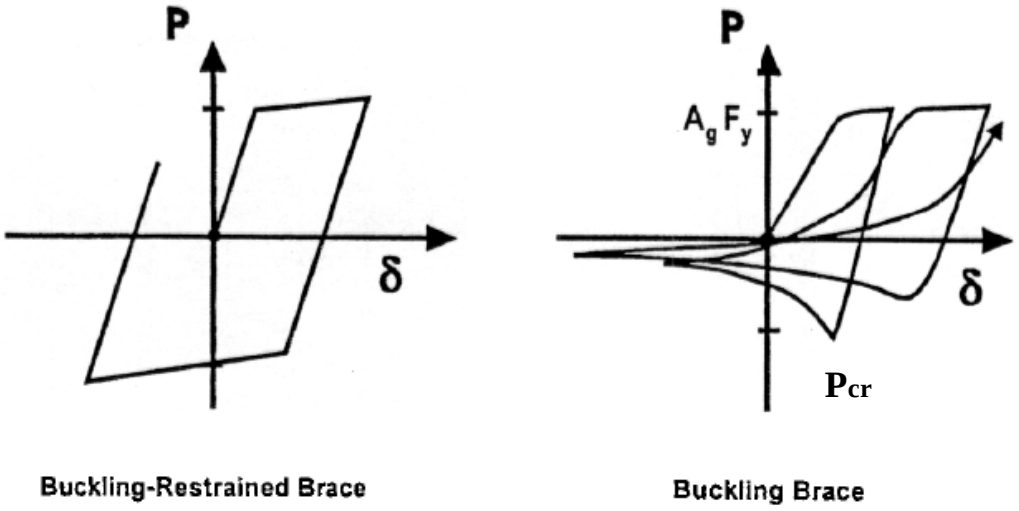

Figure 2-1: Comparison of BRB Hysteresis and Conventional Brace Hysteresis [Sabelli, 2001]

The first research on BRBs was conducted by Yoshino [Yoshino, 1971]. Two specimens were tested under cyclic load. Both specimens consisted of a steel plate and a reinforced concrete panel casing. In one specimen, the steel plate was debonded form the concrete casing and the other one is not. The results showed that the specimen with a debonded steel plate showed more deformation capacity and dissipated more energy. Further research was then conducted by

Wakabayashi [Wakabayashi, 1973] to verify the advantages of debonding the steel plate from the concrete casing. Results showed it was necessary to debond the steel plate from the concrete casing to provide more ductility capacity. This led to the configuration of the BRBs in modern days, with steel core itself taking axial force and the casing tube providing confinement.

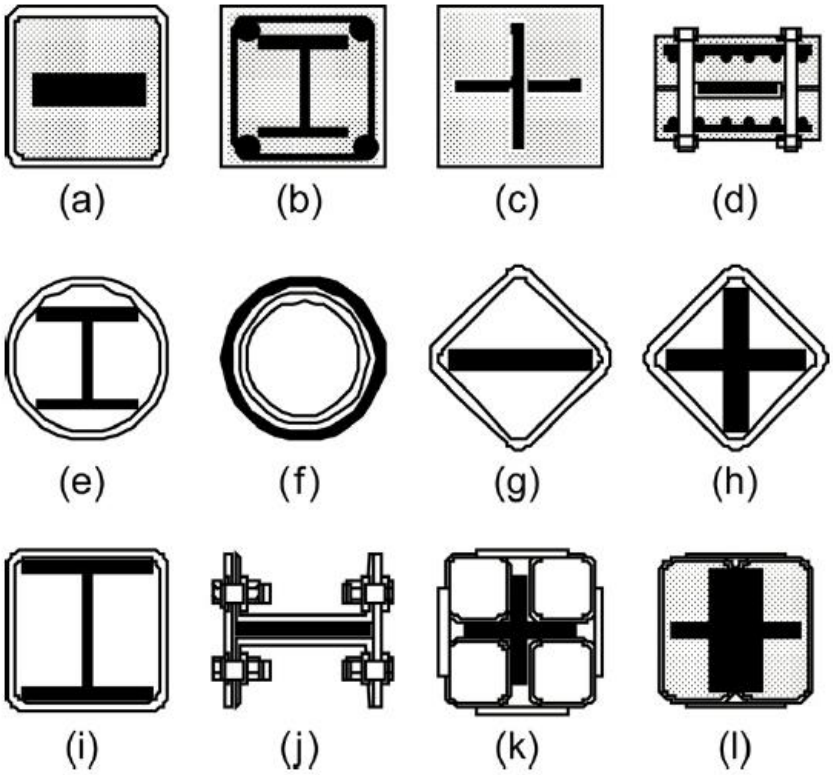

Figure 2-2: Cross-sections of BRBs Proposed by Previous Researchers [Xie, 2004]

Several researchers have proposed various cross-section shapes of the BRBs. A review made by Xie showed them as follows in Figure 2-2 [Xie, 2004]:

(a) Steel plate encased by mortar-infilled steel tube [Watanabe, 1988];

(b) I-shape steel brace enclosed by reinforced concrete [Nagao, 1988];

(c) Cruciform steel brace enclosed by steel-fiber reinforced concrete [Mase, 1995];

(d) Brace encased by bolt-connected precast concrete panels [Inoue, 1993];

(e) Wide-flange steel encased in steel tube [Suzuki, 1994];

(f) One inner circular steel tube encased by another exterior circular steel tube [Kuwahara and Tada, 1993];

(g)Steel plate encased by square steel tube [Kamiya, 1997];

(h) Cruciform steel brace encased by square steel tube [Shimizu, 1997];

(i) I-shape steel brace encased by square steel tube [Usami, 2001];

(j) Steel plate enclosed by bolt-connected steel plates [Isoda, 2001];

(k) Cruciform steel brace enclosed by four steel tubes [Narihara, 2000];

(l) Double T-shape steel enclosed by four steel tubes [Tsai, 2002].

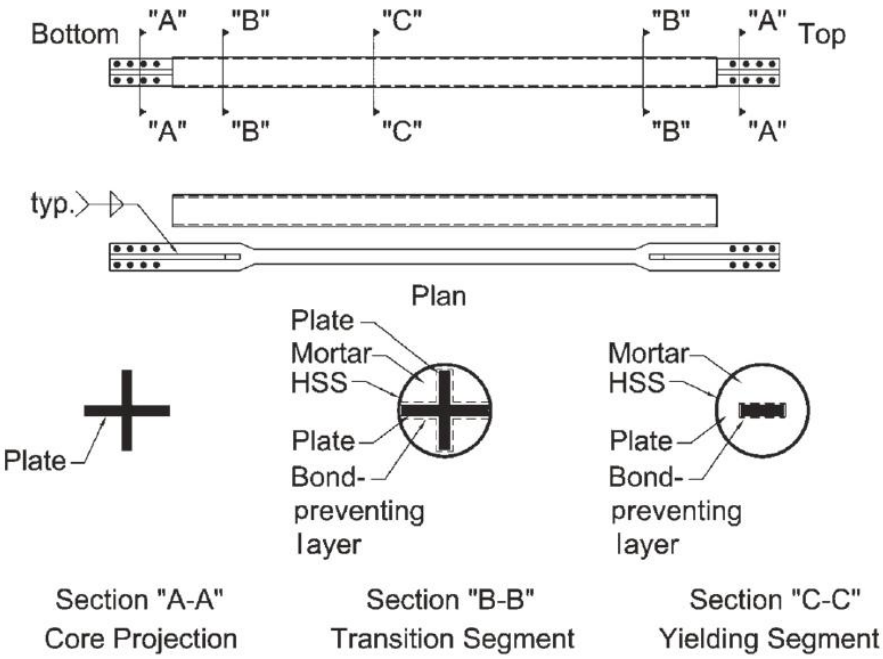

Figure 2-3: Details of a Typical BRB [Tremblay, 1999]

In modern US, Seismic Provision for Structural Steel Buildings [AISC, 2010] introduced a typical configuration of BRB (courtesy of R. Tremblay). This typical configuration of BRB is shown in Figure 2-3. As can be seen, a BRB includes two parts, steel core and confining steel tube. Figure 2-4 shows a schematic of a BRB from a different perspective [Fahnestock, 2006].

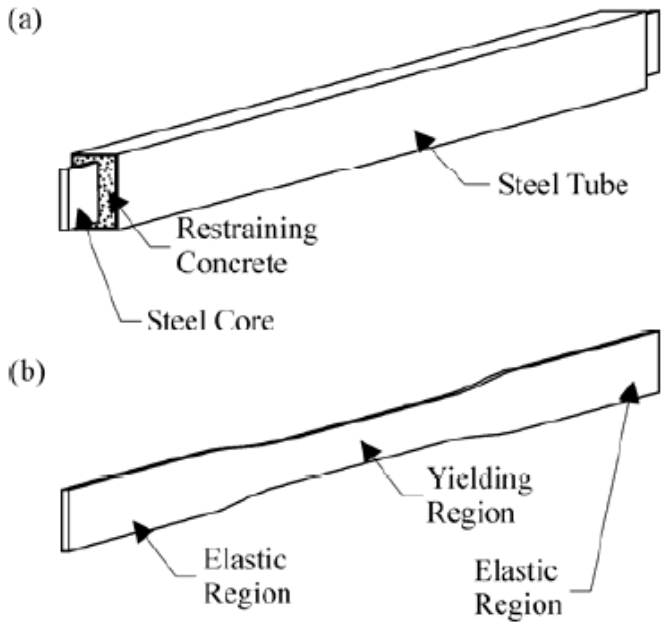

Figure 2-4: Schematic of a BRB: (a) a Complete BRB; (b) the Steel Core [Fahnestock, 2006]

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2.2 Research on Component BRBs

A series of testing on the inelastic behavior of BRBs was conducted in the past few years. Watanabe [Watanabe, 1998] tested five BRB specimens in Japan. Those BRBs had the same yielding core but different size steel encasing tube. Cross-sections of the specimens are shown in Figure 2-5. The specimens were distinguished by the ratio of Euler buckling load (P_E) of the steel tube to the yield force (P_Y) of the steel core. This ratio varied from 0.55 to 3.82, due to the different tube sizes. The specimens were tested over eight load cycles up to a final deformation corresponding to a 2% story drift. Figure 2-6 shows the set-up of the test. The results demonstrated the stable hysteresis characteristic of the BRBs in Figure 2-7 [Fujimoto, 1990].

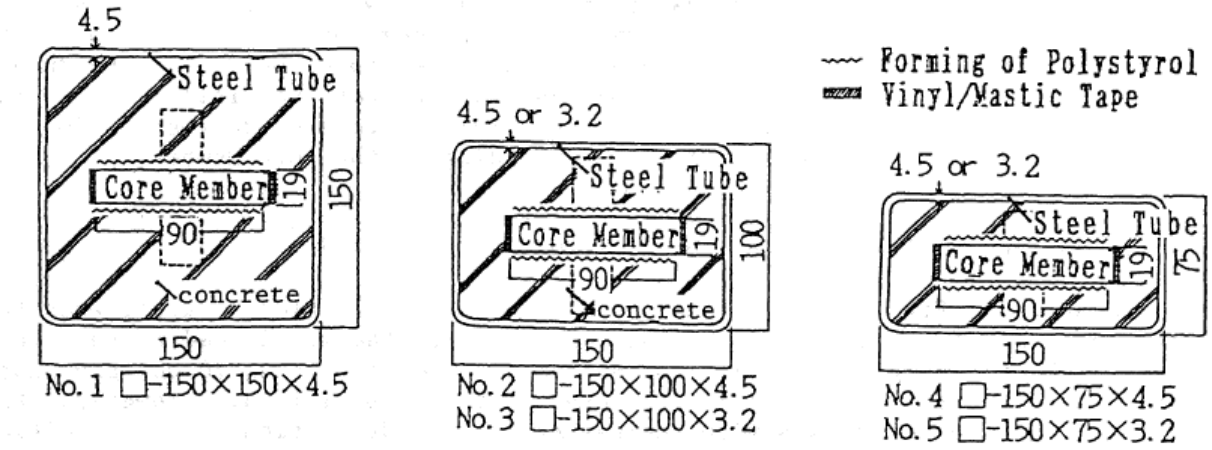

Figure 2-5: Cross-section of the Watanabe BRB Specimens [Watanabe, 1998]

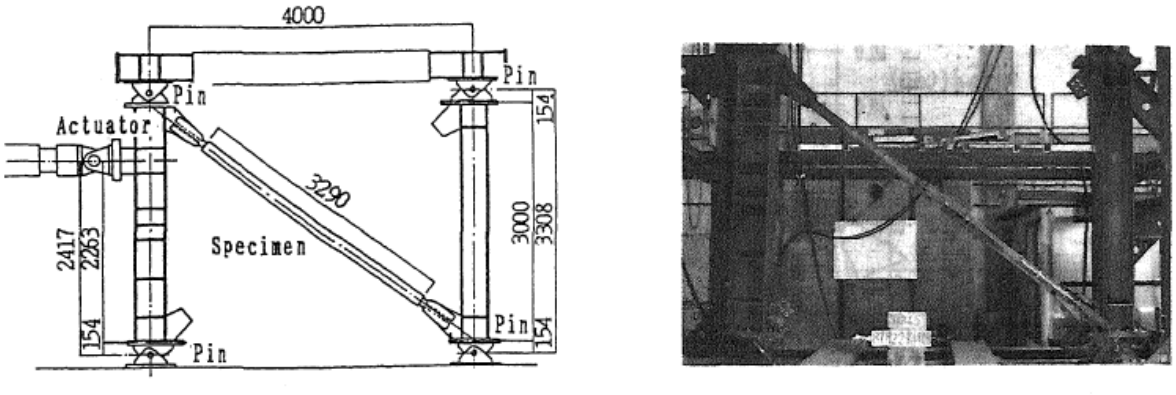

Figure 2-6 Test Set-up of the Watanabe Test [Watanabe, 1998]

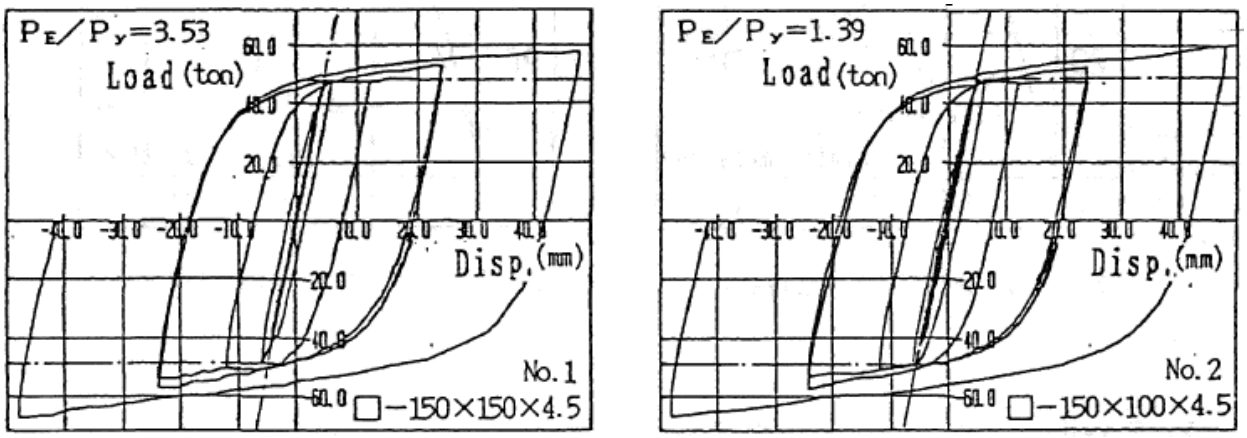

Figure 2-7: Hysteresis Loops of the Specimen 1 and 2 in the Watanabe Test [Watanabe, 1998]

Three large-scale BRBs with approximate yielding forces of 270, 360, 470 kips were tested at the University of California at Berkeley. Results in Figure 2-8 showed that the hysteresis behavior of BRBs is predictable. In addition, an approximately 10% higher compressive force than tensile force during the SAC Basic Load History were shown [Clark, 2000].

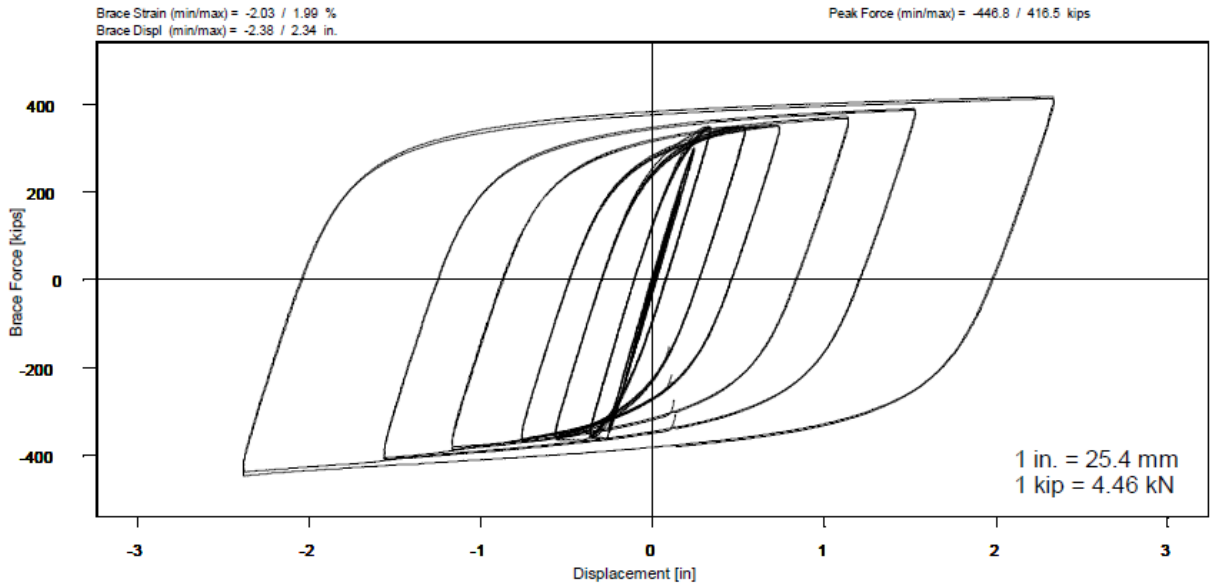

Figure 2-8: Hysteresis Behavior of Brace Specimen 2 during Basic Loading History [Clark, 2000]

Six full-scale BRB specimens with flat-shape and cruciform steel core were tested at the University of California at San Diego. Figure 2-9 shows the test set-up. BRBs were provided by CoreBrace. Results showed that all the BRBs had good performance under standard loading protocol and hysteresis behavior was stable before fracture under low-cycle fatigue testing. The BRBs showed a cumulative inelastic axial deformation ratio of 1025 on average with a range of 600 to 1400 for all the tested specimens [Merritt, 2003]. Another set of eight full-scale BRBs provide by Star Seismic were also tested by Merritt in 2003. Similar good performance was found. Two specimens with relatively smaller yielding cores fractured in the low-cycle fatigue test showing a cumulative ductility demand of 600 and 900 [Merritt, 2003]. Those tests were based on the draft provision recommendations for BRB design [SEAOC, 2001].

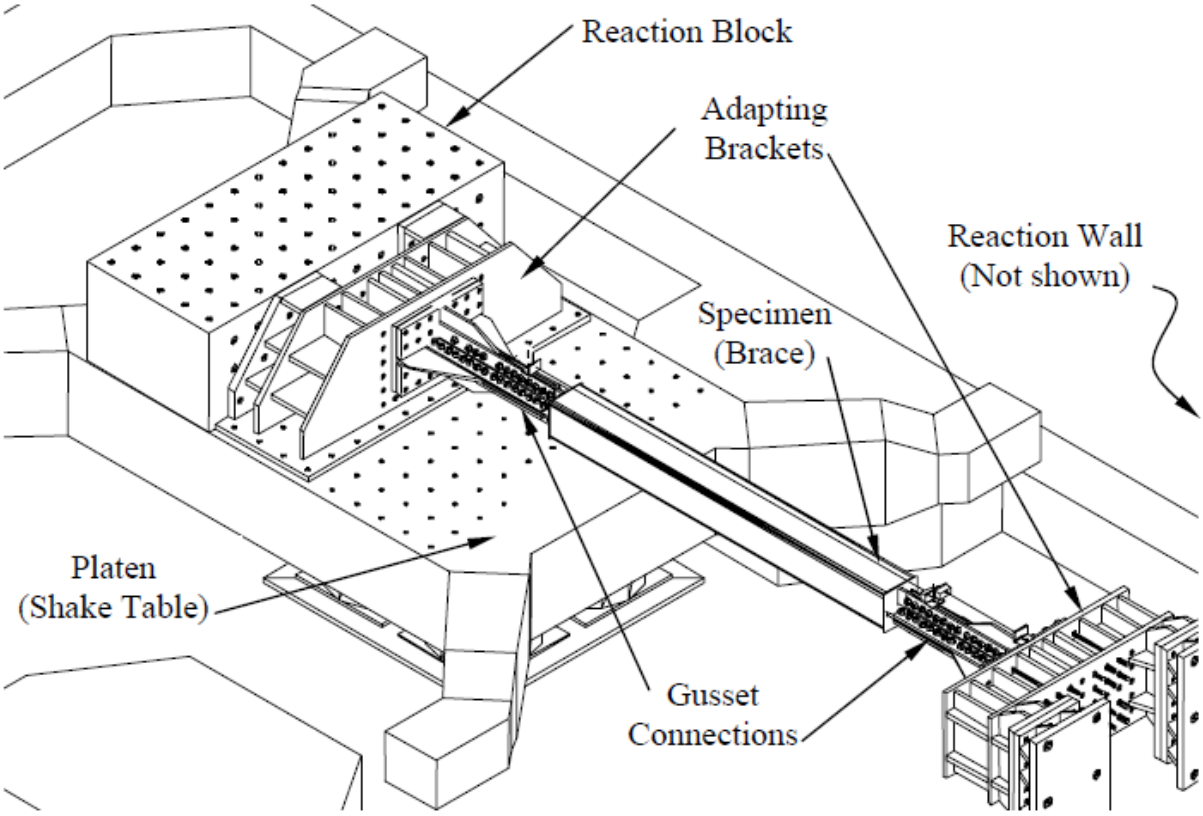

Figure 2-9: Set-up of the Test [Merritt, 2003]

Another four full-scale test specimens of BRBs provided by CoreBrace were completed in 2006 at the University of California at San Diego, based on acceptance criteria of the AISC seismic Provision [AISC, 2005] and FEMA 450 [FEMA, 2003]. All the specimens performed well without fracture. Braces were able to take an end rotation of 0.031 radians. The test results showed a cumulative ductility demand from 600 to 1200, which is significantly larger than the requirement of AISC seismic provisions [Newell, 2006]

Five BRB specimens were tested in University of California at Berkeley from 1999 to 2000. Figure 2-10 shows the test set-up. Results of low cycle tests showed stable hysteresis behavior of the BRBs and exhibited more cycles than expected. Results of the cumulative

ductility demand are shown in Table 2-1. Results of Design Basis Earthquake (DBE) level testing showed a maximum brace strain of 1.38%. Noticeably, the effect of the flexibility of the connection on the deformation of BRBs was minimal [Black, 2002].

Table 2-1: Cumulative Plastic Ductility of the Tests at UC Berkeley [Black, 2002]

specimen	test description	maximum ductility	cumulative ductility	total
UC Davis Plant and Environmental Science Building (Spring 1999)				
99-1	sac basic loading history	10.0	243.5	323.8
	sac near field protocol	20.0	80.3	
99-2	sac basic loading history	10.0	243.5	879
	low cycle fatigue tests	10.0	636.5	
99-3	sac basic loading history	10.0	243.5	278.7
	displacement derived from Sylmar motion	2.35	8.6	
	displacement derived from El Centro motion	8.30	26.6	
Kaiser Santa Clara Medical Center (Fall 2000)				
00-11	OSHPD brace loading history	15.0	345.4	1045
	Low cycle fatigue test	6.7	699.6	
00-22	OSHPD brace loading history	15.0	345.4	537.7
	Record derived from design basis earthquake	3.49	54.3	
	Record derived from upper bound earthquake	7.26	138	

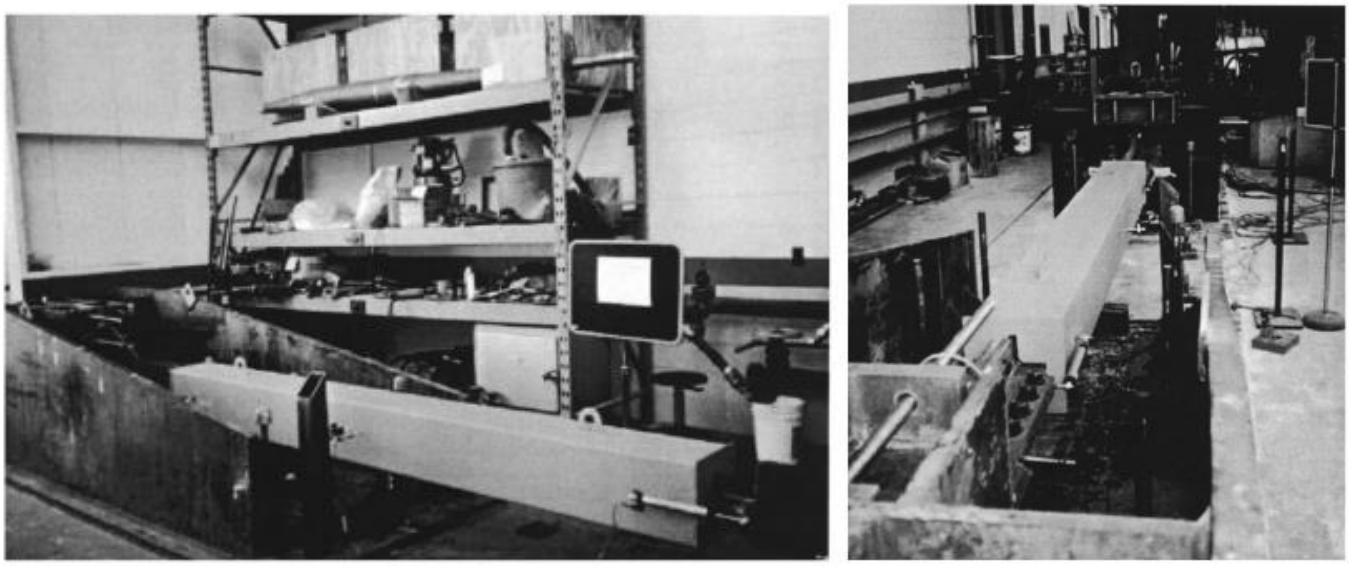

Figure 2-10: View of the Test Set-up at University of California Berkeley [Black, 2002]

2.3 Research on System-level Behavior of BRBs

Significant research was conducted on the property and behavior of single BRBs, while research focused on the behavior of BRBs in a BRBF system and the system-level behavior is limited [Fahnestock, 2006].

Three large scale tests on BRB subassemblies tests were conducted at the University of California at Berkeley. A two story partial BRB frame with chevron and single diagonal braced configurations were tested with lateral force applied at the second story. Figure 2-11 shows the set-up of the test. Results showed BRBs performed well in all the tests with stable hysteresis loops. No apparent differences were shown between chevron and single diagonal configurations. Remarkably, the brace strength could be precisely estimated by uniaxial test data. Figure 2-12 shows the hysteresis loop of test number1 in Aiken's research. In this test, the BRB specimen showed an approximate ductility of 15 and an approximate cumulative ductility of 326 corresponding to a 2% story drift deformation. Additional attention was drawn to the connections because the columns experienced significant flexure and shear yielding. The beams and gusset plates also experienced yielding at the connections [Mahin, 2004].

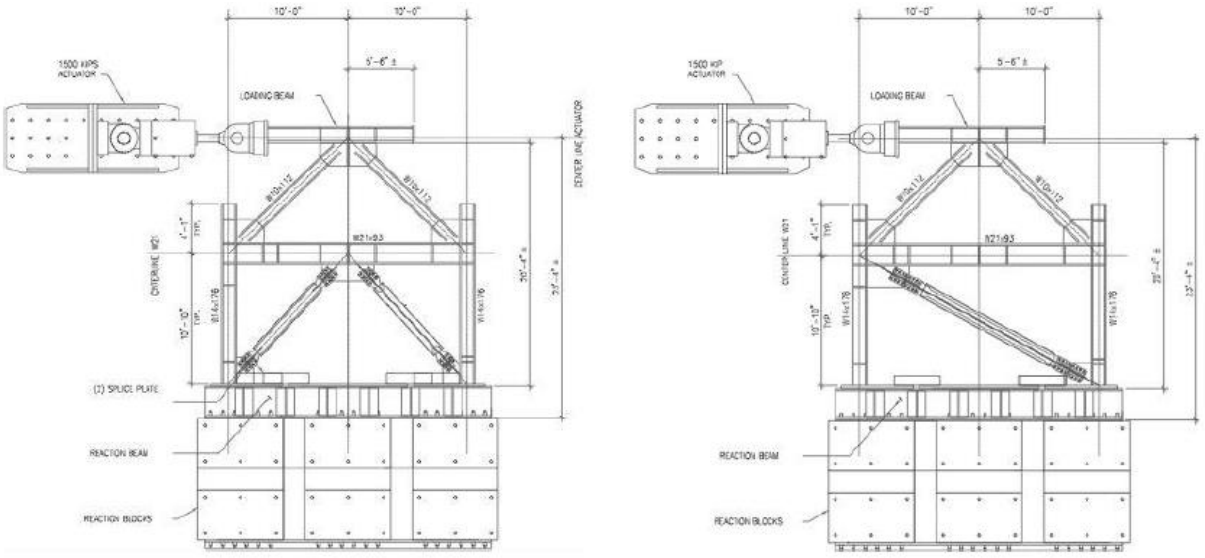

Figure 2-11: Test Set-up for BRB Specimens (Left: Test for Specimen No. 1; Right: Test for Specimen No. 2 and 3) [Mahin, 2004]

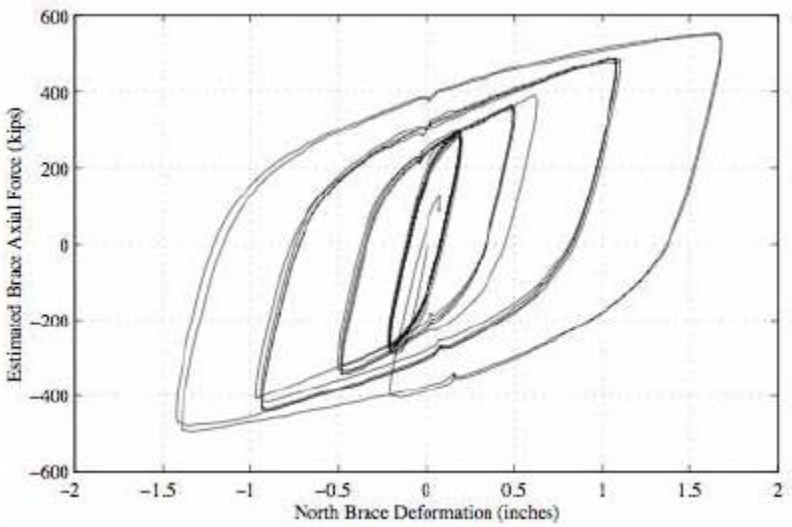

Figure 2-12: Hysteresis Loop of Test 1 [Mahin, 2004]

Three-story and six-story buildings with chevron braced BRBs were designed and 2D models extracted from those buildings were analyzed. The elevation of the 2D models is shown in Figure 2-13. Those prototypes frames were located in Los Angeles, CA. Ground motions were scaled to two suites. One had 2% chance of exceedance in 50 years and the other had 10% chance of exceedance in 50 years. Results of story drift and ductility demand consisting of two

parts were presented: (a) maximum value of individual ground motion; (b) statistical mean and standard deviation for the suite of ground motion. Statistical results are shown in Table 2-2. Figure 2-14 shows the BRB hysteresis loops of six-story chevron model subjected to records LA20. Comparison of results of behavior between CBF system and BRBF system were presented [Sabelli, 2001].

Table 2-2: Maximum Response Quantities for BRBF [Sabelli, 2001]

Model Properties		Maximum Response Quantities for Ground Motion Suite					
Model	Hazard level	Mean and Mean + Standard Deviation	Maximum Drift	Residual Drift	Column Rotation	Maximum Brace Ductility	Cumulative Brace Ductility
3 story chevron	10%	μ	1.4	0.5	0.8	9.7	39
		μ+σ	2.1	1.0	1.1	13.6	63
6 story chevron	10%	μ	1.6	0.7	1.0	10.7	83
		μ+σ	2.2	1.1	1.4	14.5	135
6 story chevron	50%	μ	1.0	0.4	0.6	6.6	45
		μ+σ	1.2	0.5	0.9	8.2	71
6 story chevron	2%	μ	4.5	2.2	3.0	17.4	139
		μ+σ	6.6	3.2	4.6	25.1	185
6 story chevron	Near Field	μ	2.5	1.1	1.8	14.6	95
		μ+σ	4.0	2.2	2.9	20.6	157

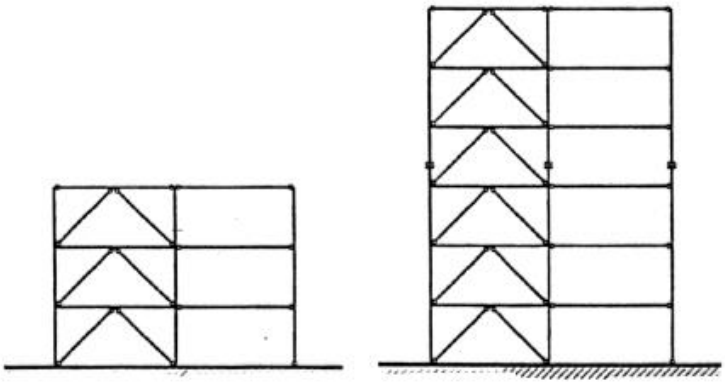

Figure 2-13: Elevation of Three & Six-Story Models [Sabelli, 2001]

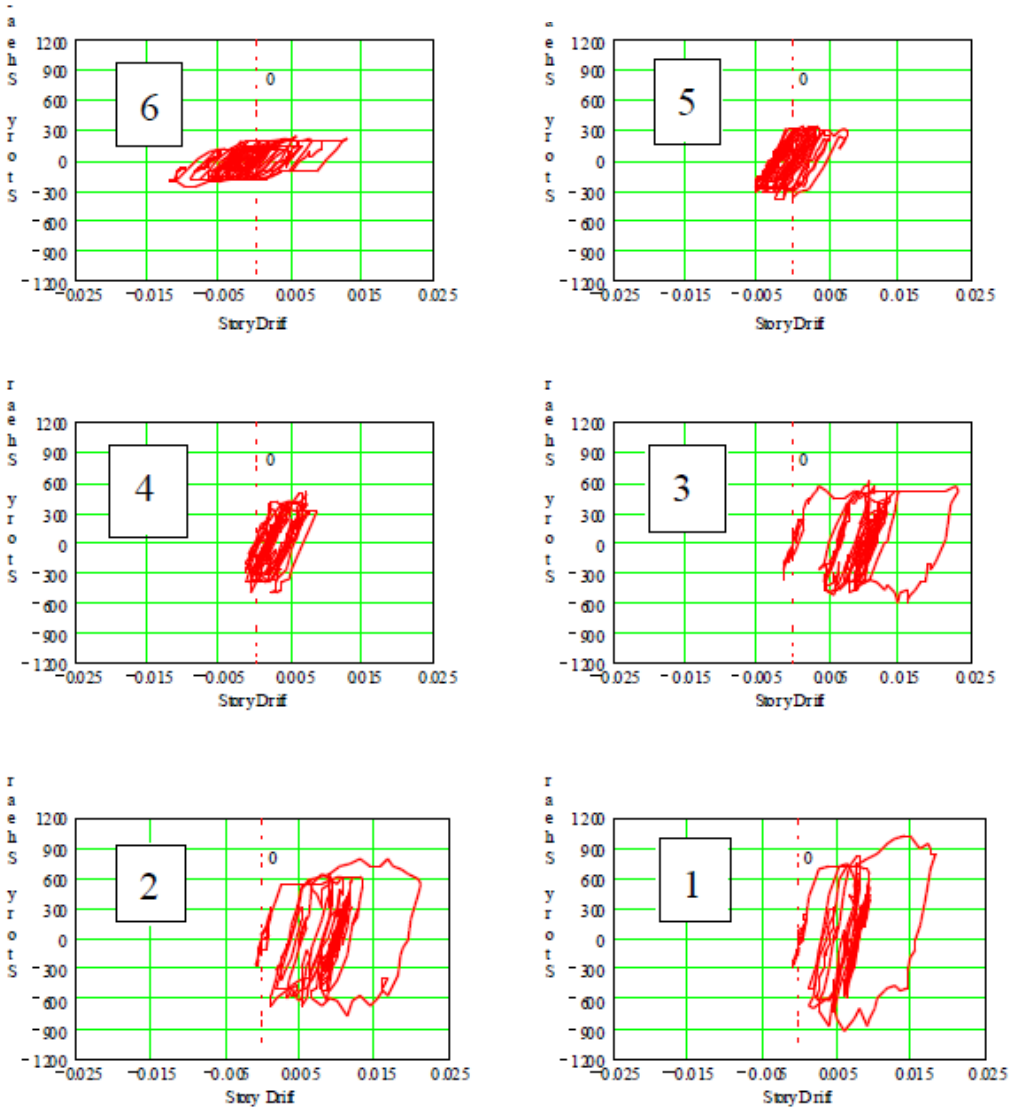

Figure 2-14: Story Level Relations between Story Shear and Story Drift – Six-story Chevron Model Subjected to Record LA20 at 10% Hazard Level [Sabelli, 2001]

A full scale three-story 3-bay BRBF with concrete filled tube (CFT) columns were tested with two earthquake records, 1999 Chi-Chi and 1989 Loma Prieta, scaled to DBE and Maximum Considered Earthquake (MCE) levels. Figure 2-15 shows the prototype and the dimensions of the CFT/BRB frame. Analytical models were run prior to the experimental test. The test results showed that the BRBs performed well without failure during the tests. It was also found that BRBs carried about 80% of the story shear at each story before yielding. The test results validated the energy dissipation capacity of BRBs at different earthquake levels. In the tests, the BRBs showed a cumulative ductility demand from 250 to 350, which was smaller than that in component tests. The maximum ductility demands of the BRBs in DBE and MCE level were 5.0 and 10.0 respectively. Noticeably, the maximum ductility of the BRBs in this test appeared at the second story and BRBs at the second and third story experienced more cumulative deformation than those in the first story. A summary of the cumulative ductility demand of the test is shown in Table 2-3 [Tsai, 2008].

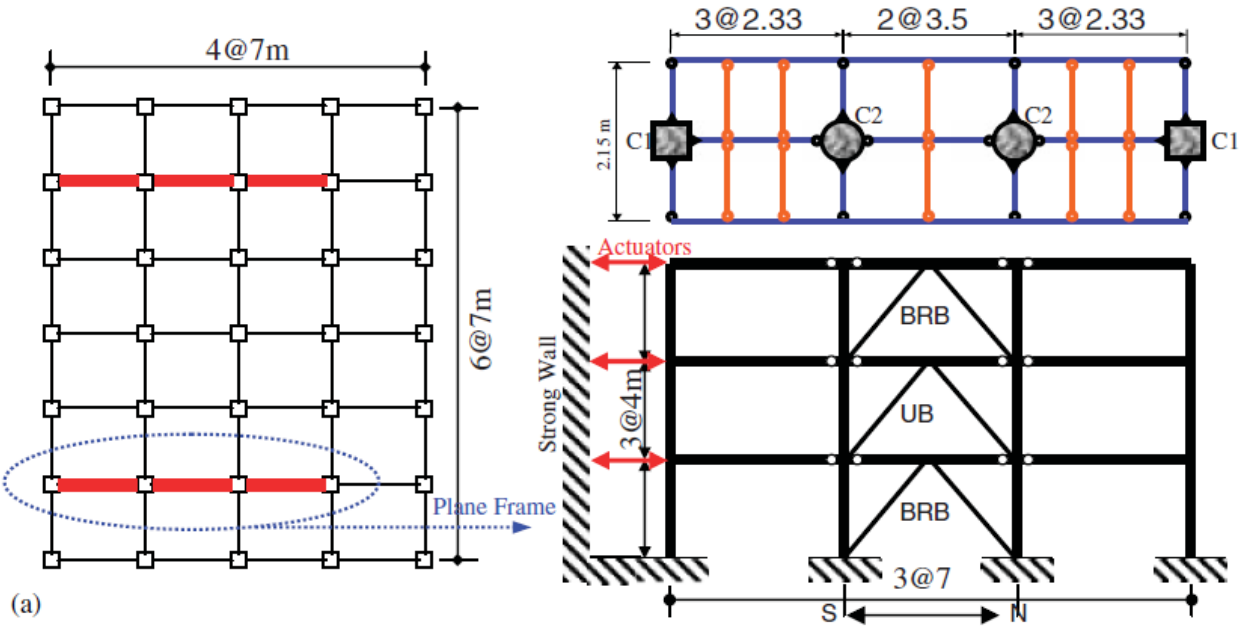

Figure 2-15: Prototype and Dimensions of the Full Scale CFT/BRB Frame [Tsai, 2008]

Table 2-3: Cumulative Ductility Demand of BRBs in Tsai's Test [Tsai, 2008]

	Test at 50% in 50 years hazard Suite		Test at 10% in 50 years hazard Suite		Test at 2% in 50 years hazard Suite		After Cyclic Loading		Summary	
	North	South	North	South	North	South	North	South	North	South
3rd Story	4.4	4.4	14.7	14.5	26.2	26.9	122.0	158.6	167.3	204.4
2nd Story	11.80	12.0	28.9	27.4	54.4	50.6	117.4	114.3	212.5	204.3
1st Story	8.9	7.4	19.3	16.8	38.0	34.7	117.8	119.0	184	177.9

A two-dimensional, four-story BRB prototype frame was designed and modeled. Static pushover analysis and time-history analysis were conducted. Figure 2-16 shows the elevation of the tested frame. Ground motions scaled to the MCE and DBE levels were applied. Results are presented as "response to selected individual ground motion records" and "statistical summary". Maximum values for story drift and ductility demand were determined for each ground motion. Mean and standard deviation were determined for ground motion suite. Time-history results are shown in Table 2-4. A 3/5 scale experimental test was conducted to compare with the results of MCE model [Fahnestock, 2006].

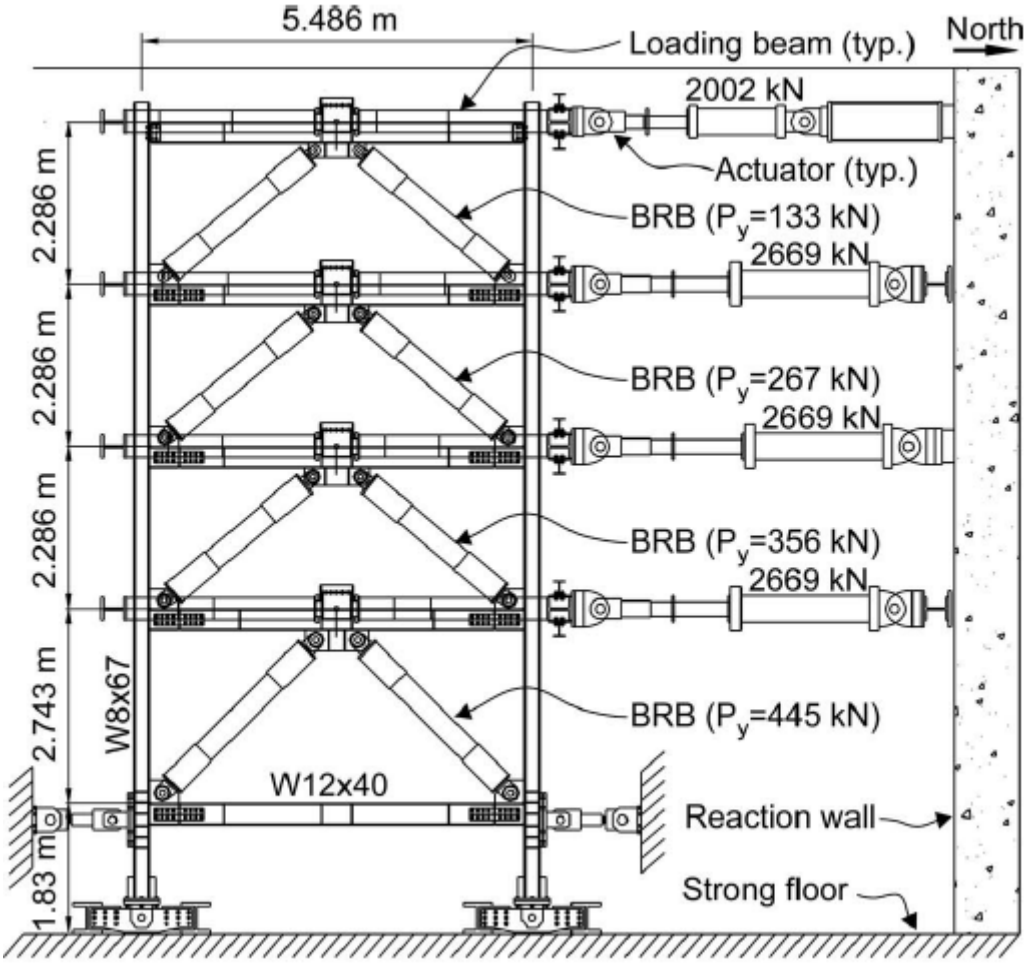

Figure 2-16: Four-Story Tested Frame Elevation [Fahnestock, 2006]

Table 2-4: Statistical Evaluation of Maximum Response Quantities from Time-history Analysis [Fahnestock, 2006]

Seismic Input	Statistical Quantity	Maximum Roof Drift	Maximum Roof Drift	BRB Ductility Demand	
				Maximum	Cumulative
DBE	μ	0.011	0.018	11.1	60
	μ+σ	0.016	0.022	13.1	80
MCE	μ	0.023	0.030	18.6	120
	μ+σ	0.031	0.040	23.5	154

A time-history analysis was conducted on a one-bay three-story single diagonal BRBF by Chou [2012]. The prototype building was assumed to be built in a stiff soil condition in Los Angeles, CA. The prototype evaluation is shown in Figure 2-17. Ten earthquake records were chosen to set up the ground motion suites at DBE and MCE earthquake level. Earthquake records factors and story drifts results are shown in Table 2-5. Demands of the BRBF were presented in term of maximum story drift and maximum brace strain, which were used to indicate satisfaction of the design requirement and the AISC provisions. BRB strain and story drift demand are shown in Figures 2-18 and 2-19 [Chou, 2012].

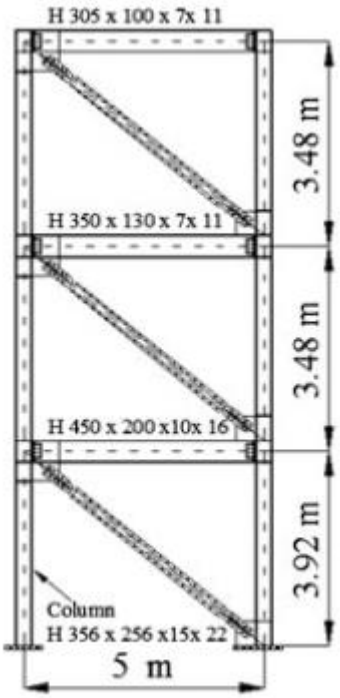

Figure 2-17: Three-Story Prototype Elevation of Tested BRBF [Chou, 2012]

Table 2-5: Earthquake Records, Scale Factors and Results [Chou, 2012]

Earthquake	Record	Original PGA (g)	Scaled PGA (g)		Maximum roof Drift (%)	
			DBE	MCE	DBE	MCE
Chi-Chi	TCU 074	0.60	0.38	0.57	1.12	1.71
	TCU 039	0.21	0.41	0.62	1.28	2.10
Landers	JOSHUA 90	0.28	0.41	0.62	0.93	1.31
	IND 090	0.11	0.40	0.60	1.18	2.96
Loma	AND 360	0.24	0.50	0.75	0.93	1.31
Prieta	STG 090	0.32	0.56	0.84	0.68	1.17
Northridge	CAST 360	0.51	0.4	0.60	1.02	2.41
	CNP 196	0.42	0.47	0.71	1.36	1.96
Superstition	ICC 090	0.25	0.46	0.69	0.85	1.33
Hills	WSM 180	0.21	0.38	0.57	1.16	1.17

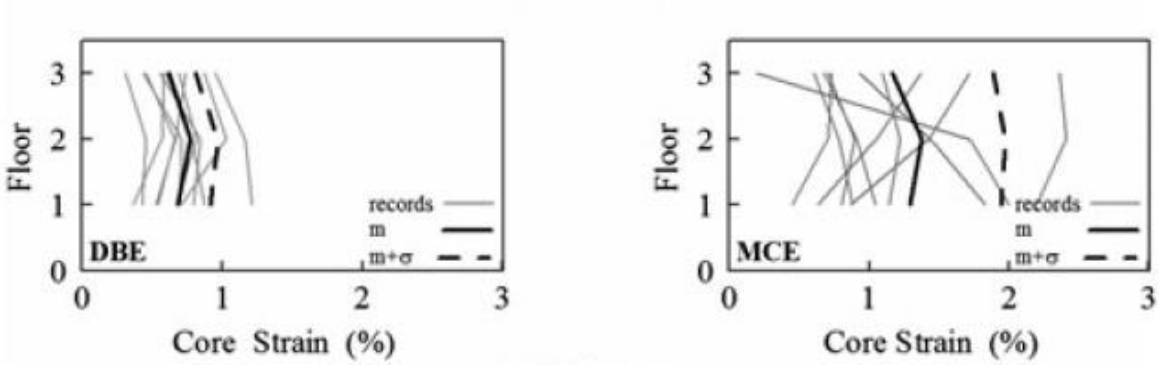

Figure 2-18: BRB Strain Demand in the Three-Story BRBF under DBE and MCE Motions [Chou, 2012]

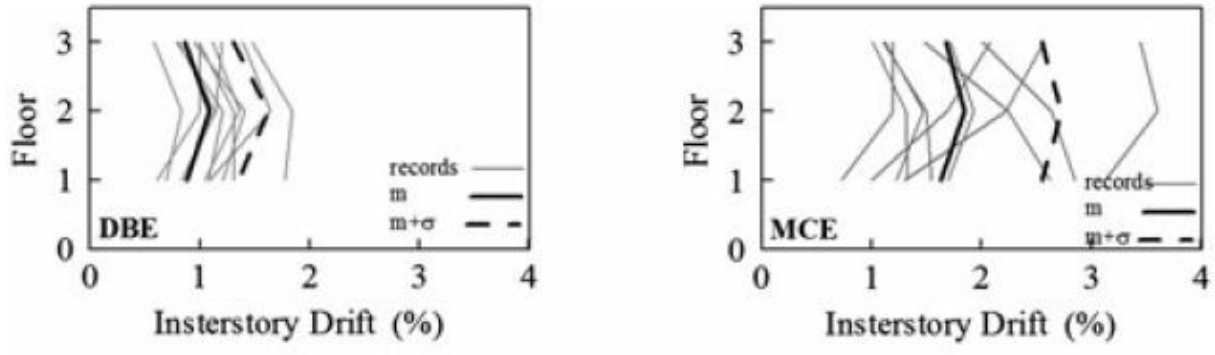

Figure 2-19: Story Drift Demand in the Three-Story BRBF under DBE and MCE Motions [Chou, 2012]

2.4 Research on modeling BRBs

One of the critical issues of the time history analysis of BRBF is the modeling methods. In previous research several ways of modeling the inelastic behavior were applied. A basic bilinear force-displacement diagram of BRBs is provided by the Seismic Provision for Structural Steel Buildings [AISC, 2010].

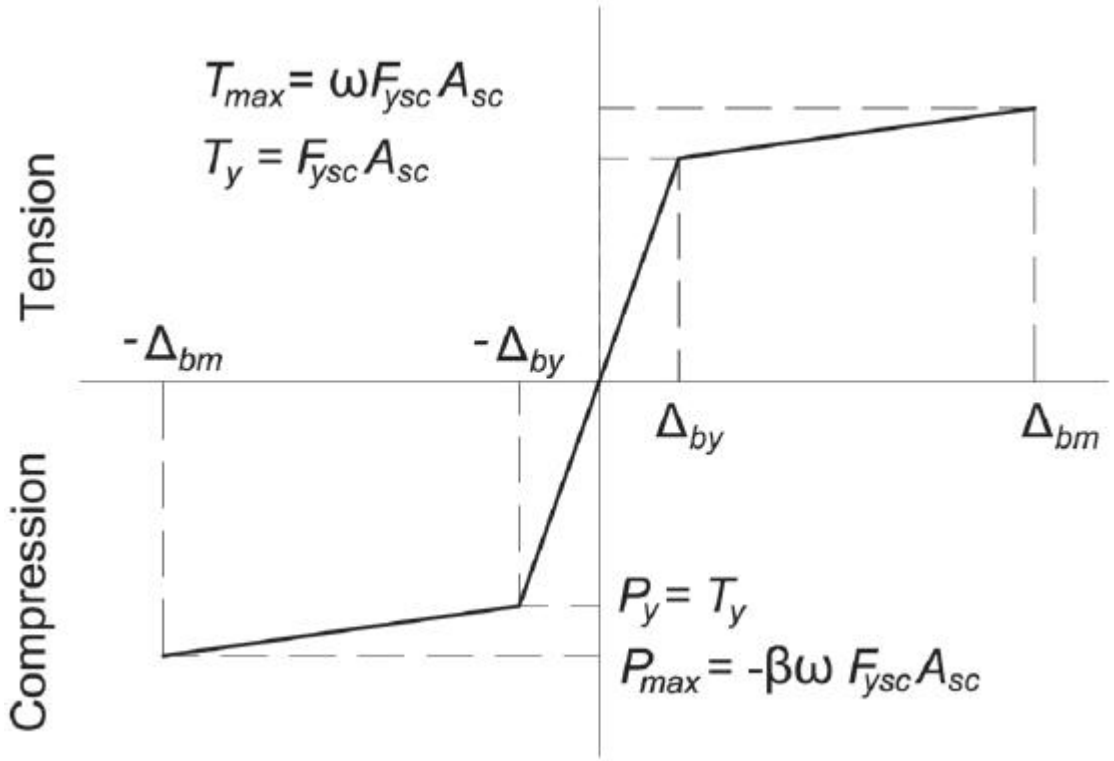

Figure 2-20: Diagram of Bilinear Brace Force-Displacement in Seismic Provision for Structural Steel Buildings [AISC, 2010]

Black introduced macroscopic modeling of hysteretic behavior of BRBs which was originally proposed by Bouc [1971] and developed by Wen [1975; 1976], known as the Bouc-Wen model. The model of approximating the hysteresis behavior of the BRBs is shown in Eqn. 2-1. In Eqn. 2-1, *u(t)* is axial brace deformation; *K* is stiffness before yielding; α is the ratio of

the stiffness after yielding to stiffness before yielding; u_y is the yield displacement; and z(t) is a dimensionless quantity governed by Eqn. 2-2. In Eqn. 2-2, β, γ and n are dimensionless quantities which determine the shape of the hysteresis loops. Figure 2-21 shows the prediction of Bouc-Wen hysteresis loop of one of the specimen Black tested and recorded the test data of the specimen [Black, 2004].

$$P(t) = \alpha K u(t) + (1-\alpha) K u_y z(t) \qquad \text{(Eqn. 2-1)}$$

$$u_y \dot{z}(t) + \gamma |\dot{u}(t)| z(t) |z(t)|^{n-1} + \beta \dot{u}(t) |z(t)|^n - \dot{u}(t) = 0 \qquad \text{(Eqn. 2-2)}$$

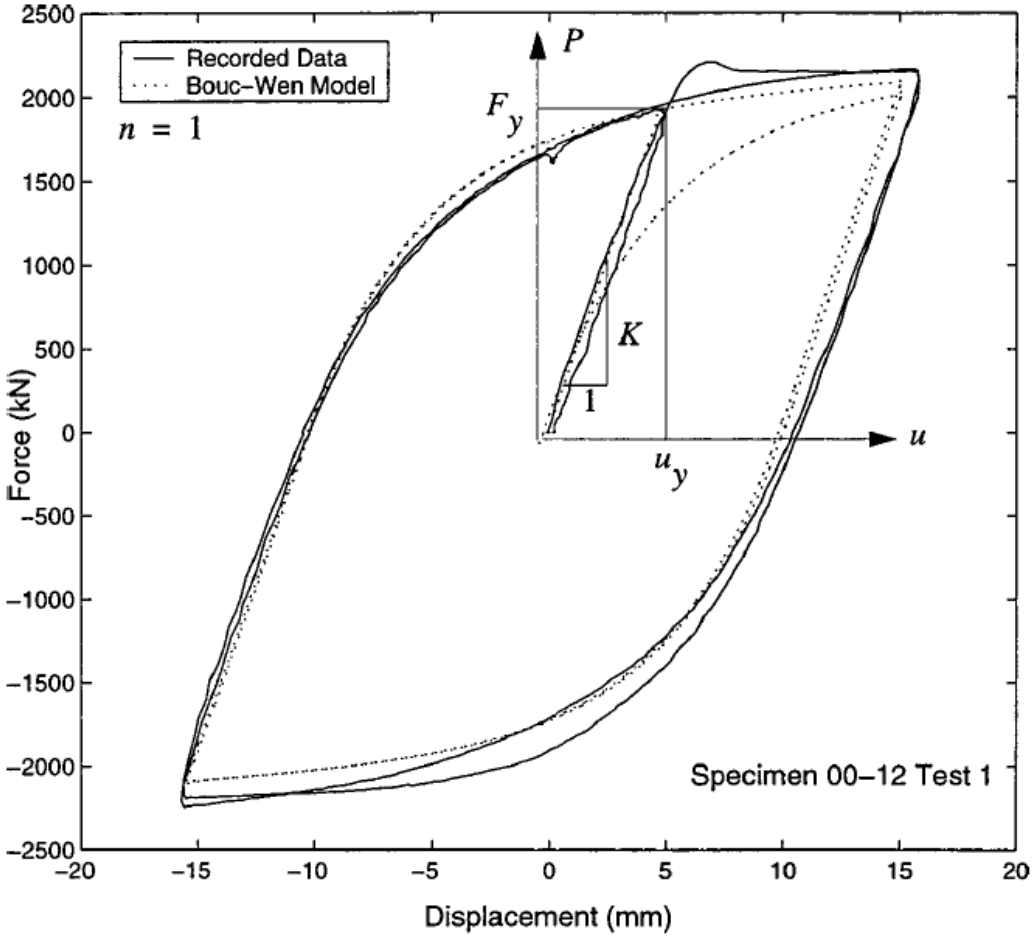

Figure 2-21 Comparison of Hysteresis Loops of Predicted Bouc-Wen Model and Testing Records [Black, 2004]

Fahnestock applied both kinematic and isotropic hardening properties to model the behavior of the BRBs under cyclic load. Kinematic hardening refers to the post-yield hardening with a positive post-yield stiffness. Isotropic hardening refers to the expansion of the hysteresis loops with same shape but larger stress after the first cycle. Fahnestock used DRAIN-2DX [Prakash 1993] to model the BRBs and run the analysis. In DRAIN-2DX, modeling kinematic hardening properties was already built in. Fahnestock used experimental data of BRB testing by Merritt [Merritt 2003] to determine the modeling parameters for BRB isotropic hardening. The isotropic hardening model and the critical parameters are shown in Figure 2-22. The final BRB models were modified with isotropic hardening based on the kinematic hardening in DRAIN-2DX. The hysteresis loops of the BRBs using this hybrid hardening model were compared to the experimental hysteresis loops. The results matched pretty well. Figure 2-23 shows a comparison of experimental and analytical hysteresis behavior of BRB specimen 1. [Fahnestock, 2006].

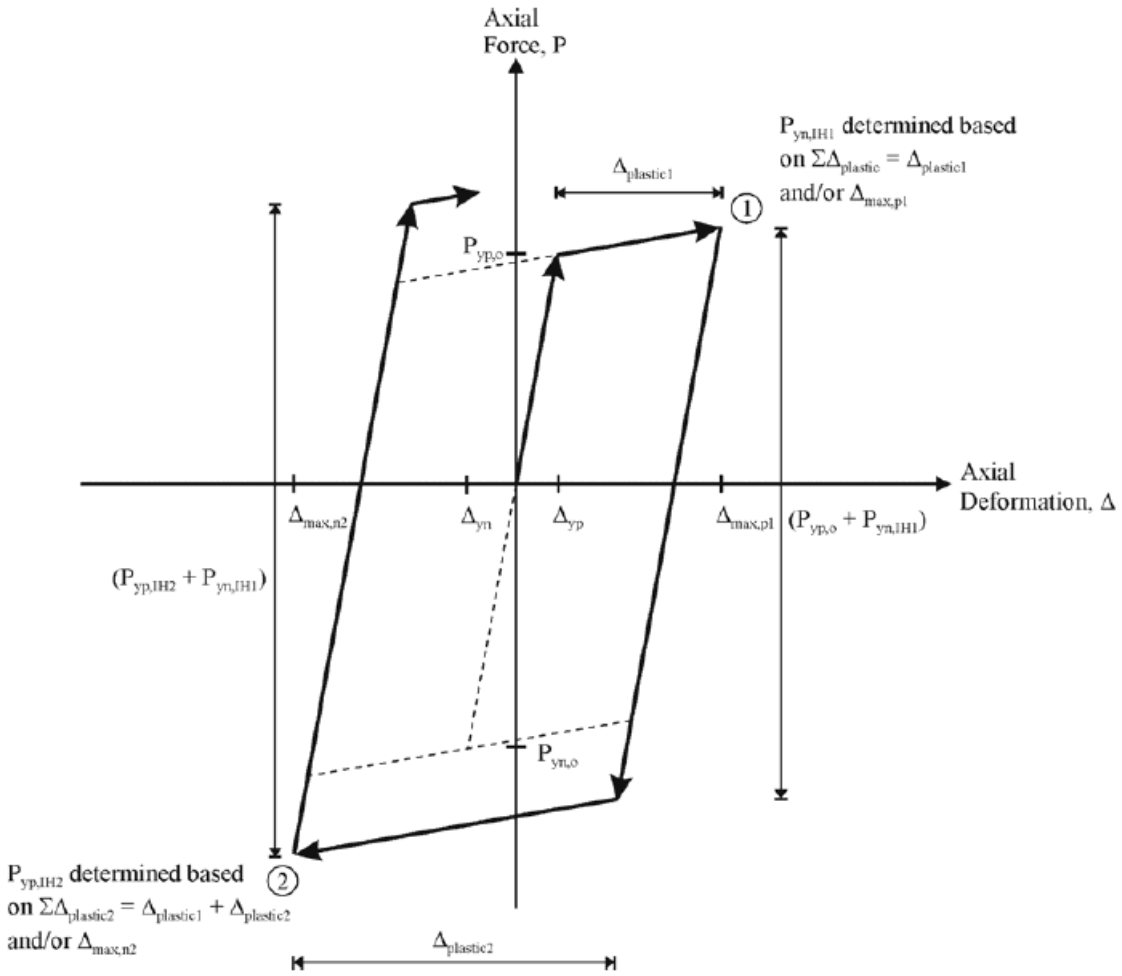

Figure 2-22 Isotropic Hardening Behavior Modeled in DRAIN-2DX [Fahnestock, 2006]

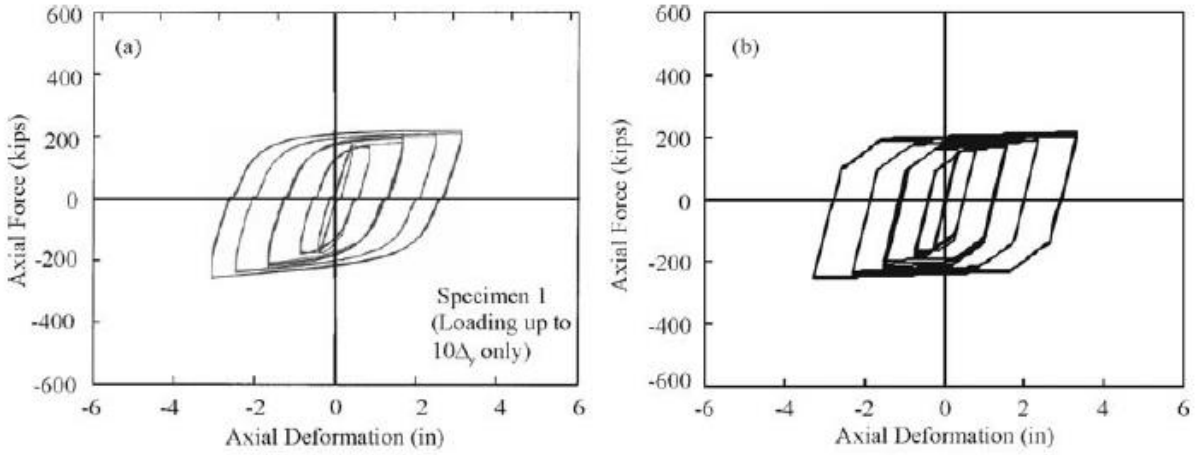

Figure 2-23 Comparison of the Experimental and Analytical BRB Cyclic Behavior of Specimen 1 [Fahnestock, 2006]

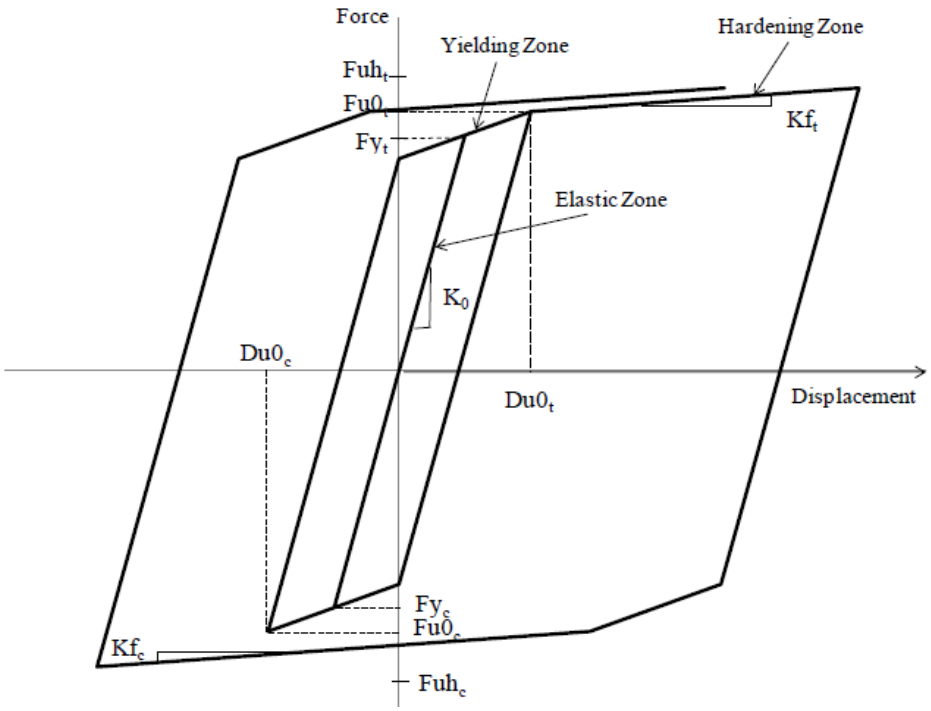

Figure 2-24 Tri-linear Hysteresis Model of BRB [Alemdar, 2012]

The tri-linear hysteresis BRB model matches well with component tests. The tri-linear model is also used in Perform 3D. Figure 2-24 shows a trilinear force-displacement relationship in BRB modeling used by Alemdar [2013]. Parameters used to determine the strain stress relationship are based on the property of the BRB yielding core. Fy is yielding force; Fu0 is force for the first loading cycle; Fuh is strength after full hardening; Ko is the stiffness before yielding; Kf is the post-yielding stiffness. Figure 2-25 shows the tri-linear hysteresis BRB model used in Perform 3D.

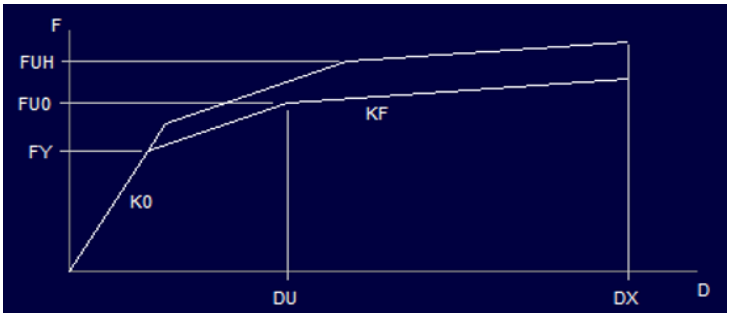

Figure 2-25 Tri-linear Hysteresis Model of BRB in Perform 3D

2.5 Design of the BRBF

A flowchart provided by one of the BRB manufacturers, , shows a typical BRB design process using equivalent lateral force method. This flowchart shows the design process involved with both the EOR and the manufacturers in Figure 2-26. [Kimberley, 2012]

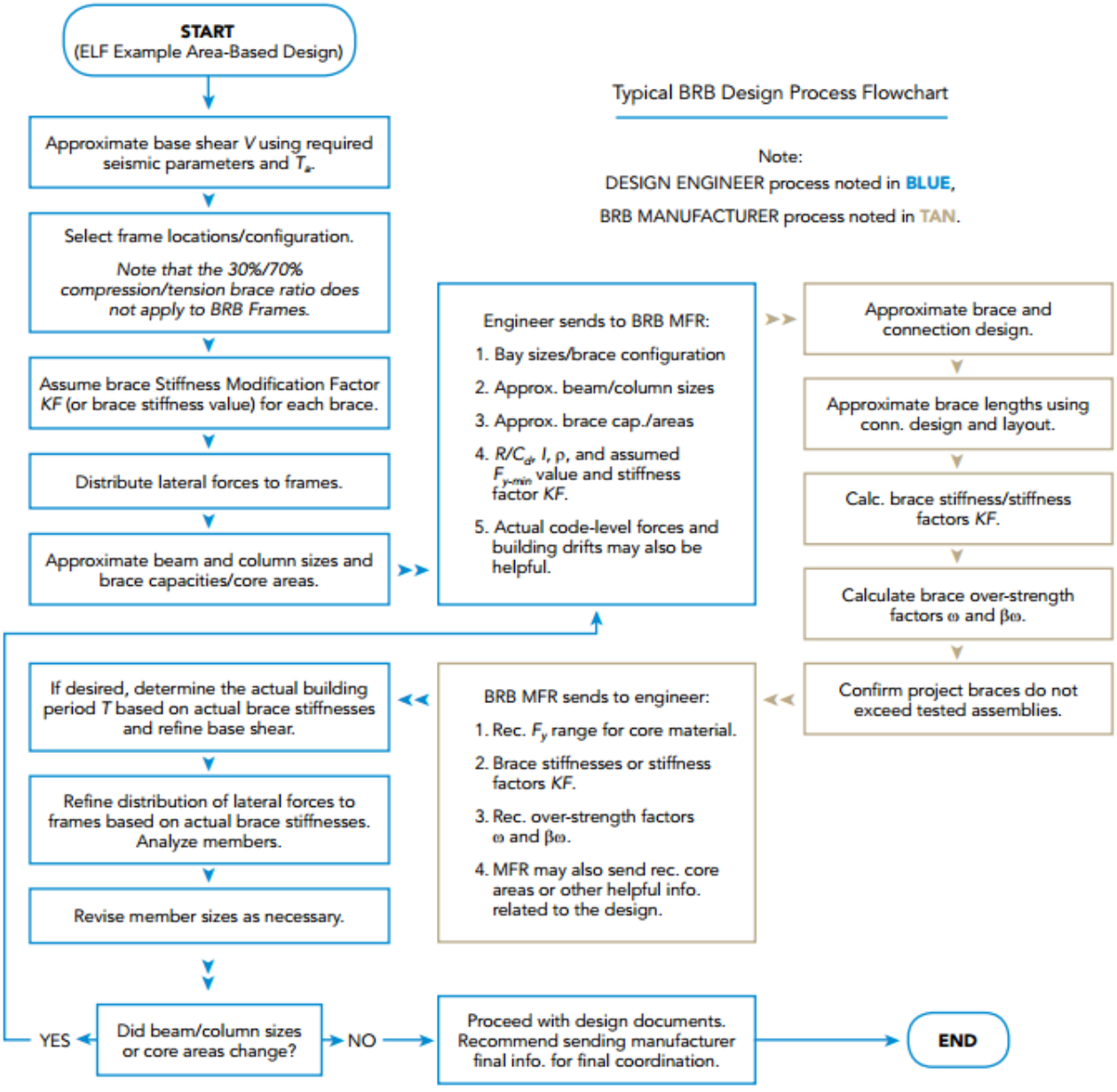

Figure 2-26: Flowchart of Typical BRB Design Process [Kimberley, 2012]

As BRBF is a relatively new lateral-force resisting system applied in USA, the design provision has been modified for several times. The most recent seismic design coefficient factors for seismic force-resisting systems provided by ASCE 7-10 [ASCE 2010] are:

Response modification coefficient, R=8;

Overstrength factor, Ω_0=2.5;

Deflection amplification factor, C_d=5.

Design provisions are provided in the AISC Seismic Provision for Steel Structural Buildings [AISC 2010]. As described before, the axial force of the BRBs are fully resisted by the steel core. In the design procedure for the steel core, the steel core should be designed to resist the entire axial force in the BRB. The design axial strength, φP_{ysc} for LRFD is determined as follows:

$P_{ysc}=F_{ysc}A_{sc}$, φ=0.90

Where, P_{ysc} is the axial yield strength of the steel core; A_{sc} is the cross section area of the yielding core; F_{ysc} is the specified minimum stress of the steel core or actual yield stress found from the test.

In the design procedure for brace connections and adjoining members, the adjusted brace strength shall be used. The adjusted brace strength in compression is $\beta\omega R_y P_{ysc}$ and the adjusted brace strength in tension is $\omega R_y P_{ysc.}$

Where, β is the compression strength adjusted factor; ω is the strain hardening adjustment factor. β and ω are defined in Eqn. 2-3 and Eqn. 2-4; R_{yi} is the ratio of the expected yield stress to the specified minimum yield stress, F_y.

$$\beta = \frac{\beta\omega F_{ysc} A_{sc}}{\omega F_{ysc} A_{sc}} = \frac{P_{max}}{T_{max}} \qquad \text{(Eqn. 2-3)}$$

$$\omega = \frac{\omega F_{ysc} A_{sc}}{F_{ysc} A_{sc}} = \frac{T_{max}}{F_{ysc} A_{sc}} \qquad \text{(Eqn. 2-4)}$$

Where, P_{max} is the maximum compression force and T_{max} is the maximum tension force with brace deformations corresponding to 200% of the design story drift. Note that P_{max} and T_{max} are all measured from the qualification test of the test specimens.

The Seismic Design Manual [AISC, 2012] is an important reference in the design of BRBs. It is specified that BRBs should be designed based on the qualification cyclic test results. In modern US design practice, BRBs are provided by manufacturing companies who have already conducted the BRB qualification tests conforming to the AISC Seismic Provisions. Therefore in the design process of BRBs, work involves both designers and manufacturers, as shown in the flowchart in Figure 2-26.

2.6 Summary

BRBs show significant advantages over conventional braces, as a lateral force resisting system. The development background of BRBs is concisely introduced. Research conducted on components and assemblies of BRBs proved its competence with significant ductility capacity and predictable hysteresis loops. Further research on the system-level behavior of BRBF system was presented and discussed. Methods used to model BRBs in nonlinear analysis are discussed. Design background of the BRBF is discussed. A brief design process of the BRB is also introduced in this chapter.

Chapter 3 Modeling of BRB Frames

3.1 Building parameters

3.1.1 Three-story structural parameters

The three story models are designed based on the SAC building models of Sabelli [Sabelli, 2001]. The building is a typical office building usage. Story height is 13 ft. The structure plan dimensions are 124 ft by 184 ft. The bay size is 30 ft by 30 ft. A 13 ft tall penthouse is set on the roof of the building with a plan dimension of 30 ft by 60 ft. Braces are placed at the perimeter of the building. The plan lay-out of the three-story building is illustrated in Figure 3-1. Three-story buildings are designed for two different hazards—Los Angeles (LA), CA and Riverside (Riv), CA. At each location, the BRBs are designed in a chevron configuration and a single diagonal configuration. For each configuration, BRBs are designed to have normal yield length (NYL) and shortened yield length (SYL). In addition, a critical building with an importance factor Ie=1.5 is also designed. The BRBs of this building are designed to be in chevron configuration with normal yield length. With these variations of all the models, comparison between different brace configurations and brace stiffness can easily be conducted. This will furthermore provide a comprehensive understanding of the seismic induced ductility of the BRBs in different frames. Design loads, seismic weights and design coefficients are shown in Table 3-1, 3-2 and 3-3.

In total, ten three-story buildings will be designed and analyzed. They are:

1. Building with NYL BRBs in chevron configuration at LA (LA3NCh)

2. Building with NYL BRBs in chevron configuration with Ie=1.5 at LA (LA3NCh1.5)

3. Building with SYL BRBs in chevron configuration at LA (LA3SCh)

4. Building with NYL BRBs in single diagonal configuration at LA (LA3NSD)

5. Building with SYL BRBs in single diagonal configuration at LA (LA3SSD)

6. Building with NYL BRBs in chevron configuration at Riv (Riv3NCh)

7. Building with NYL BRBs in chevron configuration with Ie=1.5 at Riv (Riv3NCh1.5)

8. Building with SYL BRBs in chevron configuration at Riv (Riv3SCh)

9. Building with NYL BRBs in single diagonal configuration at Riv (Riv3NSD)

10. Building with SYL BRBs in single diagonal configuration at Riv (Riv3SSD)

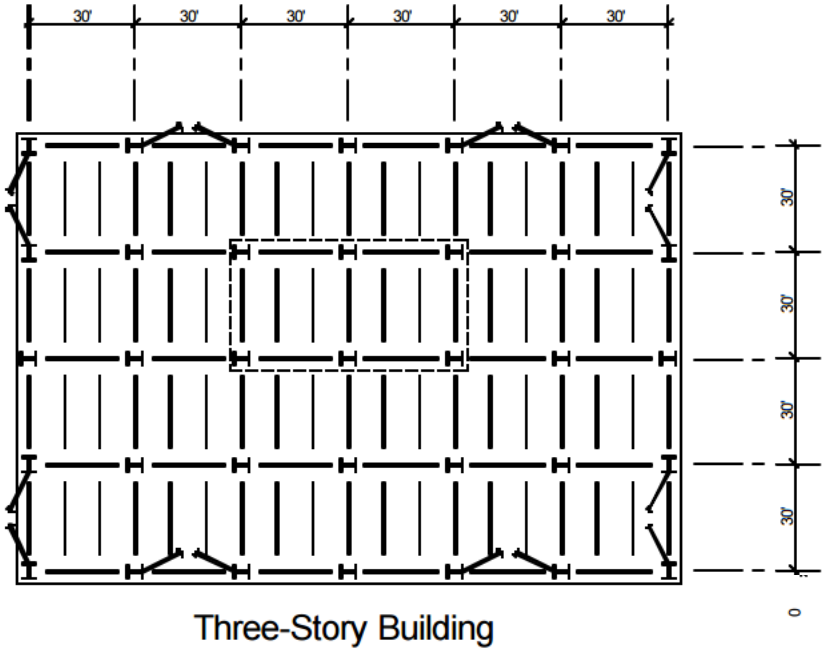

Figure 3-1: Three-Story Building Plan Layout

Table 3-1: Design Loads for Three-Story Buildings

Gravity Loads for Design	
Steel weight	13 psf
Ceilings/ Flooring weight	3 psf
Roof weight	7 psf
Mechanical/ Electrical weight	7 psf
Mechanical/ Electrical weight at Penthouse	47 psf
Exterior Wall weight	25 psf
Metal decking weight	42 psf
Gravity framing partition weight	20 psf
Seismic framing partition weight	10 psf
Live load	50 psf

Table 3-2: Dead Loads, Masses and Total Weight

Floor Level	2^{nd}	3^{rd}	roof	penthouse
Dead load	84.3 psf	84.3 psf	89.13 psf	147.7 psf
Seismic Mass	4.71 kip s^2/in	4.71 kip s^2/in	4.98 kip s^2/in	0.69 kip s^2/in
Total Seismic Weight	5831 kip			

Table 3-3: Design Coefficients

	LA, I=1.0	LA, I=1.5	Riverside, I=1.0	Riverside, I=1.5
Site Class	D	D	D	D
Occupancy Cat.	II	IV	II	IV
S_{ds}	1.393	1.393	1.0	1.0
S_{d1}	0.77	0.77	0.6	0.6
Seismic Design Cat.	D	D	D	D
Important Factor I_e	1.0	1.5	1.0	1.5

3.1.2 Six-story Structural Parameters

Six-story buildings share the same loading parameters as three-story buildings in Table 3-1 and 3-3. The structural dimensions of six story buildings are 154 ft. by 154 ft. The plan lay-out of the six-story building is shown in Figure 3-2.

Likewise, ten six-story models are analyzed. They are: LA6NCh; LA6NCh1.5; LA6SCh; LA6NSD; LA6SSD; Riv6NCh; Riv6NCh1.5; Riv6SCh; Riv6NSD; Riv6SSD.

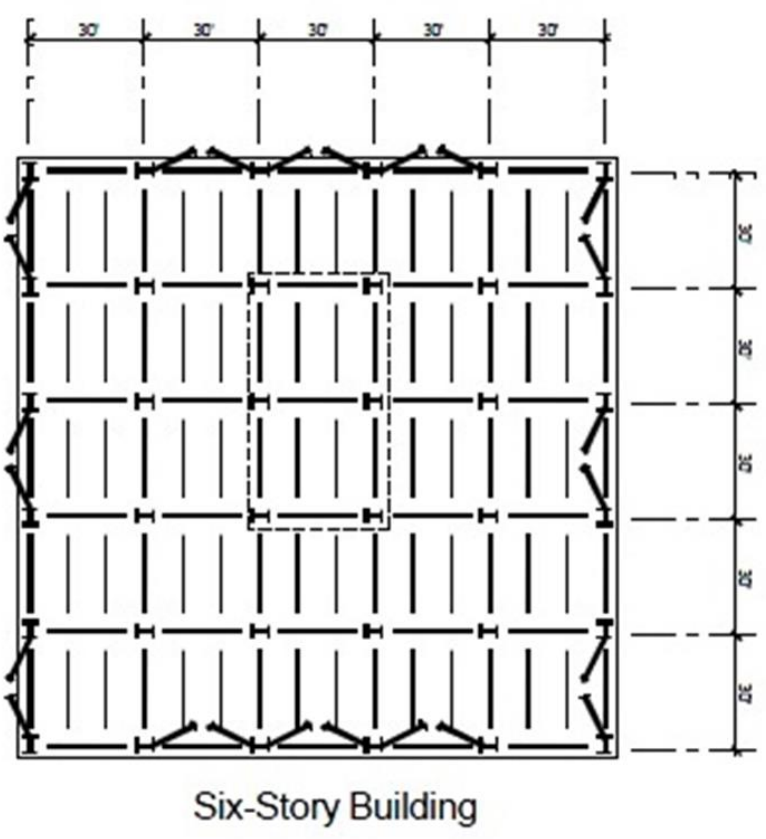

Figure 3-2: Six-Story Building Plan Layout

3.2 Design of the three- and six-story buildings

The gravity design of the buildings follows the designs completed by Sabelli [2001]. The lateral resisting system design was accomplished with the assistance of SAP 2000 v.15 [CSI, 2011].

Cross sections of columns and beams are chosen in the same manner as Sabelli's design. Tables 3-4 and 3-5 present the cross section of columns and beams in these buildings.

Table 3-4: Column and Beam Sections of Three-Story Buildings

Story	Braced frame column	Braced frame beam	Non-brace frame columns (minor axis)					
			side	interior	mechanical	Perpendicular to brace frame	I_y (in^4)	Z_y (in^3)
3	W12x96	W14x48	W14x48	W14x61	W14x74	W12x96	2015	559
2								
1								

Table 3-5: Column and Beam Sections of Six-Story Buildings

Story	Braced frame column	Braced frame beam	Non-brace frame columns (minor axis)				
			interior	mechanical	Perpendicular to brace frame	I_y (in^4)	Z_y (in^3)
6	W14x132	W14x48	W14x43	W14x53	W14x132	2591	605
5							
4							
3	W14x211	W14x48	W14x90	W14x99	W14x211	7136	1421
2							
1							

In the SAP 2000, the building is modeled as a 2D frame, which is one of the exterior frames braced by BRBs. Besides the exterior frame, a ghost column is added to the model. The

ghost column is designed to carry the gravity load of the gravity columns tributary to the planar frame. The section property of the ghost column is assigned as a special member with the cross section area and moment of inertia as the sum of the columns besides the columns in the braced frame.

Properties of the BRBs are shown in Table 3-6 and 3-7.

Table 3-6: BRB Properties of Three-Story Buildings

Model	Story Level	Yield Force (kips)	Yielding Length (in)	Model	Story Level	Yield Force (kips)	Yielding Length (in)
LA3NCh	3rd story	161.5	152.93	Riv3NCh	3rd story	123.5	158.08
	2nd story	247.0	138.52		2nd story	209.0	148.62
	1st story	304.0	131.90		1st story	228.0	138.11
LA3NCh1.5	3rd story	247.0	138.52	Riv3NCh1.5	3rd story	190.0	151.70
	2nd story	380.0	130.13		2nd story	304.0	133.24
	1st story	437.0	127.32		1st story	342.0	130.66
LA3SCh	3rd story	161.5	67.21	Riv3SCh	3rd story	123.5	66.56
	2nd story	247.0	66.55		2nd story	209.0	66.92
	1st story	304.0	65.27		1st story	228.0	64.97
LA3NSD	3rd story	266.0	270.13	Riv3NSD	3rd story	209.0	278.37
	2nd story	418.0	258.30		2nd story	342.0	261.77
	1st story	513.0	264.04		1st story	399.0	272.88
LA3SSD	3rd story	266.0	81.07	Riv3SSD	3rd story	209.0	81.33
	2nd story	418.0	81.15		2nd story	342.0	80.71
	1st story	513.0	78.35		1st story	399.0	77.91

Table 3-7: BRB Properties of Six-Story Buildings

Model	Story Level	Yield Force (kips)	Yielding Length (in)	Model	Story Level	Yield Force (kips)	Yielding Length (in)
LA6NCh	6th story	57.0	145.89	Riv6NCh	6th story	47.5	145.23
	5th story	76.0	161.70		5th story	66.5	146.25
	4th story	104.5	146.49		4th story	85.5	145.23
	3rd story	114.0	161.42		3rd story	95.0	144.92
	2nd story	123.5	161.42		2nd story	104.5	144.62
	1st story	133.0	199.66		1st story	114.0	197.47
LA6NCh1.5	6th story	76.0	160.50	Riv6NCh1.5	6th story	66.5	146.25
	5th story	104.5	144.62		5th story	95.0	144.92
	4th story	142.5	156.60		4th story	123.5	158.08
	3rd story	161.5	152.93		3rd story	133.0	157.34
	2nd story	180.5	152.23		2nd story	152.0	153.70
	1st story	190.0	190.38		1st story	152.0	192.34
LA6SCh	6th story	57.0	67.89	Riv6SCh	6th story	47.5	67.23
	5th story	76.0	66.50		5th story	66.5	68.25
	4th story	104.5	66.62		4th story	85.5	67.23
	3rd story	114.0	66.82		3rd story	95.0	66.92
	2nd story	123.5	66.08		2nd story	104.5	66.62
	1st story	133.0	77.99		1st story	114.0	79.47
LA6NSD	6th story	76.0	292.00	Riv6NSD	6th story	57.0	277.39
	5th story	114.0	290.07		5th story	95.0	276.18
	4th story	152.0	284.95		4th story	123.5	289.33
	3rd story	180.5	283.23		3rd story	133.0	288.59
	2nd story	190.0	282.71		2nd story	152.0	284.95
	1st story	199.5	327.78		1st story	152.0	329.78
LA6SSD	6th story	76.0	81.24	Riv6SSD	6th story	57.0	81.13
	5th story	114.0	81.72		5th story	95.0	81.92
	4th story	152.0	81.16		4th story	123.5	81.93
	3rd story	180.5	81.19		3rd story	133.0	81.76
	2nd story	190.0	81.01		2nd story	152.0	81.92
	1st story	199.5	102.57		1st story	152.0	103.48

Fundamental period of vibration of the three-story models are shown in Table 3-8. Fundamental period of vibration of the six-story models are shown in Table 3-9.

Table 3-8: Fundamental Period of Vibration of the Three-Story Models

Models	Fundamental period of vibration (s)	Models	Fundamental period of vibration (s)
LA3NCh	0.52	Riv3NCh	0.57
LA3NCh1.5	0.45	Riv3NCh1.5	0.49
LA3SCh	0.48	Riv3SCh	0.52
LA3NSD	0.58	Riv3NSD	0.64
LA3SSD	0.49	Riv3SSD	0.53

Table 3-9: Fundamental Period of Vibration of the Six-Story Models

Models	Fundamental period of vibration (s)	Models	Fundamental period of vibration (s)
LA3NCh	1.27	Riv3NCh	1.34
LA3NCh1.5	1.09	Riv3NCh1.5	1.18
LA3SCh	1.10	Riv3SCh	1.16
LA3NSD	1.44	Riv3NSD	1.61
LA3SSD	1.23	Riv3SSD	1.36

3.3 Modeling Procedure

3.3.1 Modeling Procedure in SAP2000

SAP2000 is used in the modeling procedure in this project for all the three-story and six-story buildings. In this section, the LA3NCh model is chosen to present the modeling procedure in SAP2000.

Three-story buildings are modeled as 2D frames. We take the exterior frame to represent half of the buildings for modeling. It is shown is Figure 3-3. Story height is 13 ft. and bay dimension is 30 ft. Columns are pinned at the base. The ghost column, representing the gravity frames of the building not modeled, is placed one-bay distance from the main frame. The ghost column is circled in Figure 3-4. The ghost column is assigned as "other frame section property type" and "general section" by moment of inertia and cross section area. Material of the ghost column is assigned as A992Fy50. Each joint of the ghost column is constrained with a body constraint to the joint of the exterior column next to the ghost column respectively. Beams are pinned in the ends. Dead load and live load are distributed on the unbraced beams. Unbraced beams are beams which are not in the braced bays, while braced beams are beams in the braced bays. No distributed loads are put on the braced beams because distributed loads on the braced beam will increase the axial load on the BRBs. Considering that BRBs are modeled subjected to only seismic loads, gravity loads are assigned as concentrated load set on the end of braced beams instead. Masses of the frame are divided into joint mass according to the distributed area assigned to joints at each story of the frame. Masses on the interior columns are twice as much as those on exterior columns. There is no mass assigned on the ghost column. The equivalent lateral force (ELF) method is applied in design of the BRBs. Loads applied on the SAP 2000 model is shown in Figure 3-4. BRBs are modeled as link members in SAP2000 with initial stiffness of

1500k/in. The ELF is divided into two equal parts and assigned as joint earthquake load on the exterior Column At each floor in the model. Load combinations are assigned as a default steel frame design combination in SAP2000. Models are run under these load combinations. Maximum axial forces on braces are collected among all the load combinations. New stiffness of links are calculated based on these forces. In the model, new stiffness is assigned to the link members respectively. The model is run again with new stiffness. New maximum axial forces of the brace are collected and reported to CoreBrace. Once detailed information from CoreBrace is received, this information is added to the model to ensure that the structure still meets the design constraints and deflection limitations.

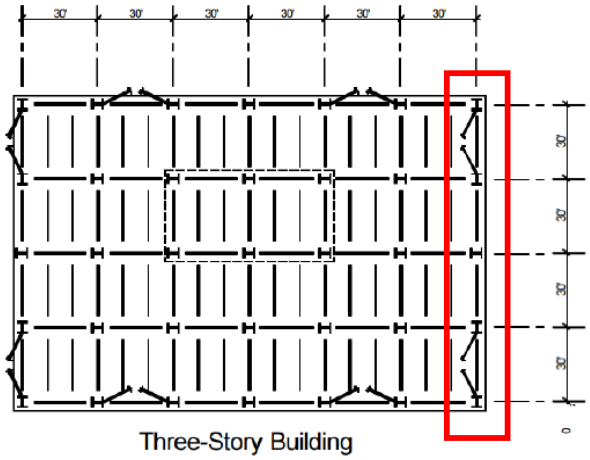

Figure 3-3: The Exterior Frame of the Three-Story Building Used for the 2D Model

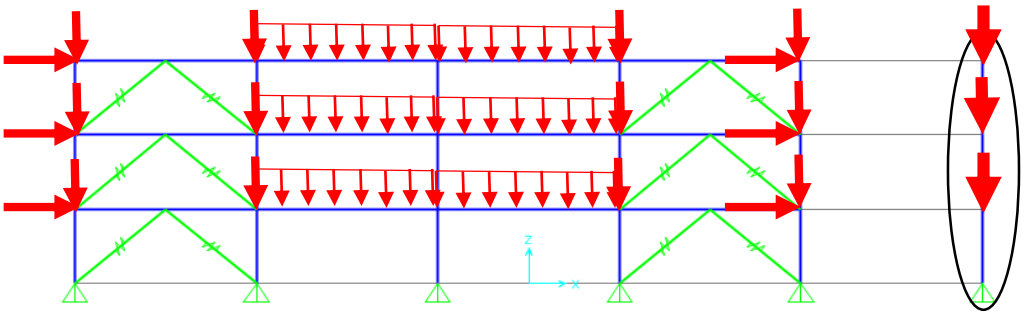

Figure 3-4: Loads applied on the three-story chevron configuration model in SAP2000

3.3.2 Modeling procedure in Perform 3D

Models built in SAP2000 can be exported as Perform3D structures. Those models in Perform 3D keep the same geometry developed in SAP2000. LA3NCh model is chosen to present the modeling procedure in Perform 3D.

In Perform 3D, modeling phase and analysis phase are two major sections. Modeling phase is used to assign the parameters of the model. Analysis phase is used to conduct analysis and show analysis results. Since the model is exported from SAP2000, the library of cross sections is already included in the model. In Perform 3D, properties of the members need to be defined first and then assigned to certain members. "Component properties" under "modeling phase" is used to determine the member properties. Beams and columns are modeled based on the cross section dimensions.

Beams in the braced bays are modeled as inelastic beams. Cross sections of the braced beams are assigned with the dimensions and a 50 ksi yield stress. Inelastic beam component is modeled as "FEMA Beam, Steel Type" based on the cross section assigned previously. "Frame Moment Compound Component" is used to represent the inelastic members. This frame is braced in a chevron configuration, so the BRBs are connected to the middle of the braced beams. Therefore braced beams are modeled in two symmetrical parts. For each part, a release is assigned at the end of the beam which connects to the column.

Beams in the unbraced bays are modeled as elastic beams. Elastic beam component is modeled as "Beam, Steel Type, Nonstandard Section". In "Frame Member Compound Component", releases are assigned at the ends of the elastic beam.

Columns adjacent to bays with bracing are modeled as inelastic columns. Cross sections of the braced columns are assigned with the existing dimensions and a 50 ksi yield stress. Inelastic column component is modeled as “FEMA Column, Steel Type” based on the assigned cross section. “Frame Moment Compound Component” is also used to present the inelastic columns. “Component Type” is “FEMA Column, Steel Type”.

Columns not adjacent to braced bays are modeled as elastic columns. Elastic column component is modeled as “Column, Steel Type, Nonstandard Section”. The ghost column is also modeled as an unbraced column with a cross section dimension exported from SAP2000 model.

The “BRB Compound Component” consists of two “basic components”, “Buckling Restrained Brace” component and “Elastic Bar” component. Elastic bar, which represent the transition part of the BRBs, is modeled as “Linear Elastic Bar” type component with assigned modulus and area. BRB component, which represent the steel yielding , is modeled as trilinear shape of relationship of strain and stress. Basic BRB element properties are shown in Figure 3-5. Elastic bar properties are shown in Figure 3-6. Parameters of Modeling BRB compound components are shown in Figure 3-7. Modeling parameters of the BRBs are provided by CoreBrace LLC. Parameters used in Figure 3-5, 3-6 and 3-7 are those for BRBs of the first story in LA3NCh.

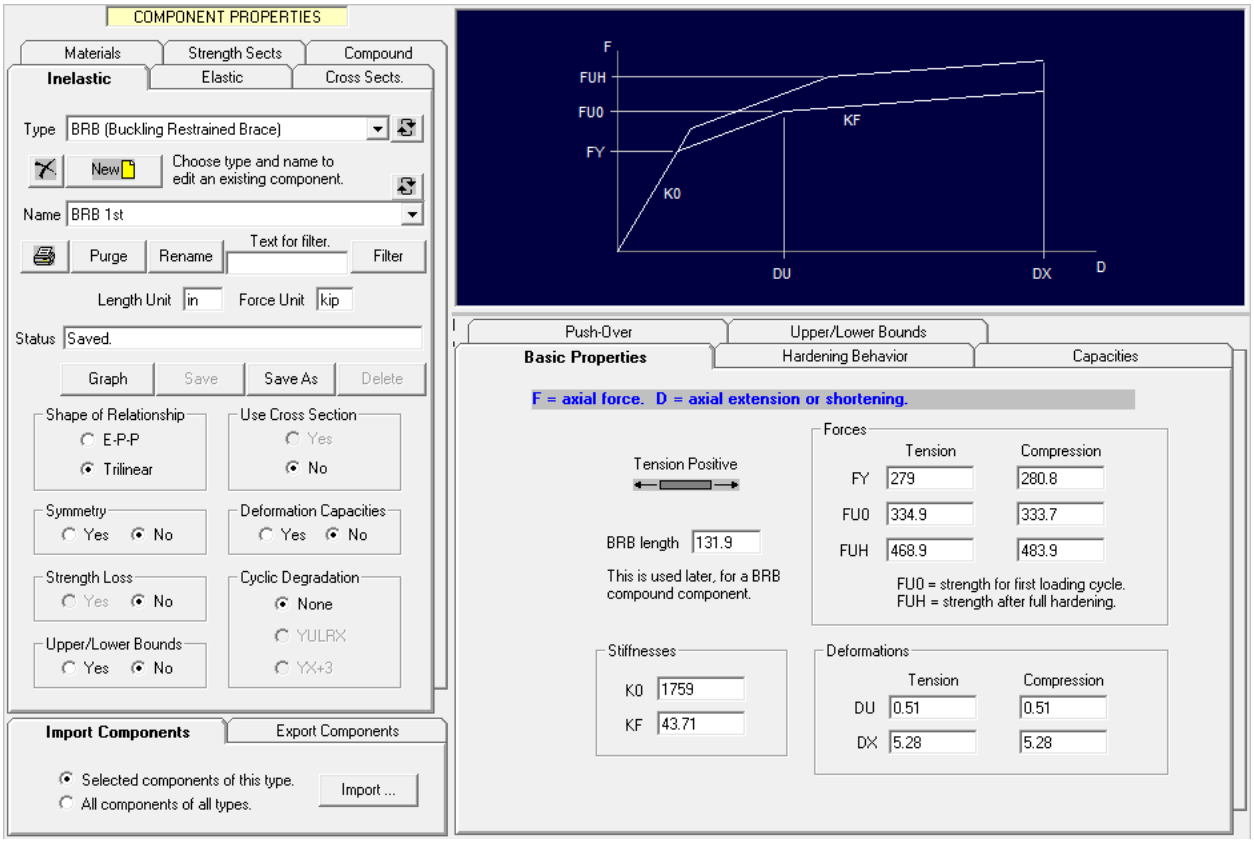

Figure 3-5: Component Properties of BRB at 1st Story in LA3NCh

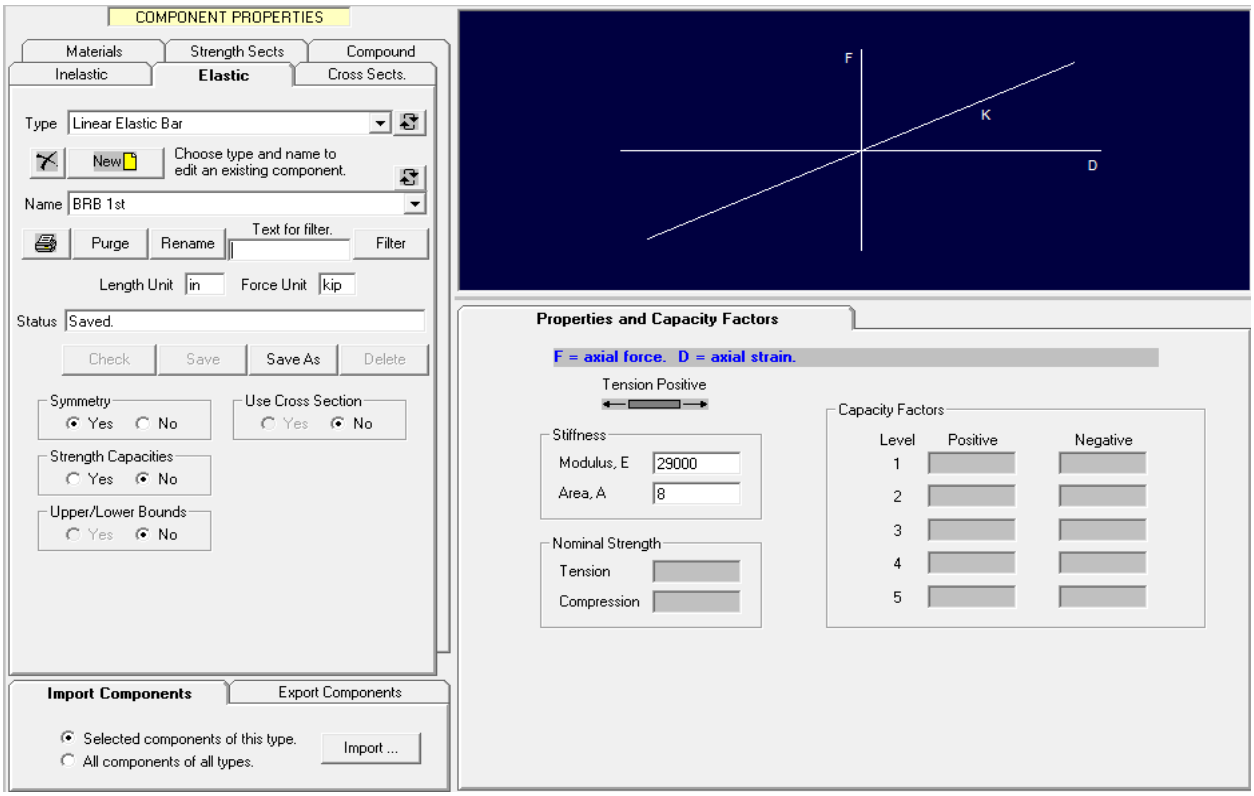

Figure 3-6: Component Properties of Elastic Bar at 1st Story in LA3NCh

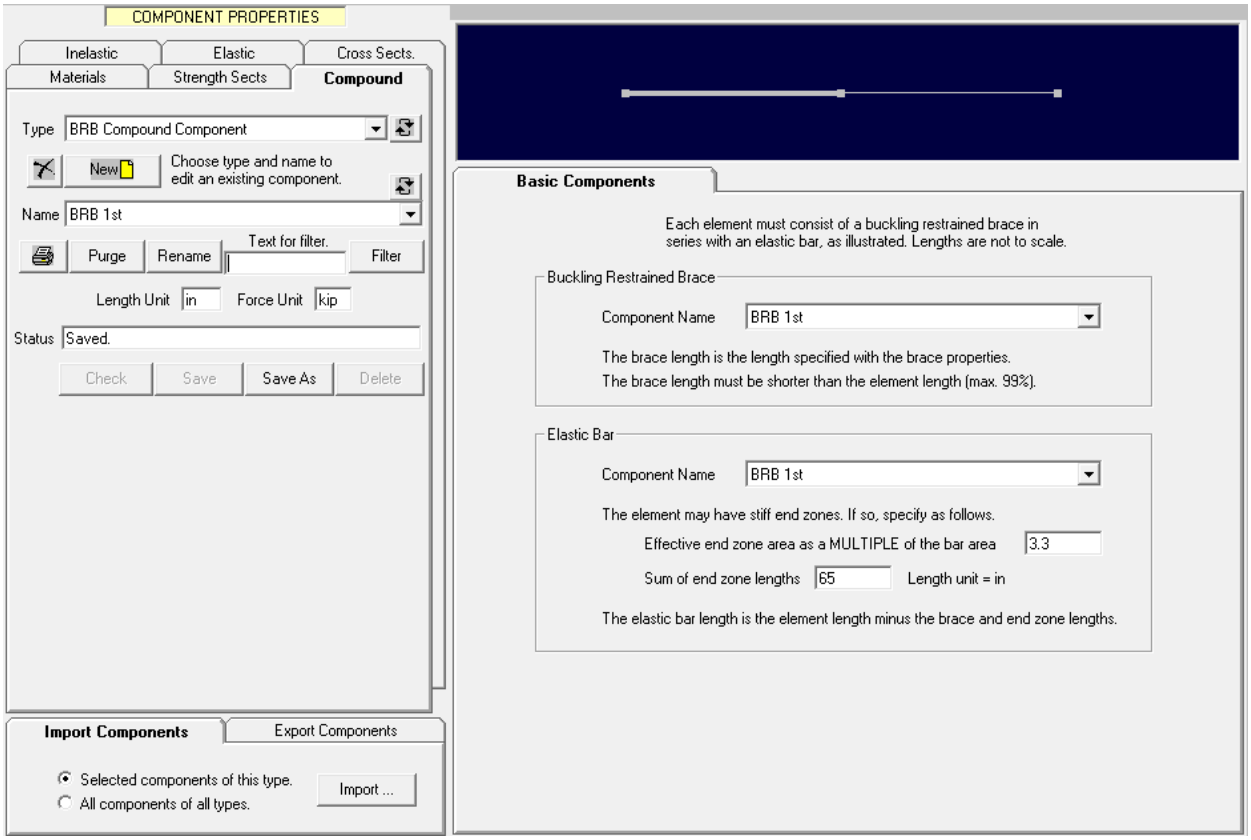

Figure 3-7: Compound Property of BRB at 1st Story in LA3NCh

Joint masses are assigned in the "nodes" section with the same value in SAP2000 models. Nodal supports are also assigned in this section. The frame is pinned at the bottom and all the other nodes are restrained in the out-of-plane direction since this is a 2D frame model. Ghost column is modeled to move with the main frame in "slaving" section. Slaving constraint type is simple equal displacements. Constraints are assigned at each story respectively.

Loads are assigned in the Load patterns section with the same value in SAP2000 models. Concentrated loads are assigned as nodal loads and distributed loads are assigned as element loads. A limit state of 8% maximum story drift is applied in the "limit states" section under the modeling phase. This 8% story drift is chosen to satisfy the collapse limit [Lignos, 2008] [FEMA P695, 2009].

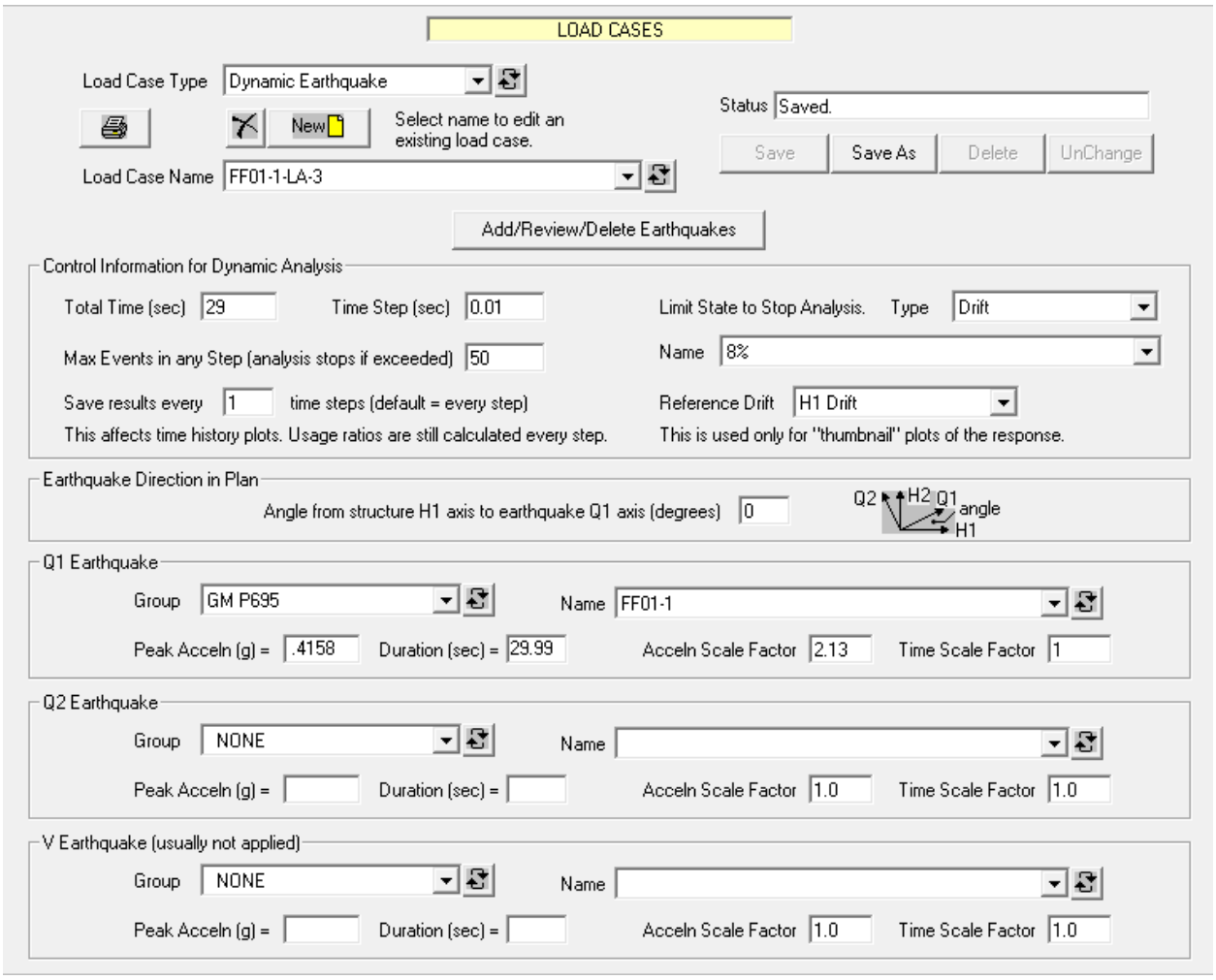

Figure 3-8: Perform 3D Scaled LA01 Load Case for Three-Story LA Model

Load cases are defined in the "set up load cases" section under analysis phase. The gravity load case is defined as D+0.5L. Dynamic Earthquake load cases are defined based on the earthquake record with acceleration scaled factor applied. A limit state of 8% story drift assigned before is chosen to stop the analysis in the "Control Information for Dynamic Analysis" section. Figure 3-8 shows the scaled LA01 load case in Perform 3D for three-story LA model.

Analysis series are set up in the "Run Analysis" section. P-Δ effects are considered. Model damping ratio is set at 2% same damping ratio for all modes. Rayleigh Damping ratio is modeled as small as possible to ensure the BRB absorbs most of the energy. The parameters used to model Rayleigh Damping are shown in Figure 3-9. In the analysis list, each analysis consists of the gravity load case followed by an earthquake load case.

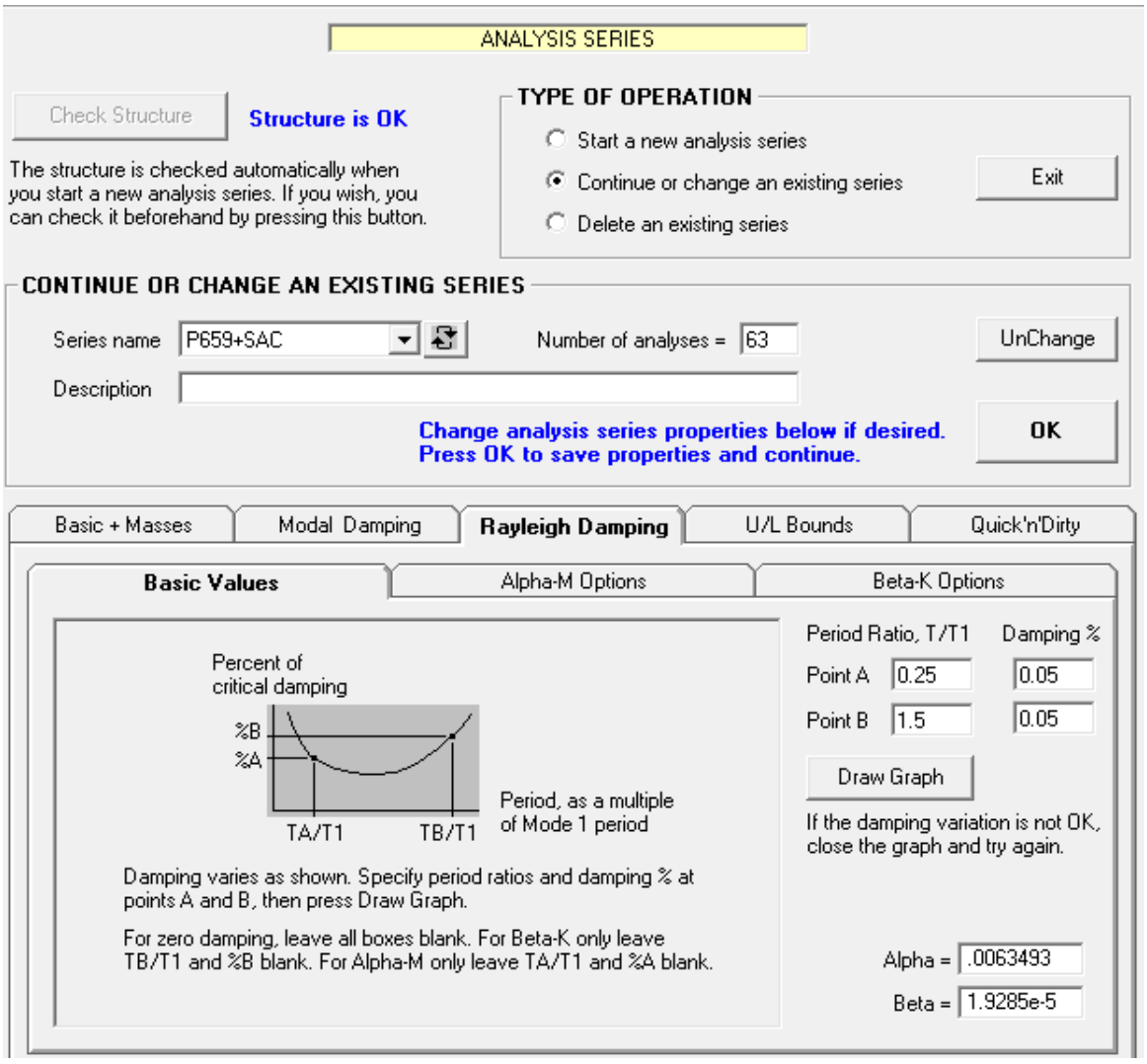

Figure 3-9: Rayleigh Damping Set-up in Perform 3D

3.4 Analysis

Six ground motion suites are run for the models. Earthquake records from the SAC study are built in the SAC ground motion suites [SAC, 1994]. SAC ground motion suites are run on the three-story and six-story models designed for LA. Selected earthquake records from FEMA P695 [FEMA, 2009] study are run on three-story models at LA, three-story models at Riverside, six-story models at LA and six-story models at Riverside. The selected ground motions from FEMA P695 include both the near and far-field sets of ground motions. All the ground motion suites are scaled to the design hazard curve with 2% chance of exceedance in 50 years. The scale factors for the various ground motions are shown in Tables 3-10 and 3-11

Table 3-10: SAC Ground Motion Suite Scale Factors

	LA3	LA6
LA21	0.89	0.85
LA22	1.05	1.04
LA23	2.02	2.05
LA24	1.49	0.99
LA25	1.13	1.02
LA26	1.17	0.88
LA27	1.55	1.48
LA28	0.80	0.85
LA29	1.42	1.43
LA30	1.08	1.05
LA31	0.80	0.91
LA32	0.79	0.85
LA33	1.31	1.20
LA34	1.23	1.17
LA35	1.20	1.08
LA36	1.24	0.91
LA37	N/A	1.10
LA38	N/A	0.93
LA39	N/A	1.57
LA40	N/A	1.29

Table 3-11: FEMA P695 Ground Motion Suite Scale Factors

	LA3	Riv3	LA6	Riv6		LA3	Riv3	LA6	Riv6
FF01-1	2.13	1.49	1.44	1.04	NF09-1	1.14	0.80	0.51	0.58
FF01-2	1.39	0.98	1.46	1.03	NF09-2	1.96	1.38	1.24	1.13
FF02-1	1.91	1.33	3.45	2.47	NF10-1	1.73	1.22	1.40	1.66
FF02-2	2.06	1.45	2.49	2.13	NF10-2	1.13	0.80	0.82	0.82
FF03-1	1.37	0.96	2.05	1.64	NF12-1	2.13	1.86	1.02	0.75
FF03-2	1.65	1.16	1.73	1.43	NF12-2	2.11	1.47	1.14	0.95
FF09-2	2.65	1.86	3.66	2.69	NF15-1	2.16	1.52	1.65	1.31
FF09-2	2.78	1.97	1.67	1.22	NF15-2	1.60	1.13	2.42	1.97
FF16-1	3.42	2.40	3.02	2.19	NF22-1	1.50	1.06	1.43	1.14
FF16-2	4.20	3.00	3.65	2.45	NF22-2	2.26	1.75	2.17	1.74
FF18-1	2.74	1.92	2.46	1.98	NF23-1	1.50	1.05	1.42	1.20
FF18-2	1.43	1.02	2.13	1.72	NF23-2	1.45	1.02	1.65	1.36
FF19-1	3.30	2.88	2.86	2.46	NF24-1	3.22	2.27	3.30	1.90
FF19-2	2.53	1.79	1.77	1.49	NF24-2	1.52	1.07	1.53	1.28
NF02-1	4.20	2.98	2.09	1.69	NF26-1	2.36	1.66	1.46	1.12
NF02-2	2.55	1.79	1.86	1.42	NF26-2	2.08	1.47	1.80	1.34
NF04-1	1.90	1.66	1.05	0.78	NF27-1	0.92	0.81	0.59	0.53
NF04-2	2.72	1.92	2.37	1.66	NF27-2	2.26	1.59	2.06	1.49
NF06-1	2.50	1.75	2.18	1.70	NF28-1	3.36	2.99	1.85	1.34
NF06-2	2.23	1.67	1.32	0.96	NF28-2	2.47	2.16	1.23	0.92
NF07-1	2.14	1.49	2.93	2.50					
NF07-2	1.50	1.04	1.66	1.23					

3.5 Data Collection and Reduction

Data from Perform 3D models can be exported in text files. Nodal displacements, nodal absolute accelerations, axial force in columns, brace forces and brace deformations are all collected.

The results of the three-story buildings with chevron configurations are extracted from BRBs in Group A and Group B shown in Figure 3-12. The results of the three-story buildings with Single Diagonal configuration are extracted from BRBs in Group A and Group B shown in Figure 3-13. Likewise, the result of the six-story building with chevron and single diagonal configuration is extracted from two columns, shown in Figure 3-14 and Figure 3-15 respectively.

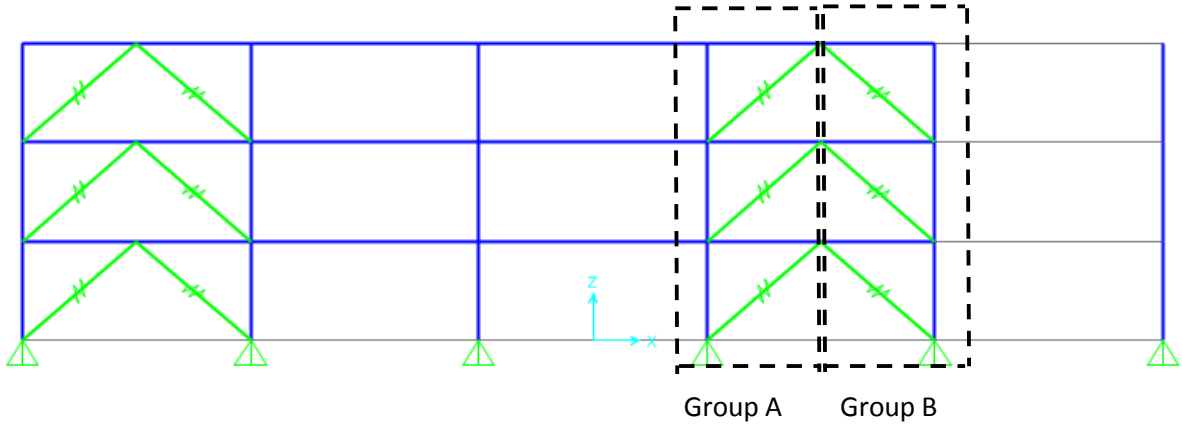

Figure 3-12: Three-Story Chevron Configuration

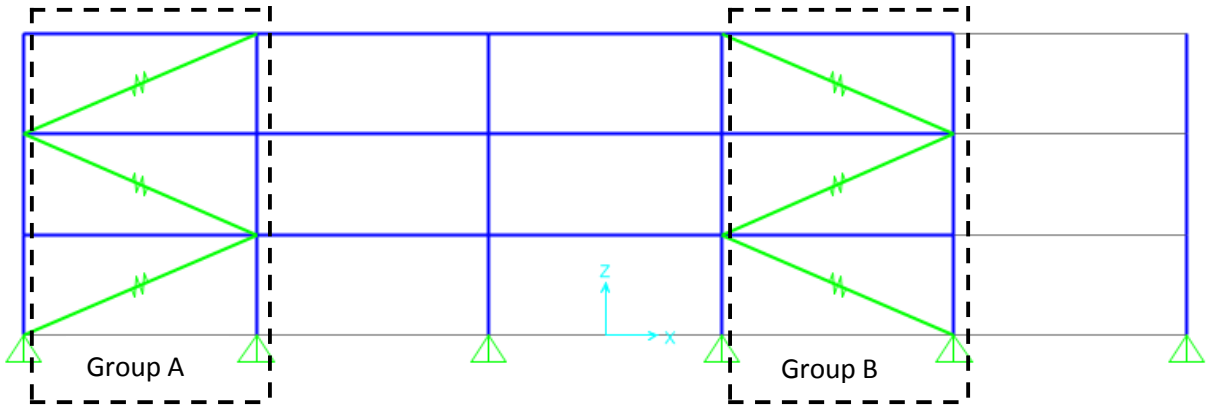

Figure 3-13: Three-Story Single Diagonal Configuration

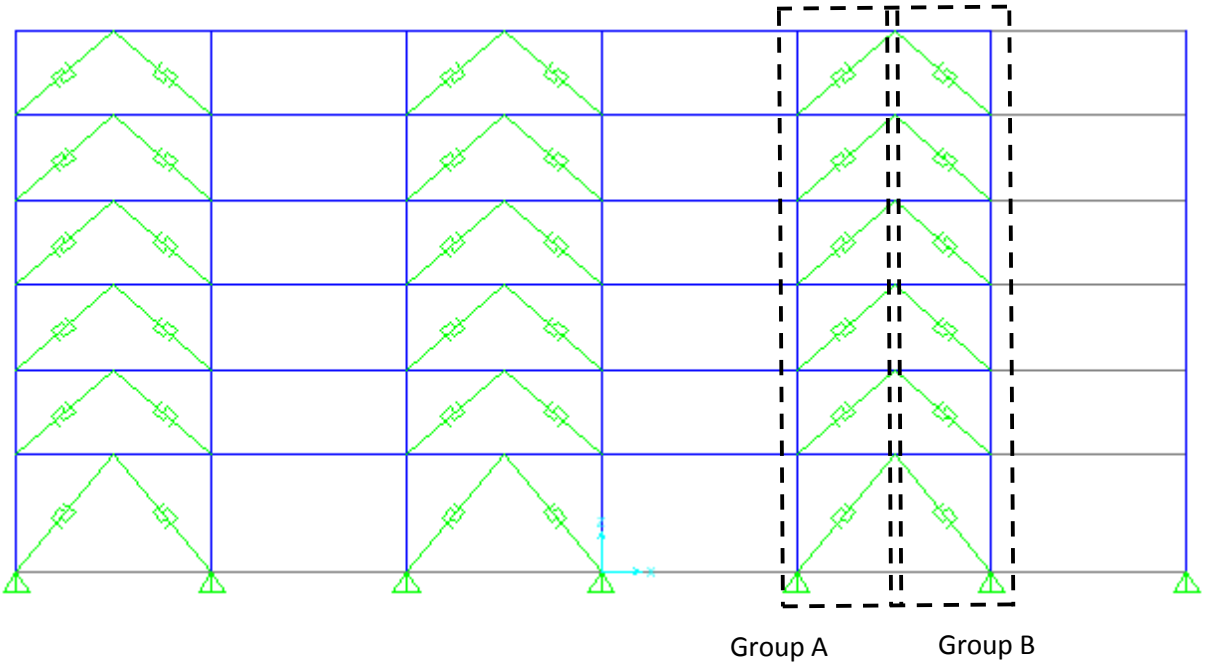

Figure 3-14: Six-Story Chevron Configuration

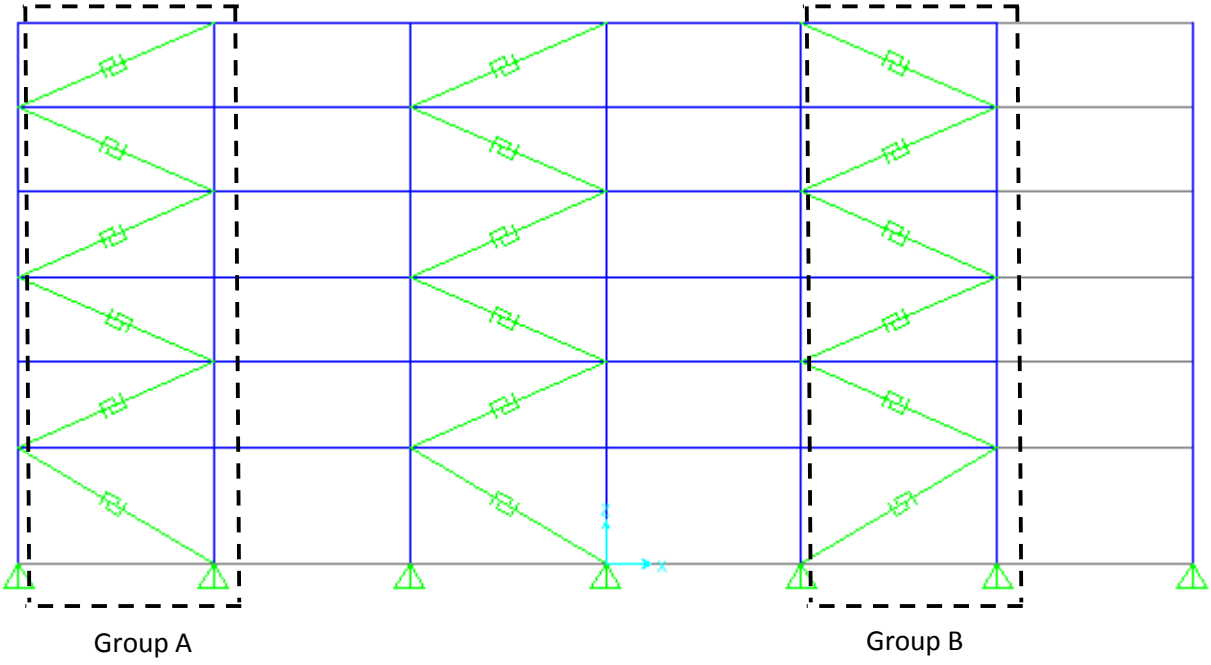

Figure 3-15: Six-Story Single Diagonal Configuration

Data generated from the results include maximum story drift, maximum residual story drift, maximum nodal absolute acceleration, maximum normalized brace force in tension, maximum normalized brace force in compression, maximum brace tensile ductility demand ratio, maximum brace compressive ductility demand ratio, maximum brace strain in tension, maximum brace strain in compression, maximum brace cumulative ductility demand ratio, maximum reference tensile ductility demand ratio, maximum reference compressive ductility demand ratio, maximum column rotation, maximum column stress in tension, maximum column stress in compression and maximum column uplift force.

The max drift is the maximum drift of all the stories. Residual drift measures the story drift remaining in all stories after the earthquake. The max acceleration presents the maximum absolute acceleration which occurs at the roof. Normalized brace force in tension is the brace force divided by the yield force in tension of that brace. Likewise, normalized brace force in compression is the brace force divided by the yield force in compression of that brace. Tensile ductility is calculated with the maximum inelastic displacement of BRB in tension of a single cycle divided by the BRB yield displacement. For the BRB at each story, there is a maximum value of all the cycles. Likewise, compressive ductility is calculated with the maximum inelastic displacement of BRB in compression of a single cycle divided by the BRB yield displacement. The max brace strain is the maximum brace strain of BRBs from all the stories. The cumulative ductility is the summed up ductility of all the hysteresis cycles. The max cumulative ductility is the maximum cumulative ductility of all the stories. Reference tensile ductility is calculated with the maximum tensile displacement divided by the yield displacement of the BRB. Likewise, reference compressive ductility is calculated with maximum compressive displacement divided by the yield displacement of the BRB. Column rotation is calculated with the difference between

the story drift of two adjacent stories. The max column uplift force is the maximum column force at the first story in tension.

Among those results, for each ground motion, the results of BRBs are the maximum value of the results of Group A and Group B. Taking results in this way is sensible because these two sets of the BRBs are symmetrical in configuration. When the BRBs in Group A have the maximum deformation in tension, the BRBs in Group B have the maximum deformation in compression. A single set of the BRBs in one direction may not experience the maximum deformation in both tension and compression during the nonlinear analysis. If only one set of the BRBs is considered, either the maximum value in tension or the maximum value in compression will be missed. In addition, for the results of the columns, we take the maximum result of columns in Group A and Group B. This is because the force on interior columns is generally larger than that of exterior columns due to the difference between the gravity loads on interior and exterior columns. Thus, the maximum compressive force often happens on the interior Column and the maximum tensile force often happens on the exterior column. In order to condense the data analysis process, we take the results of the column from two columns, an interior column (Group A) and an exterior column (Group B).

3.6 Summary

In this chapter, the modeling of the BRB frames is presented. Parameters of the three-story building and the six-story building are provided. Models with variation in BRB stiffness, brace configuration and hazard levels are designed to be analyzed. The BRBs are designed in SAP 2000 using the ELF method. SAP 2000 modeling procedures are introduced. Parameters and methodology for nonlinear dynamic modelingthe BRBs in Perform 3D were provided by the CoreBrace LLC. Perform 3D modeling procedure are introduced. Data collection and reduction were discussed.

Chapter 4 Results and Discussion

4.1 Three-story Perform 3D results

This section provides all the results generated from the Perform 3D models of the three-story buildings. They are: LA3NCh; LA3NCh1.5; LA3SCh; LA3NSD; LA3SSD; Riv3NCh; Riv3NCh1.5; Riv3SCh; Riv3NSD; Riv3SSD

Table 4-1 shows the results of all the three-story models subjected to the FEMA P695 scaled ground motions. For each model, the first row of the results is the mean value of the ground motion suite. The second row of the results is the mean value plus one standard deviation of the ground motion suite. Table 4-2 shows the results of the three-story LA models under the impact of SAC scaled ground motions. Results of each model with individual ground motions are presented in Appendix A.

Table 4-1: Three-Story FEMA P695 Results

		Story Drift	Residual Story Drift	Roof Acceleration (g)	Normalized Brace Force Tension	Normalized Brace Force Compression	Tensile Ductility	Compressive Ductility	Brace Strain in Tension	Brace Strain in Compression	Cumulative Ductility	Reference Tensile Ductility	Reference Compressive Ductility	Column Rotation	Column Stress in Tension (ksi)	Column Stress in Compression (ksi)	Column Uplift Force (kips)
LA3NCh	μ	3.6%	1.26%	1.736	1.918	1.876	24.5	23.4	3.09%	2.78%	102.4	23.6	21.2	1.5%	11.5	19.4	322.9
	μ+σ	5.1%	1.93%	2.060	2.214	2.142	36.1	35.0	4.48%	4.03%	167.0	34.2	30.8	2.0%	13.7	21.6	386.0
LA3NCh1.5	μ	2.7%	1.07%	1.861	1.715	1.683	18.0	17.0	2.34%	2.10%	67.3	17.9	16.0	1.2%	16.3	24.2	459.0
	μ+σ	3.7%	1.62%	2.251	1.916	1.866	26.6	25.3	3.31%	3.01%	102.6	25.3	23.0	1.7%	17.7	25.7	499.4
LA3SCh	μ	2.6%	0.44%	1.891	2.400	2.344	38.8	37.8	4.21%	3.88%	178.7	32.1	29.6	1.1%	14.7	22.7	414.4
	μ+σ	3.5%	0.62%	2.221	2.837	2.754	56.3	55.0	5.78%	5.36%	277.6	44.1	40.9	1.4%	17.9	25.9	505.7
LA3NSD	μ	3.9%	1.81%	1.601	1.714	1.713	15.6	15.5	2.02%	2.02%	64.7	15.4	15.4	1.7%	19.4	29.7	547.0
	μ+σ	5.7%	2.90%	1.893	1.950	1.949	22.9	22.8	2.98%	2.97%	103.5	22.7	22.7	2.3%	22.9	33.0	645.0
LA3SSD	μ	2.5%	0.48%	2.151	2.330	2.337	36.1	35.8	3.89%	3.89%	164.5	29.7	29.7	1.1%	27.7	37.7	780.8
	μ+σ	3.4%	0.65%	2.524	2.733	2.745	53.0	52.7	5.40%	5.40%	252.6	41.2	41.2	1.4%	33.6	43.0	946.3
Riv3NCh	μ	3.0%	1.20%	1.161	1.797	1.770	21.0	20.1	2.57%	2.35%	85.1	19.6	18.0	1.3%	7.9	15.9	222.6
	μ+σ	4.4%	1.93%	1.414	2.138	2.086	36.1	34.7	4.39%	4.04%	155.3	33.5	30.8	1.8%	9.8	17.7	275.0
Riv3NCh1.5	μ	2.2%	0.91%	1.309	1.595	1.572	14.1	13.3	1.85%	1.68%	52.4	14.1	12.8	1.0%	11.5	19.5	323.3
	μ+σ	3.2%	1.45%	1.567	1.789	1.753	21.8	21.0	2.78%	2.53%	91.6	21.2	19.3	1.5%	12.8	20.8	360.2
Riv3SCh	μ	2.2%	0.52%	1.230	2.224	2.180	33.2	32.3	3.75%	3.47%	154.1	28.6	26.5	1.0%	9.7	17.8	274.9
	μ+σ	3.4%	0.81%	1.456	2.701	2.627	53.1	51.9	5.79%	5.38%	272.3	44.2	41.0	1.4%	12.5	20.5	351.7
Riv3NSD	μ	3.2%	1.50%	1.116	1.596	1.601	12.6	12.6	1.62%	1.61%	51.0	12.3	12.3	1.4%	13.1	23.5	369.2
	μ+σ	5.0%	2.70%	1.332	1.842	1.850	20.3	20.2	2.53%	2.53%	90.5	19.3	19.3	1.9%	16.0	26.3	450.2
Riv3SSD	μ	2.2%	0.49%	1.519	2.144	2.151	30.1	30.0	3.34%	3.34%	140.3	25.5	25.5	0.9%	18.8	28.8	529.5
	μ+σ	3.1%	0.69%	1.806	2.573	2.577	47.4	47.4	4.87%	4.85%	247.8	37.2	37.0	1.3%	23.9	33.8	674.1

Table 4-2: Three-Story SAC Results

		Story Drift	Residual Story Drift	Roof Acceleration (g)	Normalized Brace Force Tension	Normalized Brace Force Compression	Tensile Ductility	Compressive Ductility	Brace Strain in Tension	Brace Strain in Compression	Cumulative Ductility	Reference Tensile Ductility	Reference Compressive Ductility	Column Rotation	Column Stress in Tension (ksi)	Column Stress in Compression (ksi)	Column Uplift Force (kips)
LA3NCh	μ	3.9%	1.23%	1.896	2.023	1.981	29.5	28.3	3.37%	3.03%	110.4	25.7	23.1	1.6%	12.2	20.1	344.0
	μ+σ	5.2%	1.99%	2.124	2.314	2.247	46.1	44.5	4.56%	4.12%	147.5	34.8	31.4	2.2%	14.0	21.8	395.2
LA3NCh1.5	μ	3.3%	1.29%	2.078	1.898	1.857	23.8	22.3	2.92%	2.51%	88.0	22.3	19.2	1.5%	17.5	25.4	493.0
	μ+σ	4.3%	1.90%	2.395	2.125	2.065	33.4	31.6	3.88%	3.41%	123.2	29.6	26.1	1.9%	19.6	27.4	551.5
LA3SCh	μ	3.1%	0.35%	2.112	2.699	2.625	47.1	46.4	5.05%	4.61%	204.3	38.5	35.2	1.3%	16.8	24.8	474.6
	μ+σ	4.1%	0.51%	2.373	3.230	3.118	68.7	67.1	6.88%	6.29%	265.1	52.5	48.0	1.7%	20.8	28.7	585.5
LA3NSD	μ	4.3%	1.93%	1.691	1.756	1.766	18.4	18.4	2.22%	2.21%	71.9	16.9	16.8	1.9%	20.5	31.0	579.0
	μ+σ	5.9%	3.10%	1.956	1.973	1.997	28.6	28.6	3.11%	3.10%	94.6	23.8	23.7	2.4%	23.8	34.1	670.9
LA3SSD	μ	3.0%	0.34%	2.253	2.597	2.625	43.9	43.7	4.60%	4.59%	194.8	35.1	35.0	1.3%	32.4	42.0	914.3
	μ+σ	4.1%	0.53%	2.502	3.069	3.129	64.9	64.7	6.21%	6.28%	258.3	47.4	47.9	1.7%	39.4	47.6	1110.4

The mean values of maximum story drift at each level of the three-story models at LA and Riverside are presented in Figure 4-1 and Figure 4-2 respectively. Story drift results of each model with mean value minus standard deviation and mean value plus standard deviation of each story are presented in Appendix B.

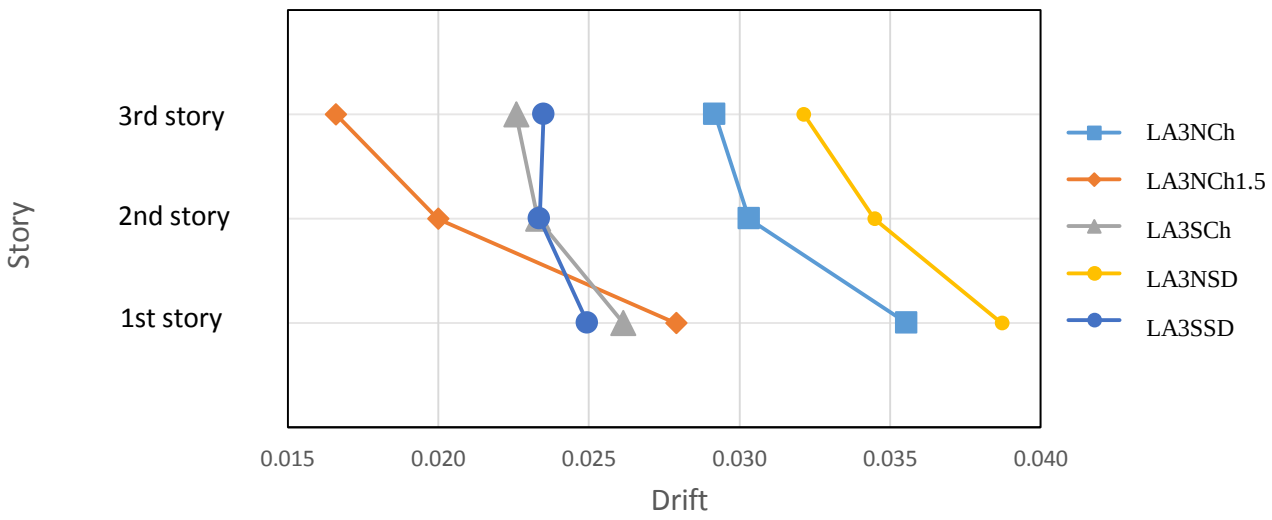

Figure 4-1: Mean Story Drift for the Three-Story LA Models

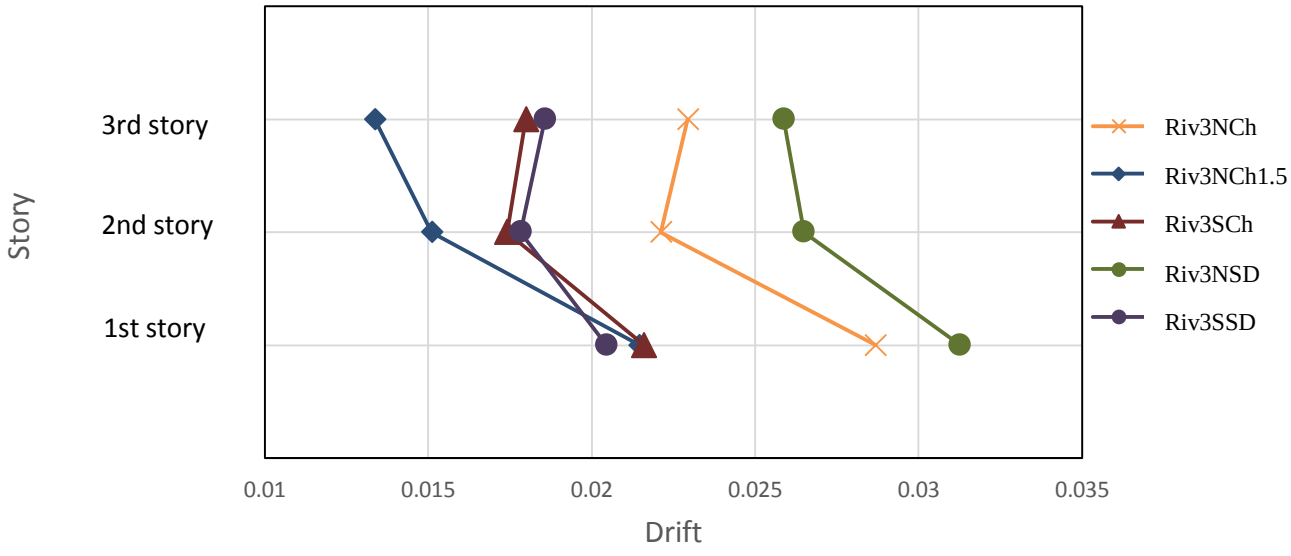

Figure 4-2: Mean Story Drift for the Three-Story Riverside Models

FEMA P695 Ground Motion FF19-2 and the LA3 models are chosen here to show how all the models behave under the same ground motion and how the results are generated under a certain ground motion. FF19-2 is chosen because of the relatively larger roof displacement and relatively more cycles of the BRBs' hysteresis loops. Roof displacement represents the frame behaviors and hysteresis loops can represent the BRB behavior. The hysteresis loops of each story are taken from the BRBs of Group B in Figure 3-12 and Figure 3-13.

The plot of roof displacement versus time for the selected three-story LA models is presented in Figures 4-3, 4-5, 4-7, 4-9 and 4-11. The plot of BRB hysteresis loops are presented in Figures 4-4, 4-6, 4-8, 4-10 and 4-12.

Similarity in the shape of roof displacement of the three-story LA models subjected to FF19-2 record can be seen in Figures 4-5, 4-7, 4-9, 4-11 and 4-13. Maximum values occur around 40 seconds into the record. However, it is apparent that the maximum roof displacement is significantly reduced in models with shortened yield length BRBs. For example, the maximum roof displacement of LA3NCh in Figure 4-3 is around 25 in. while the maximum roof displacement of LA3SCh in Figure 4-7 is around 11 in. The maximum roof displacement of LA3NSD in Figure 4-9 is around 32 in. while the maximum roof displacement of LA3SSD in Figure 4-11 is around 11 in. In addition, the maximum roof displacement of LA3NCh1.5 is also reduced significantly. Moreover, the residual drift also shows dramatic variety in those models. Models with normal yield length of BRBs have a range of residual roof displacement from 8 in. to 12 in. However, models with shortened yield length of BRBs have a residual displacement around 1 in.

It can be seen that all the three-story models have significant yielding behavior in the BRB hysteresis loops in Figure 4-4, 4-6, 4-8, 4-10 and 4-12. That means energy dissipation is distributed to all the stories. Also, it can be seen that the similarity of the shape of hysteresis

loops between LA3NCh and LA3SCh and the similarity between LA3NSD and LA3SSD. However, the deformation of shortened yield length BRBs is reduced significantly.

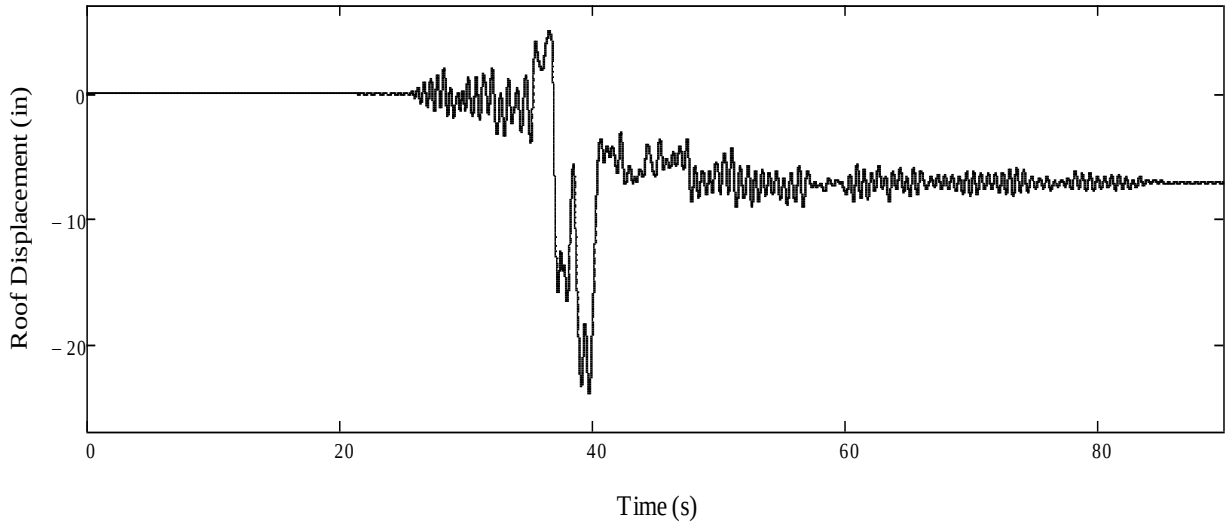

Figure 4-3: Roof Displacement for LA3NCh (FEMA P695 FF19-2)

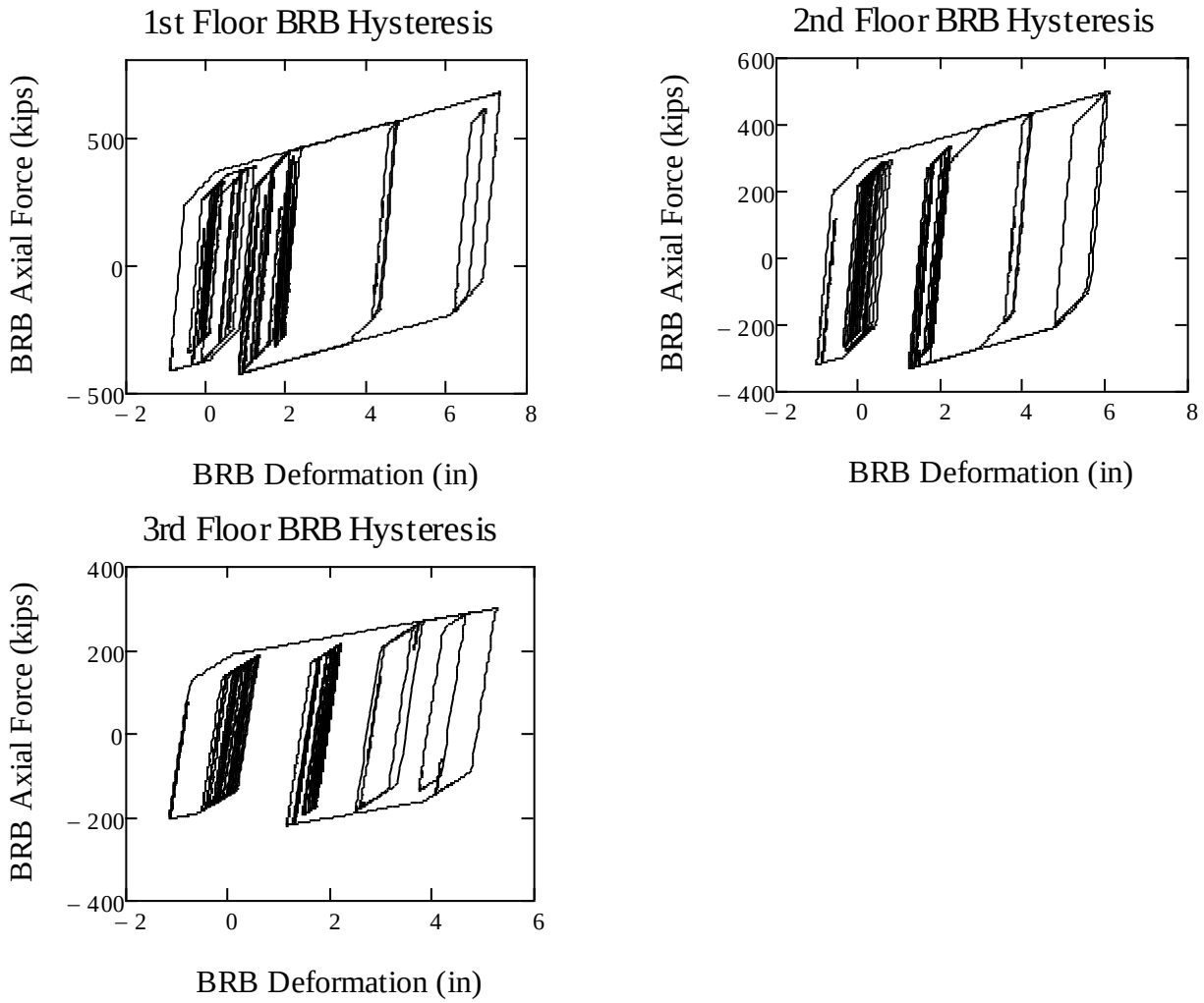

Figure 4-4: BRB Hysteresis Loops for LA3NCh (FEMA P695 FF19-2)

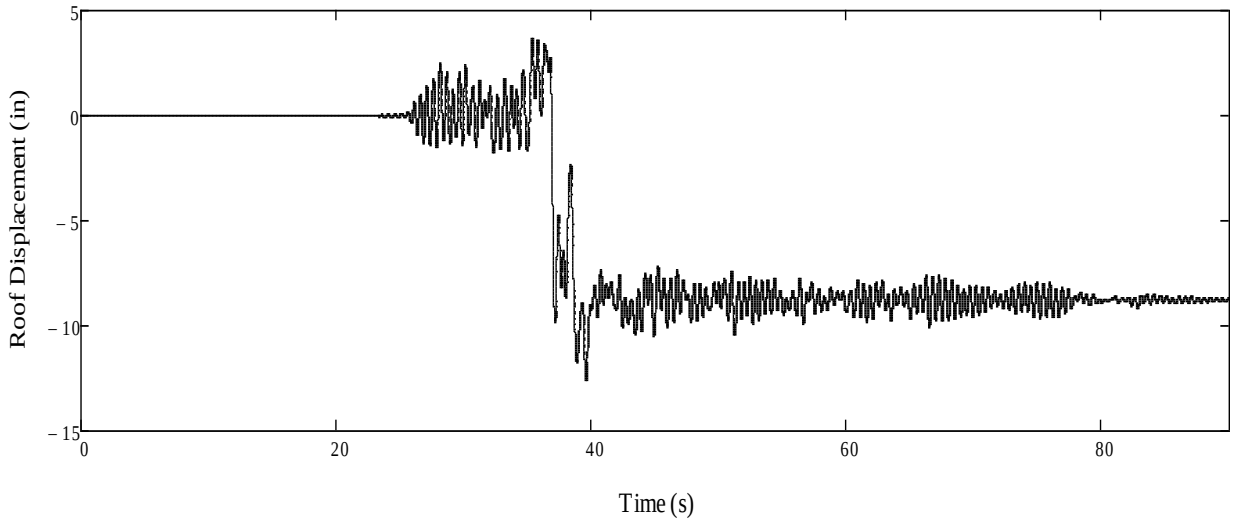

Figure 4-5: Roof Displacement for LA3NCh1.5 (FEMA P695 FF19-2)

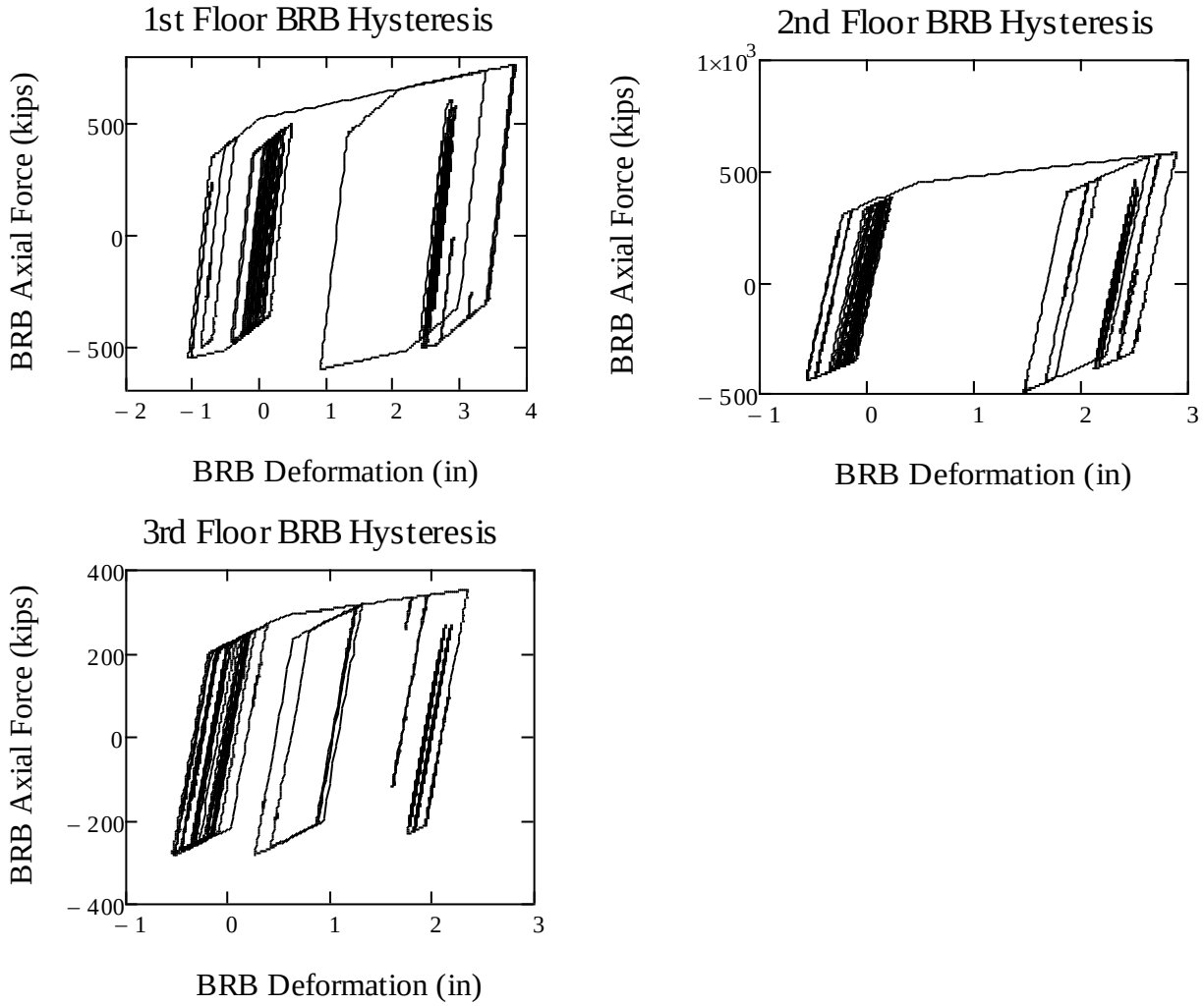

Figure 4-6: BRB Hysteresis Loops for LA3NCh1.5 (FEMA P695 FF19-2)

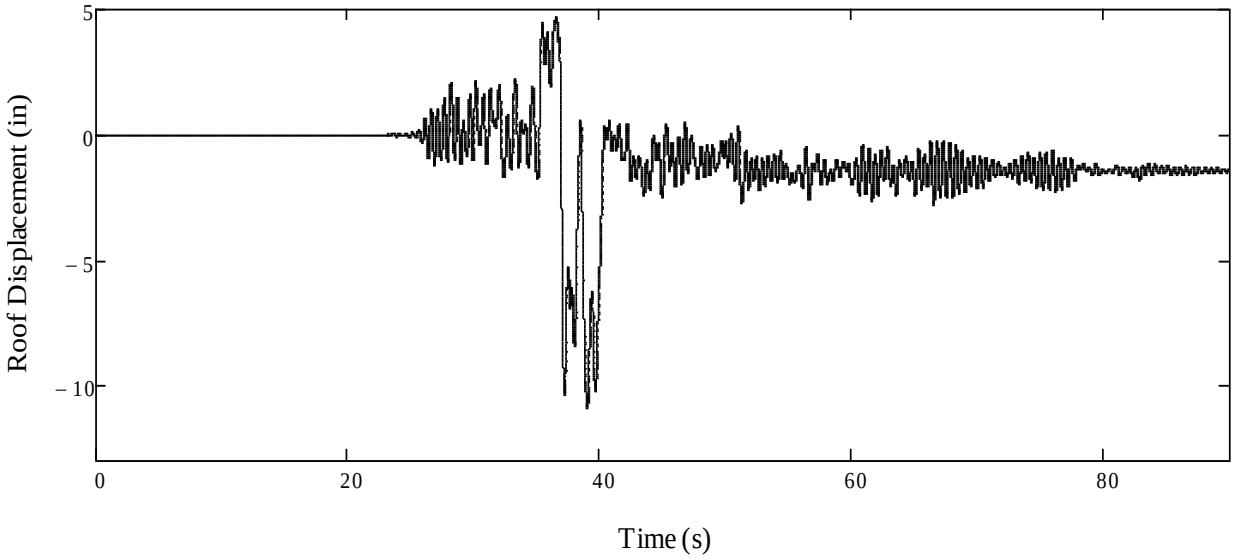

Figure 4-7: Roof Displacement for LA3SCh (FEMA P695 FF19-2)

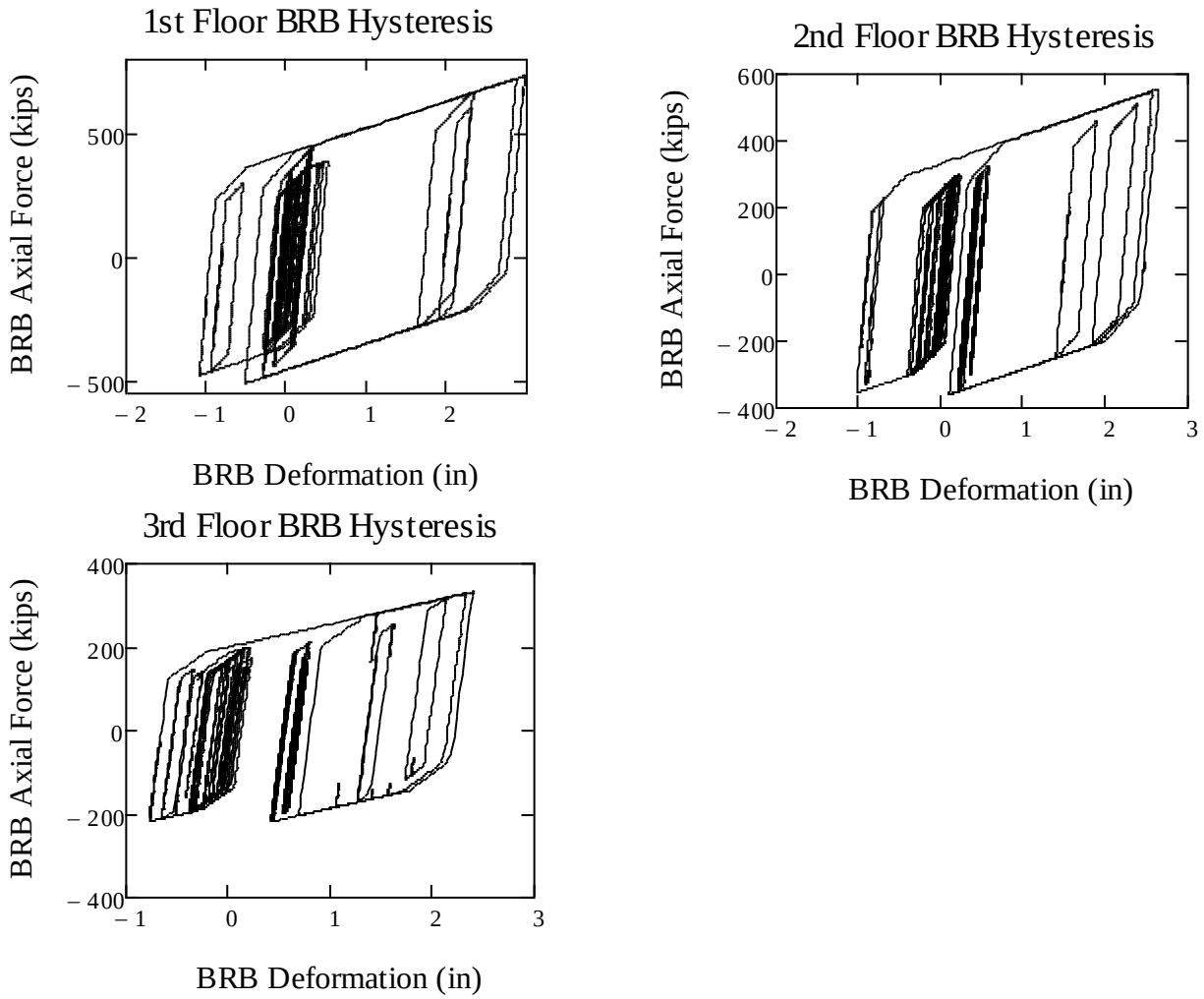

Figure 4-8: BRB Hysteresis Loops for LA3SCh (FEMA P695 FF19-2)

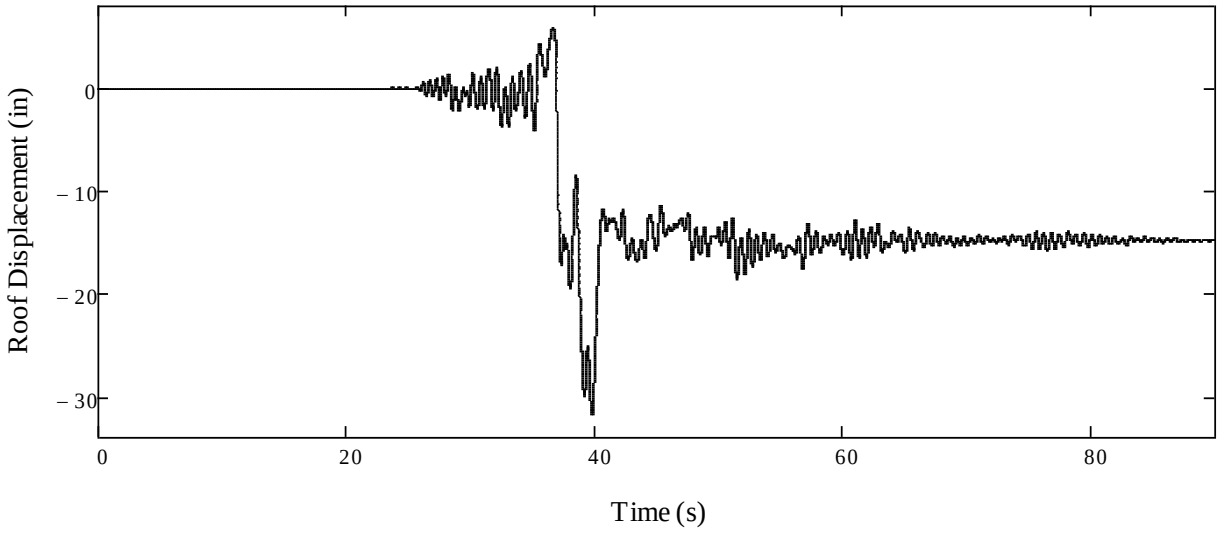

Figure 4-9: Roof Displacement for LA3NSD (FEMA P695 FF19-2)

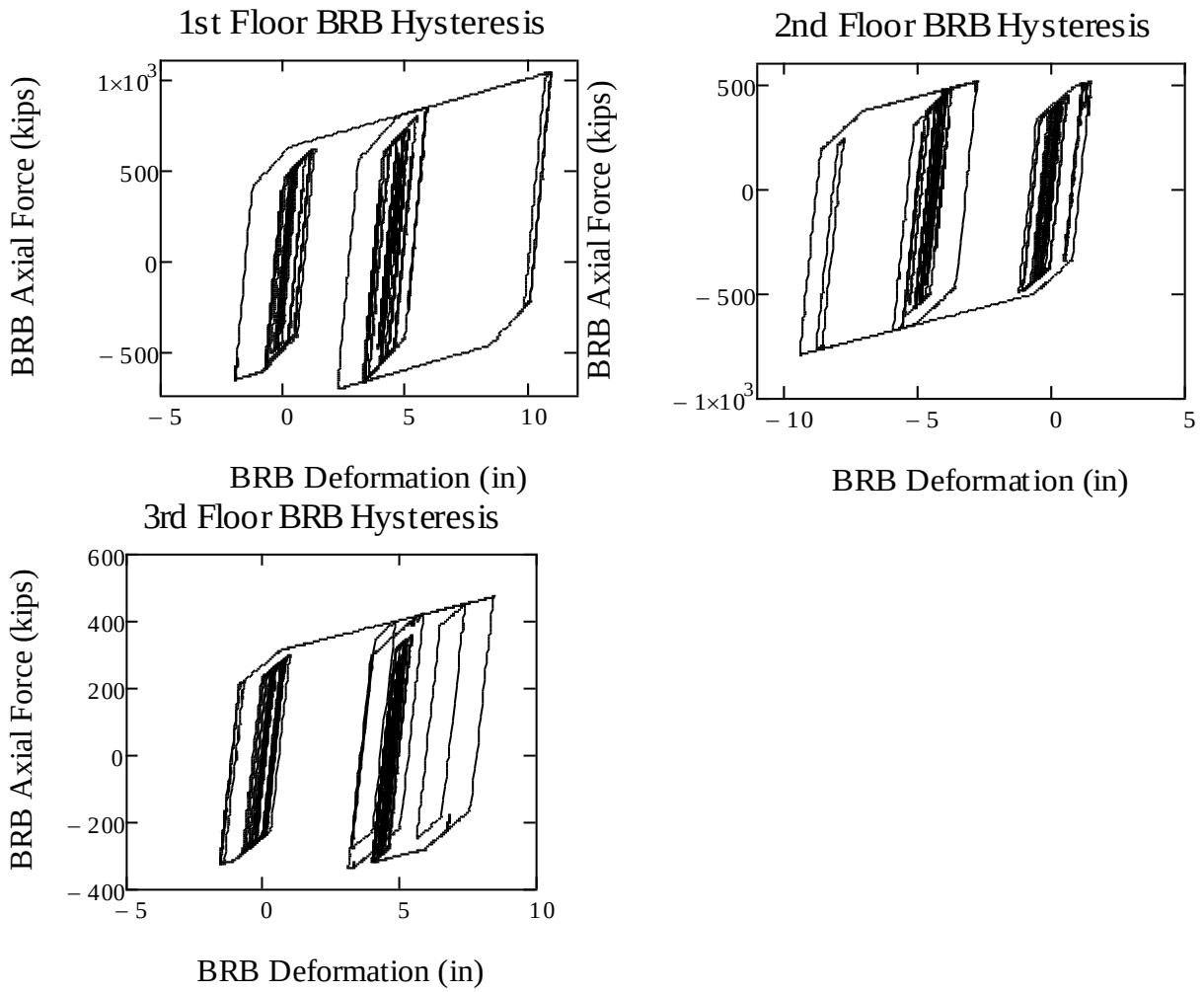

Figure 4-10: BRB Hysteresis Loops for LA3NSD (FEMA P695 FF19-2)

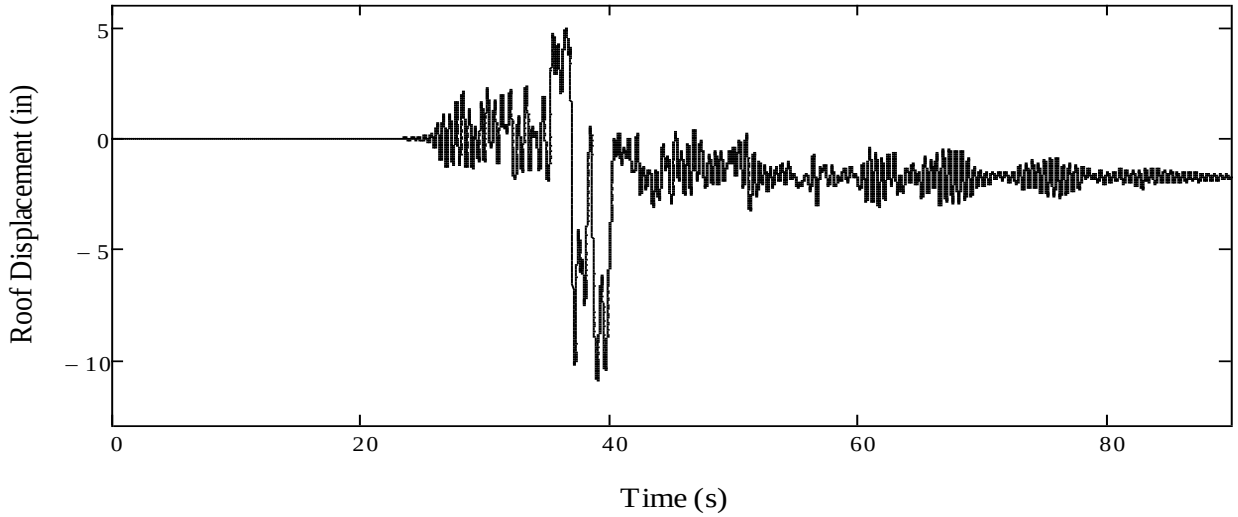

Figure 4-11: Roof Displacement for LA3SSD (FEMA P695 FF19-2)

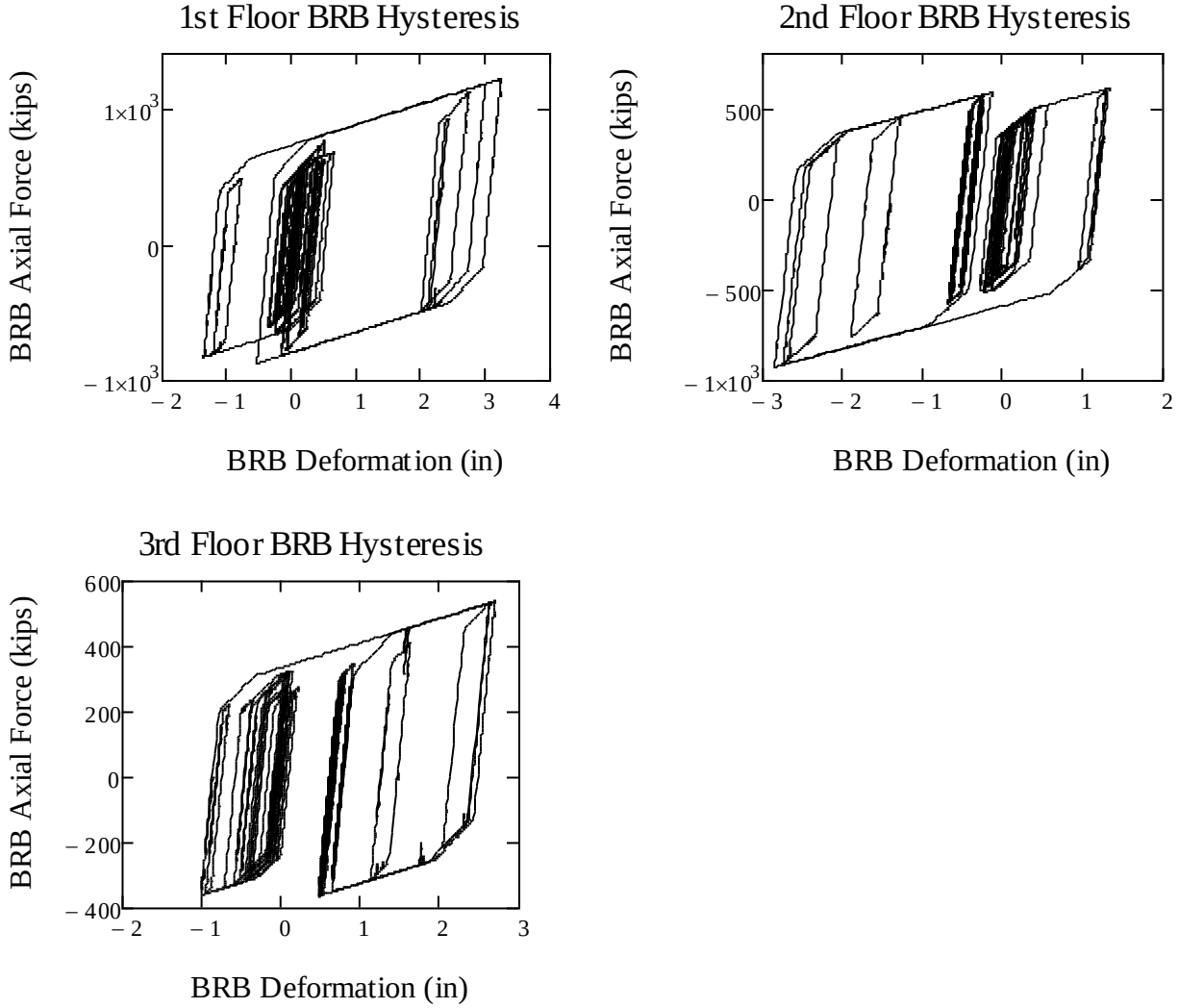

Figure 4-12: BRB Hysteresis Loops for LA3SSD (FEMA P695 FF19-2)

Overstrength factors (maximum force demand normalized by the yield force) and maximum strain of the BRBs in the time-history analyses are desirable. Figure 4-13 and 4-14 show the plots of overstrength factor vs. brace strain of all the three-story models. Results are taken from BRBs from all the 3 levels of Group A and Group B, which are mentioned previously in Figure 3-12 and 3-13. For each model and each earthquake the maximum tension and compression value are shown in the plots.

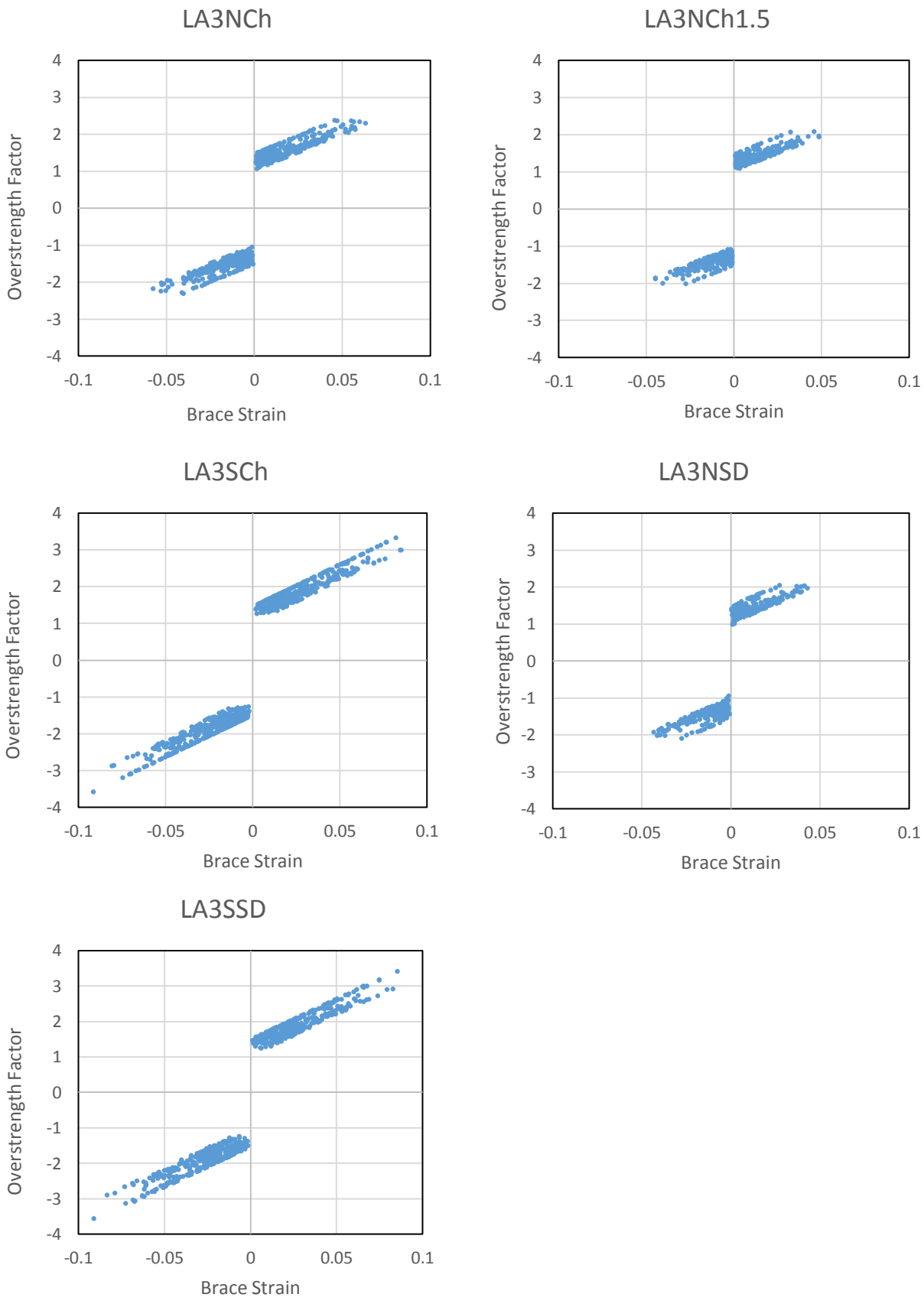

Figure 4-13: Plots of Overstrength Factor vs. Brace Strain of the Three-Story LA Models

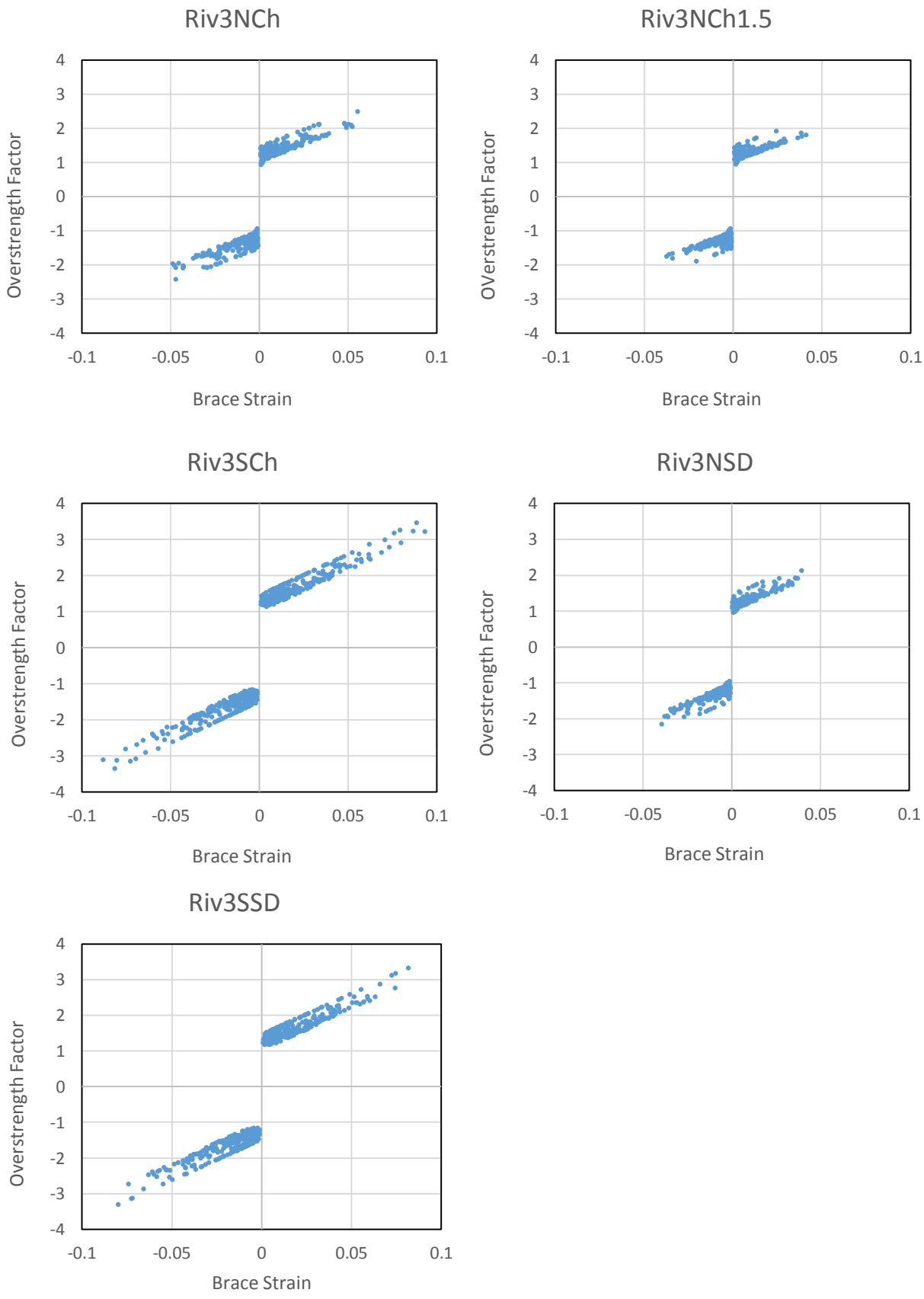

Figure 4-14: Plots of Overstrength Factors vs. Brace Strain of the Three-Story Riverside Models

4.2 Six-story Perform 3D Results

This section provides all the results generated from the Perform 3D models of the six-story buildings. They are: LA6NCh; LA6NCh1.5; LA6SCh; LA6NSD; LA6SSD; Riv6NCh; Riv6NCh1.5; Riv6SCh; Riv6NSD; Riv6SSD

The results of the buildings with chevron configuration are extracted from BRBs in Group A and Group B shown in Figure 3-10. The results of the buildings with single diagonal configuration are extracted from BRBs in Group A and Group B shown in Figure 3-11.

Table 4-3 shows the results of all the ten six-story models under the impact of FEMA P695 scaled ground motions. Table 4-4 shows the results of the six-story models at LA under the impact of SAC scaled ground motions. Results of each model with individual ground motions are presented in Appendix A.

Table 4-3: Six-Story FEMA P695 Results

		Story Drift	Residual Story Drift	Roof Acceleration (g)	Normalized Brace Force Tension	Normalized Brace Force Compression	Tensile Ductility	Compressive Ductility	Brace Strain in Tension	Brace Strain in Compression	Cumulative Ductility	Reference Tensile Ductility	Reference Compressive Ductility	Column Rotation	Column Stress in Tension (ksi)	Column Stress in Compression (ksi)	Column Uplift Force (kips)
LA6NCh	μ	3.6%	0.94%	0.854	1.902	1.880	23.0	22.4	2.55%	2.32%	108.2	19.5	17.7	1.1%	4.5	11.2	277.4
	μ+σ	5.1%	1.55%	1.096	2.202	2.162	35.5	35.0	3.67%	3.33%	170.3	28.0	25.4	1.5%	5.6	12.2	344.6
LA6NCh1.5	μ	3.1%	1.02%	0.952	1.822	1.797	20.6	19.9	2.28%	2.05%	89.7	17.4	15.6	1.0%	6.8	13.5	418.9
	μ+σ	4.3%	1.59%	1.258	2.062	2.018	29.6	29.2	3.18%	2.86%	140.6	24.3	21.8	1.3%	8.0	14.7	497.7
LA6SCh	μ	3.3%	0.81%	0.912	2.245	2.211	57.5	56.4	5.72%	5.15%	269.3	43.6	39.3	1.1%	5.3	12.0	330.5
	μ+σ	4.6%	1.25%	1.210	2.603	2.538	87.3	86.4	8.25%	7.44%	425.4	62.9	56.8	1.4%	6.7	13.4	413.0
LA6NSD	μ	3.5%	1.15%	0.979	1.729	1.739	17.3	17.2	1.96%	1.95%	82.0	14.9	14.9	1.1%	2.4	10.6	148.3
	μ+σ	5.1%	2.02%	1.271	1.977	1.987	26.8	26.8	2.85%	2.84%	129.4	21.8	21.7	1.5%	3.2	11.4	199.0
LA6SSD	μ	2.9%	0.40%	1.172	2.617	2.633	47.4	47.2	4.80%	4.78%	247.5	36.6	36.5	1.0%	9.4	13.6	581.0
	μ+σ	4.2%	0.66%	1.493	3.215	3.225	68.8	68.5	7.02%	6.97%	380.7	53.6	53.2	1.2%	12.2	16.4	753.7
Riv6NCh	μ	3.3%	1.73%	0.640	1.810	1.793	19.3	18.6	2.36%	2.19%	84.9	18.0	16.7	1.0%	3.1	9.8	193.0
	μ+σ	4.8%	3.10%	0.824	2.095	2.058	29.5	28.7	3.47%	3.19%	136.8	26.5	24.4	1.4%	3.9	10.6	243.8
Riv6NCh1.5	μ	2.7%	0.83%	0.729	1.732	1.718	17.5	16.9	1.99%	1.82%	76.6	15.2	13.9	1.0%	5.1	18.7	308.0
	μ+σ	3.7%	1.39%	0.959	1.946	1.920	25.2	24.8	2.72%	2.48%	119.6	20.8	19.0	1.2%	6.1	20.2	367.1
Riv6SCh	μ	2.5%	0.46%	0.738	2.412	2.367	39.8	39.2	4.21%	3.92%	185.7	32.1	30.0	0.8%	4.9	11.6	303.3
	μ+σ	3.5%	0.70%	0.974	2.900	2.822	58.2	57.8	6.05%	5.62%	290.1	46.2	42.9	1.0%	6.3	13.1	392.9
Riv6NSD	μ	3.0%	1.01%	0.757	1.628	1.634	14.0	14.1	1.65%	1.65%	69.9	12.6	12.6	1.0%	0.8	9.1	52.1
	μ+σ	4.4%	1.86%	1.004	1.849	1.858	22.0	22.0	2.43%	2.42%	113.4	18.5	18.5	1.3%	1.4	9.6	86.9
Riv6SSD	μ	2.6%	0.29%	0.886	2.292	2.285	42.7	42.6	4.29%	4.29%	220.0	32.8	32.7	0.8%	5.3	10.4	330.6
	μ+σ	3.9%	0.48%	1.148	2.865	2.866	62.7	62.6	6.35%	6.35%	337.1	48.4	48.4	1.1%	7.3	12.3	454.0

Table 4-4: Six-Story SAC Results

		Story Drift	Residual Story Drift	Roof Acceleration (g)	Normalized Brace Force Tension	Normalized Brace Force Compression	Tensile Ductility	Compressive Ductility	Brace Strain in Tension	Brace Strain in Compression	Cumulative Ductility	Reference Tensile Ductility	Reference Compressive Ductility	Column Rotation	Column Stress in Tension (ksi)	Column Stress in Compression (ksi)	Column Uplift Force (kips)
LA6NCh	μ	4.8%	1.22%	0.893	2.139	2.095	31.7	30.6	3.45%	3.16%	108.1	26.4	24.1	1.5%	5.3	12.0	326.9
	μ+σ	6.8%	1.94%	1.011	2.445	2.373	43.0	42.0	4.83%	4.41%	137.4	36.8	33.7	1.9%	6.4	13.0	396.3
LA6NCh1.5	μ	4.2%	1.18%	1.060	2.053	2.007	29.8	28.7	3.18%	2.84%	96.6	24.3	21.7	1.4%	7.7	14.3	475.3
	μ+σ	5.8%	1.86%	1.254	2.335	2.264	41.9	41.3	4.37%	3.93%	121.9	33.3	30.0	1.7%	9.0	15.7	558.3
LA6SCh	μ	4.4%	0.86%	0.953	2.498	2.435	78.7	77.1	7.70%	7.02%	275.8	58.7	53.6	1.5%	6.2	12.9	381.8
	μ+σ	6.0%	1.18%	1.087	2.875	2.776	106.3	105.0	10.62%	9.68%	348.0	81.0	73.9	1.8%	7.5	14.2	467.8
LA6NSD	μ	5.1%	1.65%	1.030	1.936	1.948	24.2	24.1	2.80%	2.79%	82.6	21.4	21.3	1.6%	2.9	11.1	178.0
	μ+σ	7.1%	2.72%	1.163	2.203	2.210	33.4	33.3	3.93%	3.91%	103.7	30.0	29.9	2.1%	3.6	11.8	221.8
LA6SSD	μ	4.2%	0.41%	1.273	3.186	3.195	64.4	64.0	6.87%	6.84%	254.2	52.4	52.2	1.4%	10.5	15.7	653.8
	μ+σ	6.2%	0.58%	1.468	4.014	4.008	85.9	85.4	10.09%	10.00%	311.3	77.0	76.3	1.8%	13.6	18.9	841.1

The mean of maximum story drift at each level of the six-story models at LA and Riverside are presented in Figure 4-27 and Figure 4-28 respectively. Story drift results of each model with mean value minus standard deviation and mean value plus standard deviation of each story are presented in Appendix B.

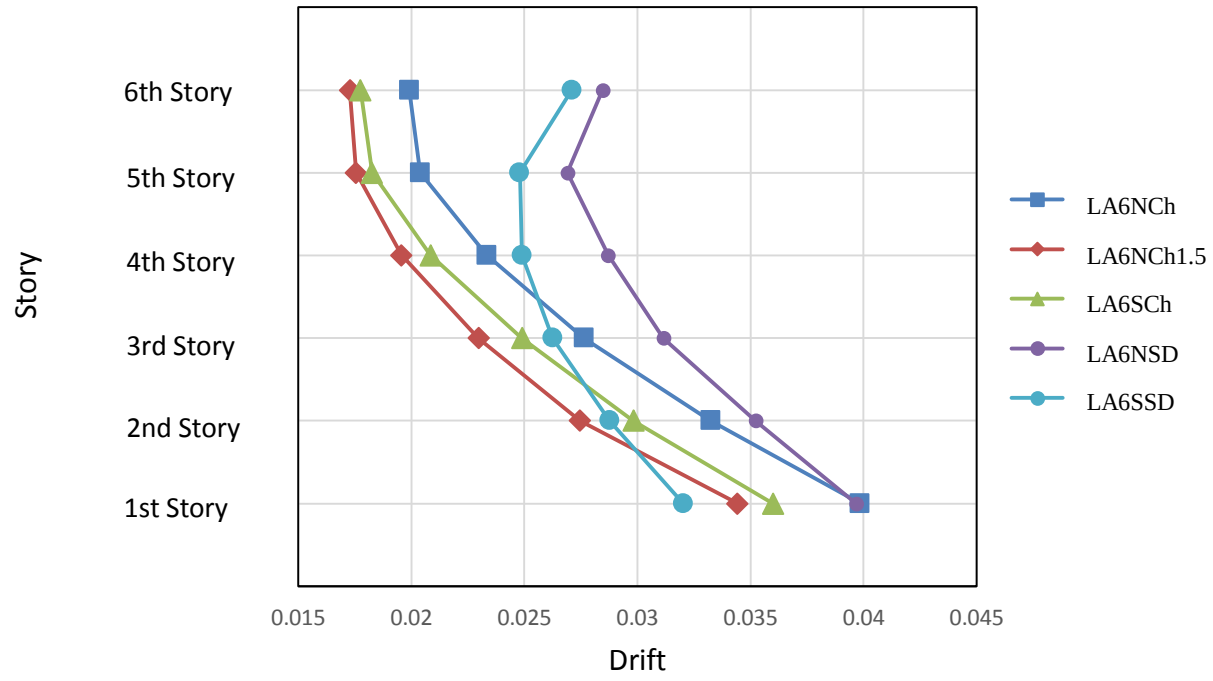

Figure 4-15: Mean Story Drifts for the Six-Story LA Models

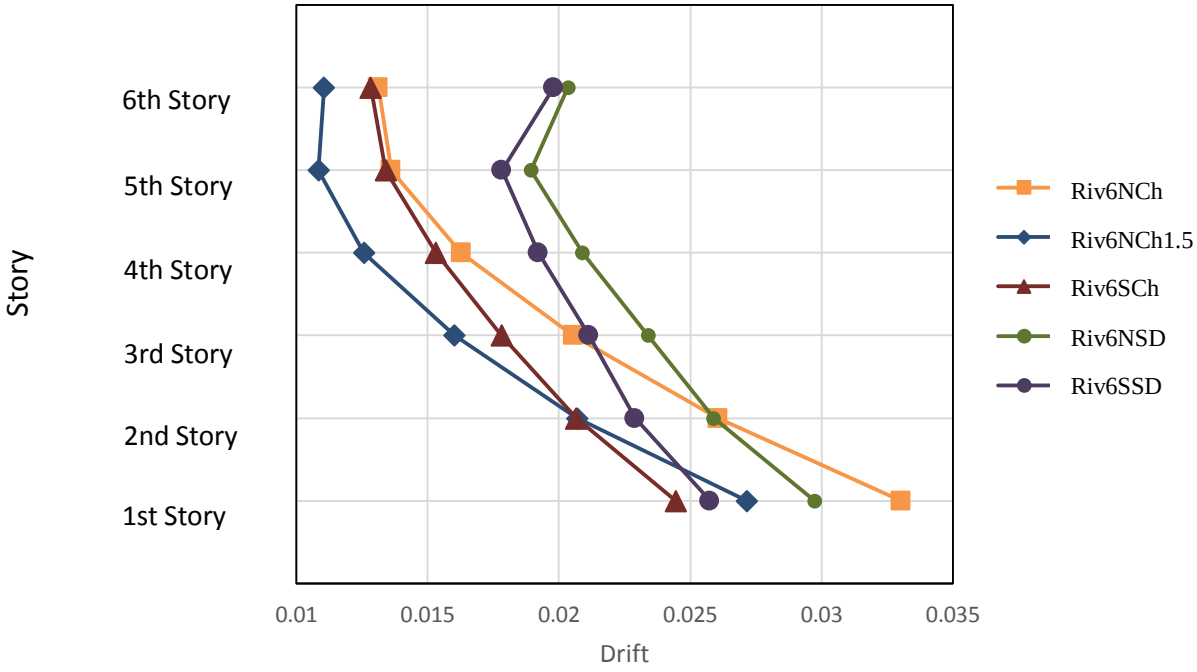

Figure 4-16: Mean Story Drifts for the Six-Story Riverside Models

As FEMA P695 Ground Motion FF19-2 was chosen to present the three-story models, FEMA P695 FF19-2 is also chosen here to show how all the six-story models behave. The hysteresis loops of each story are taken from the BRBs of Group B in Figure 3-14 and Figure 3-15. Hysteresis loops from the first story, the second story, the fourth story and the sixth story are presented.

The plot of roof displacement versus time of the six-story models are presented in Figures 4-17, 4-19, 4-21, 4-23, and 4-25.

The plot of BRBs' hysteresis loops of the six-story models are presented in Figures 4-18, 4-20, 4-22, 4-24, and 4-26.

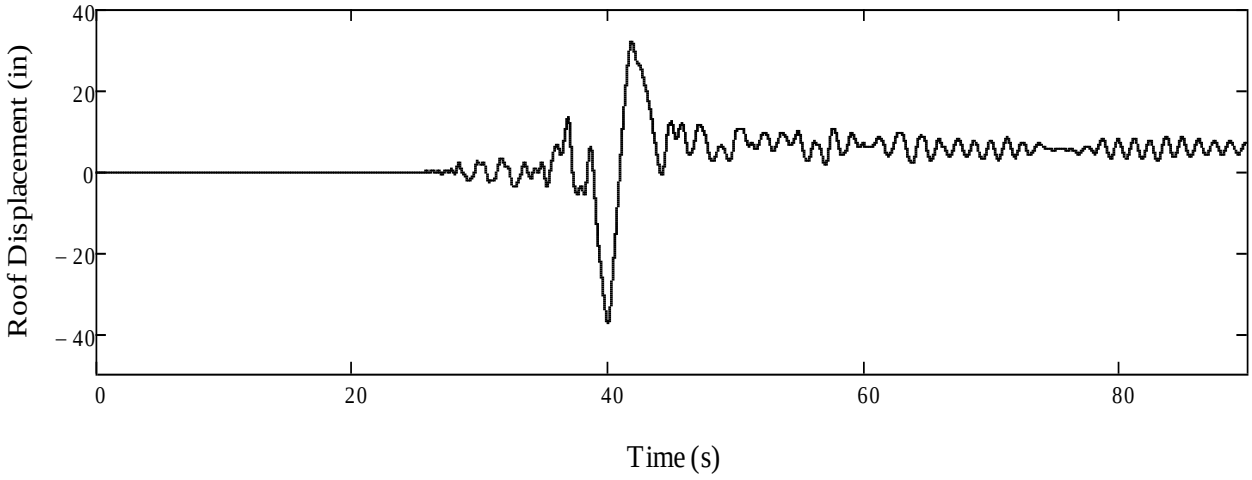

Figure 4-17: Roof Displacement for LA6NCh (FEMA P695 FF19-2)

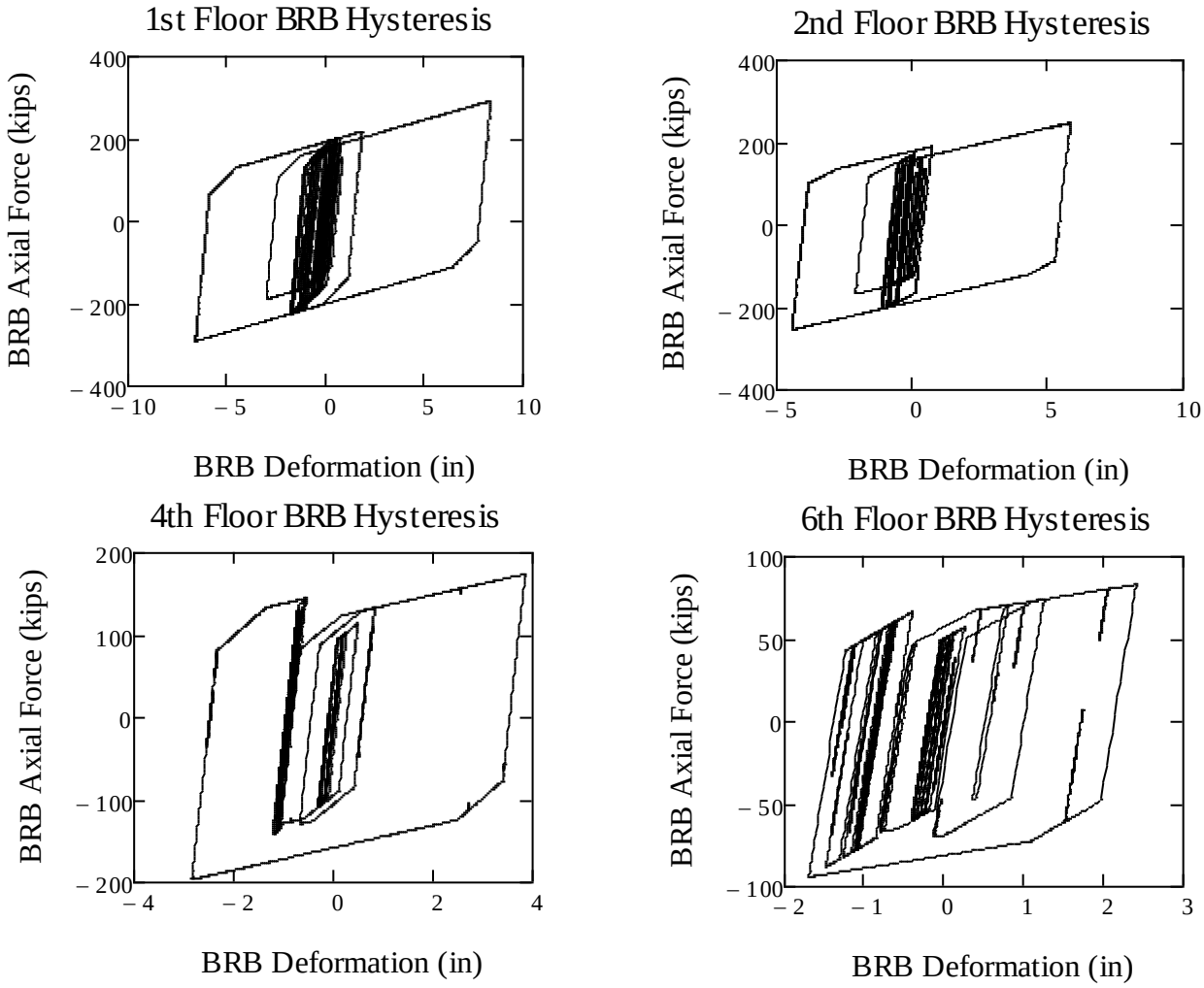

Figure 4-18: BRB Hysteresis Loops for LA6NCh (FEMA P695 FF19-2)

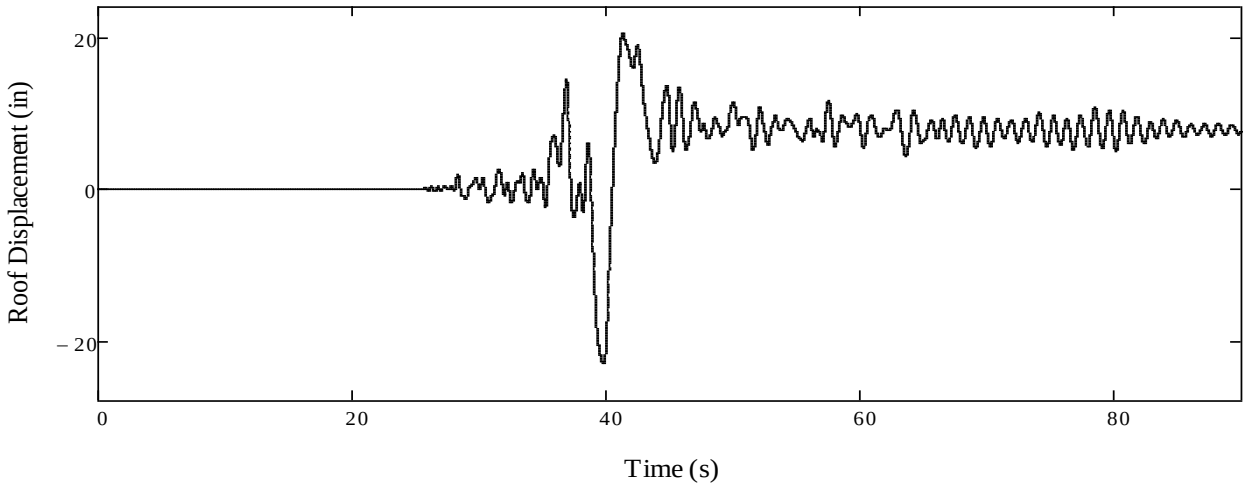

Figure 4-19: Roof Displacement for LA6NCh1.5 (FEMA P695 FF19-2)

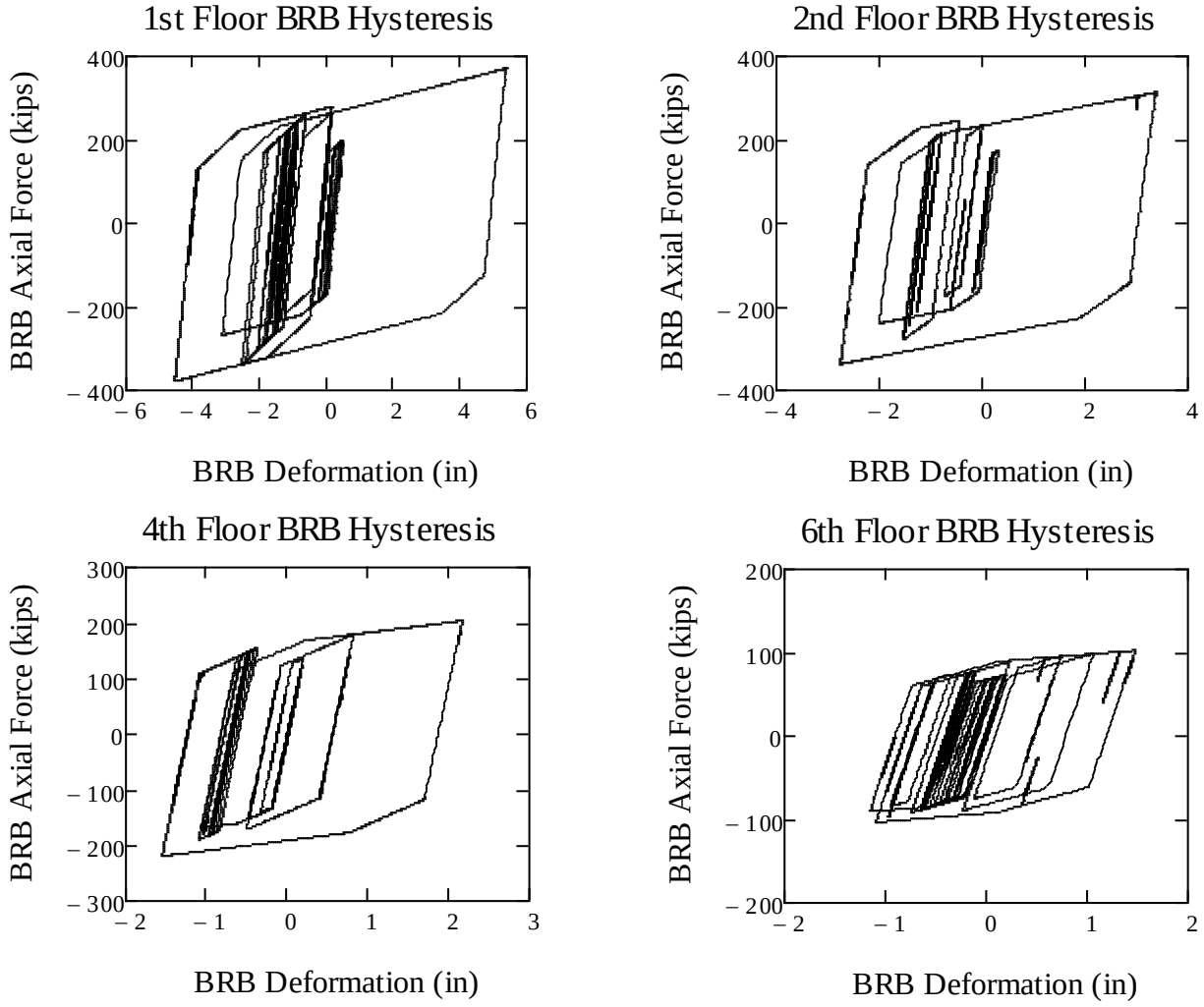

Figure 4-20: BRB Hysteresis Loops for LA6NCh1.5 (FEMA P695 FF19-2)

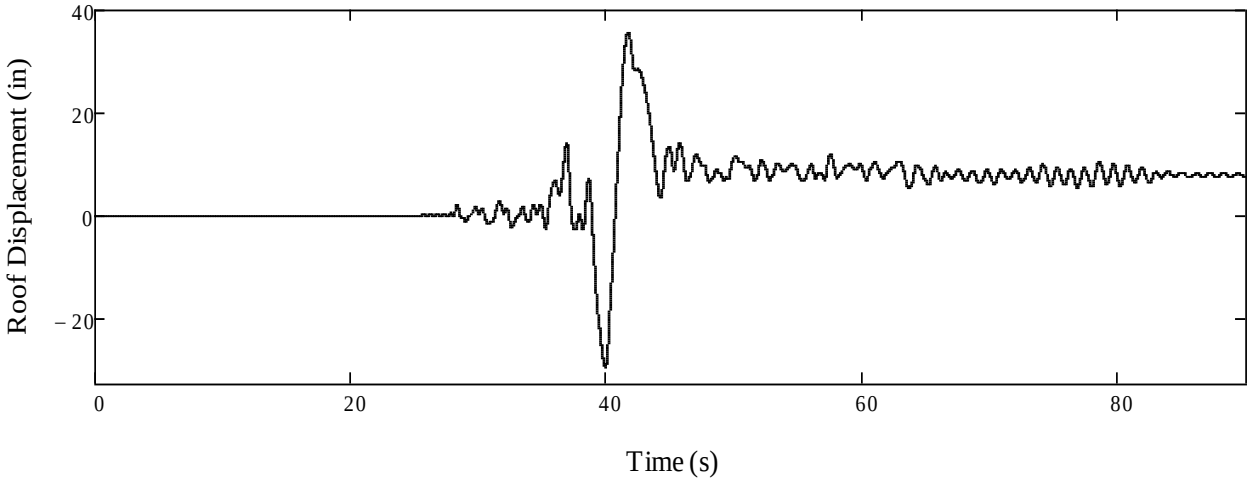

Figure 4-21: Roof Displacement for LA6SCh (FEMA P695 FF19-2)

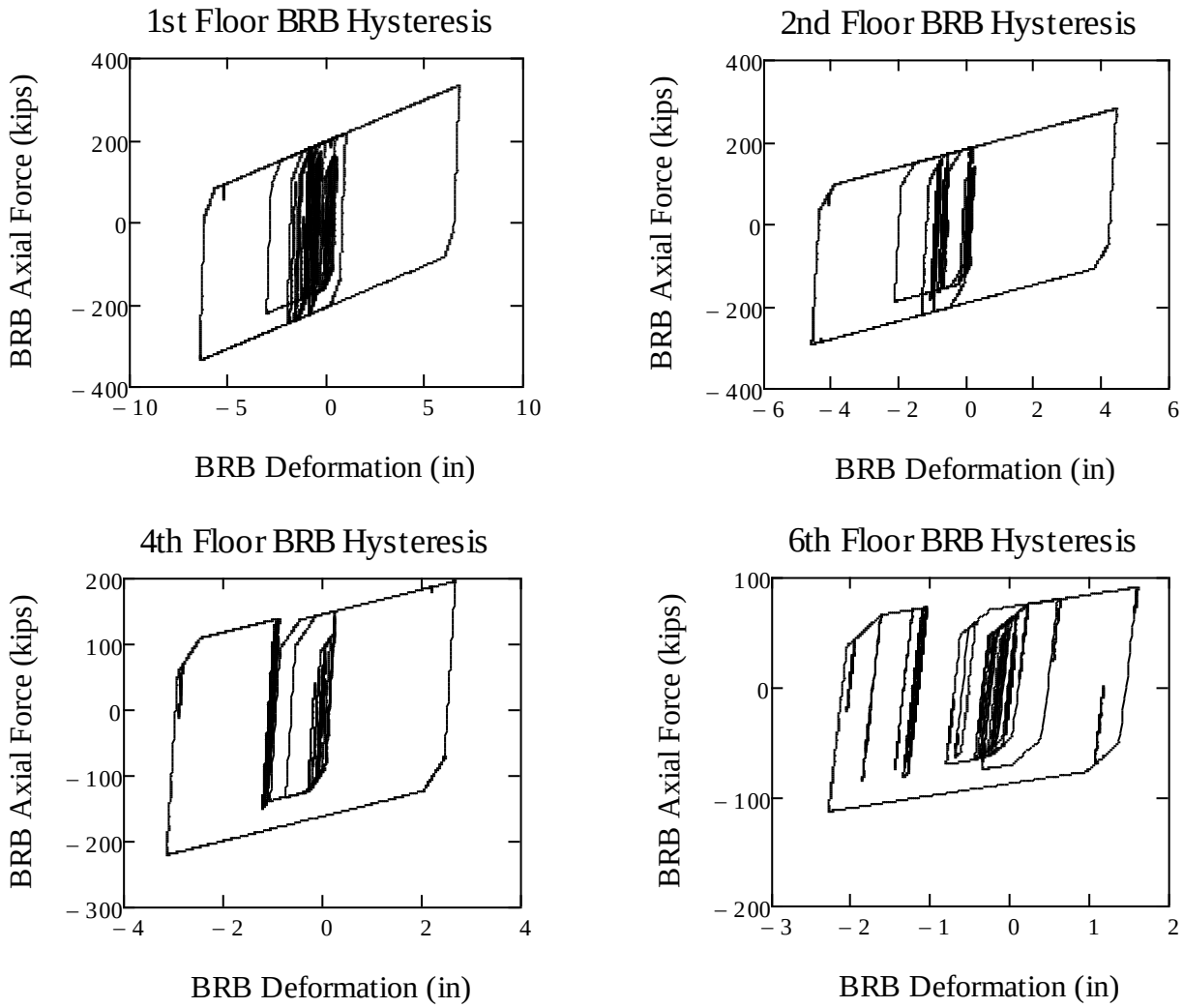

Figure 4-22: BRB Hysteresis Loops for LA6SCh (FEMA P695 FF19-2)

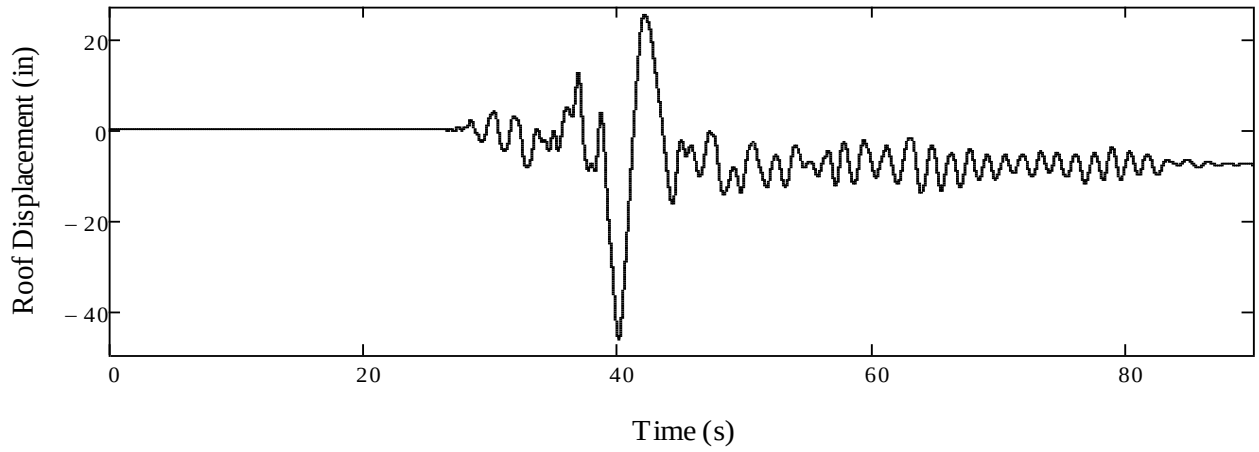

Figure 4-23: Roof Displacement for LA6NSD (FEMA P695 FF19-2)

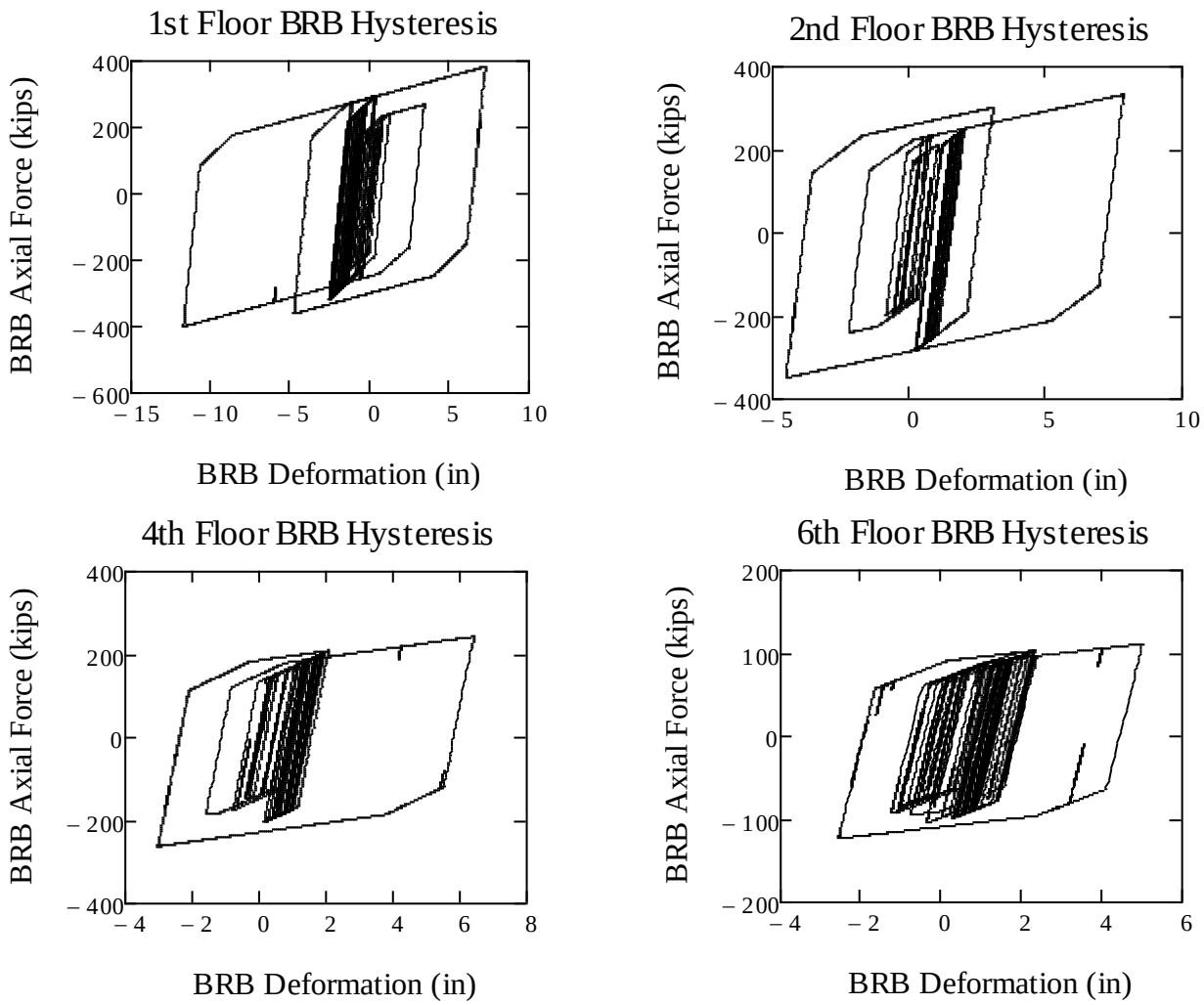

Figure 4-24: BRB Hysteresis Loops for LA6NSD (FEMA P695 FF19-2)

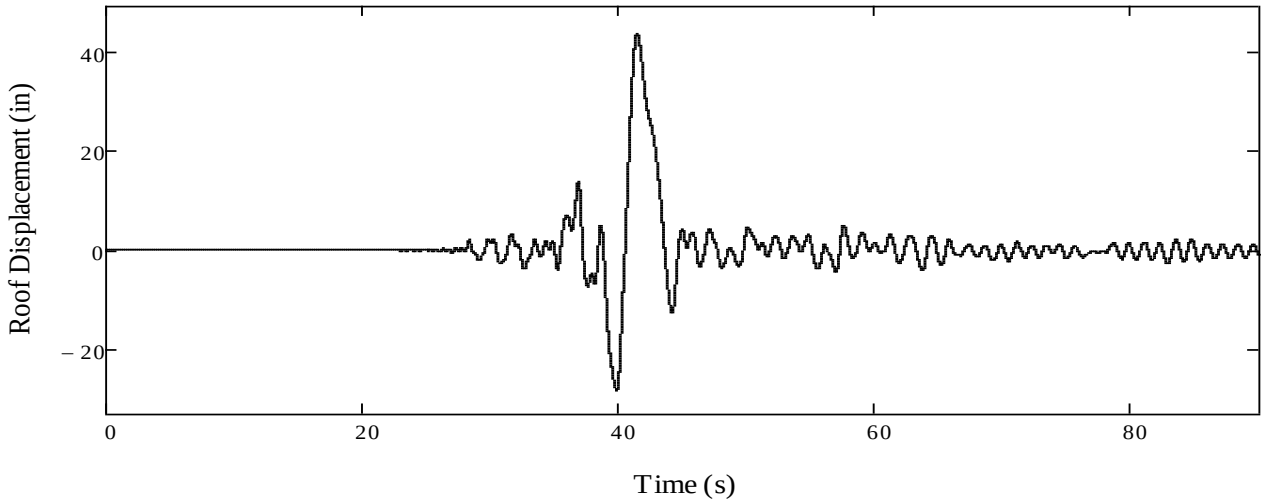

Figure 4-25: Roof Displacement for LA6SSD (FEMA P695 FF19-2)

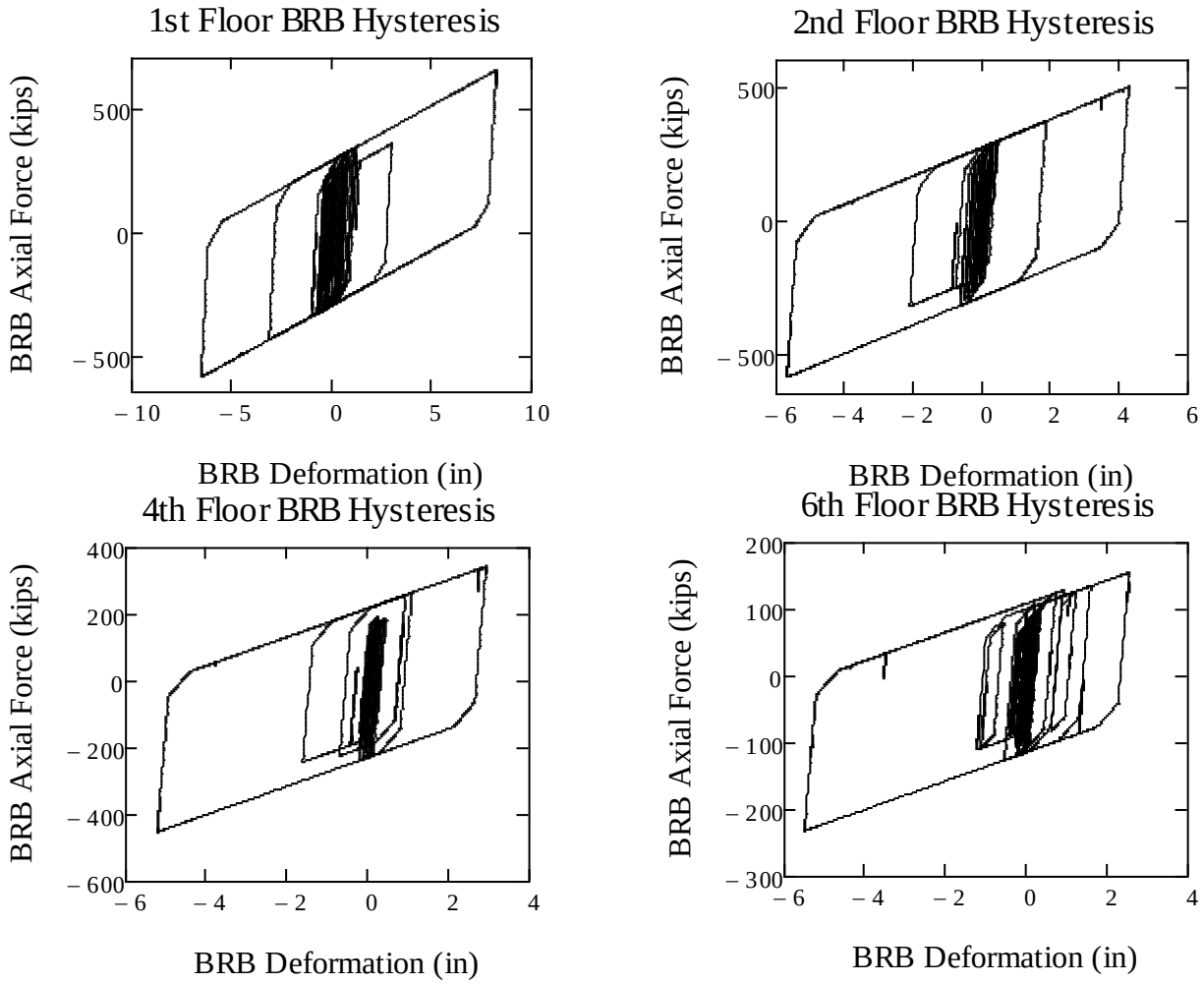

Figure 4-26: BRB Hysteresis Loops for LA6SSD (FEMA P695 FF19-2)

Overstrength factors (maximum force demand normalized by the yield force) and maximum strain of the BRBs in the time-history analyses are desirable. Figures 4-27 and 4-28 show the plots of overstrength factor versus brace strain of all the six-story models. Results are taken from BRBs from all the 6 levels of Group A and Group B, which are mentioned previously in Figures 3-14 and 3-15. For each model and each earthquake the maximum tension and compression value are shown in the plots.

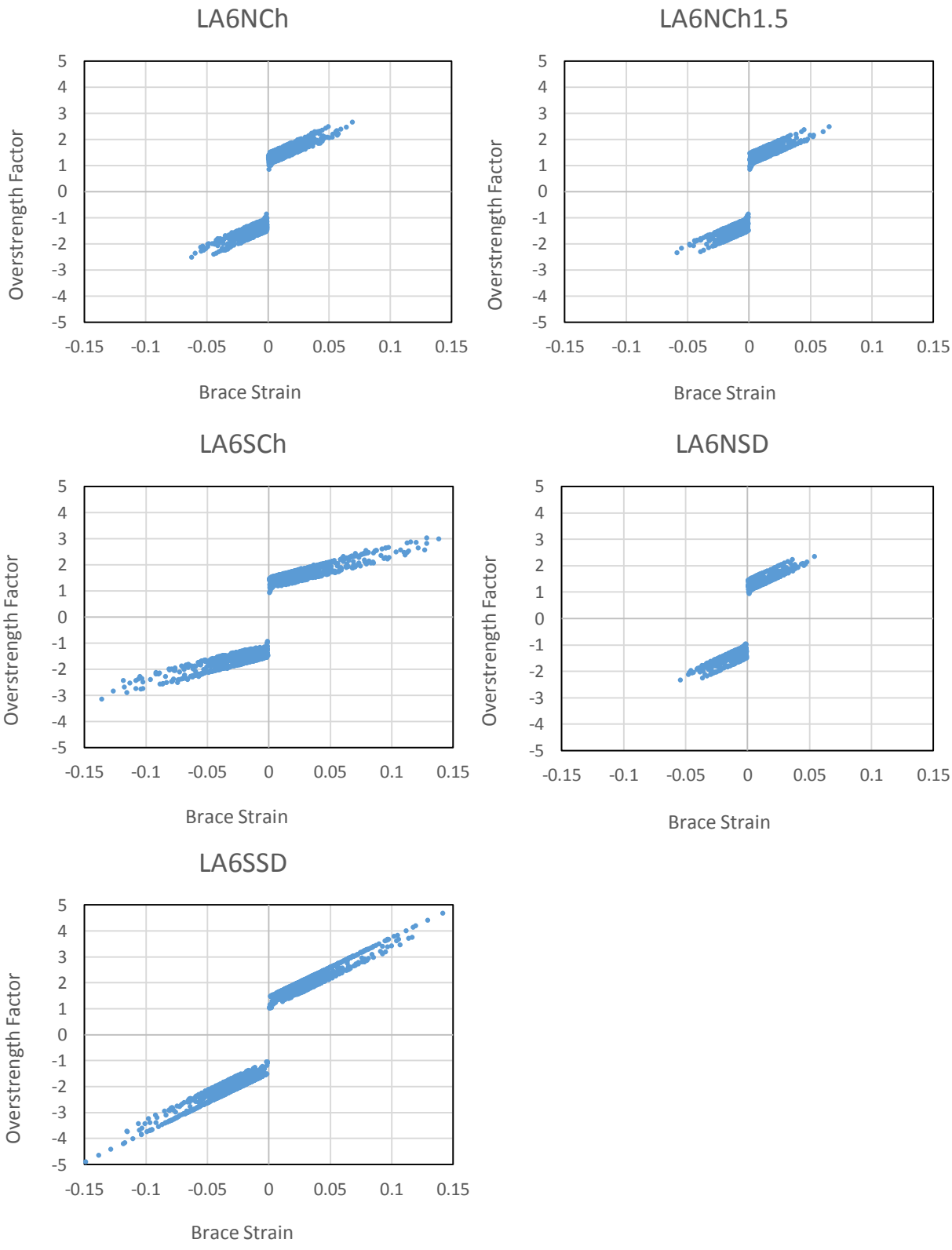

Figure 4-27: Plots of Overstrength Factors vs. Brace Strain of the Six-Story LA Models

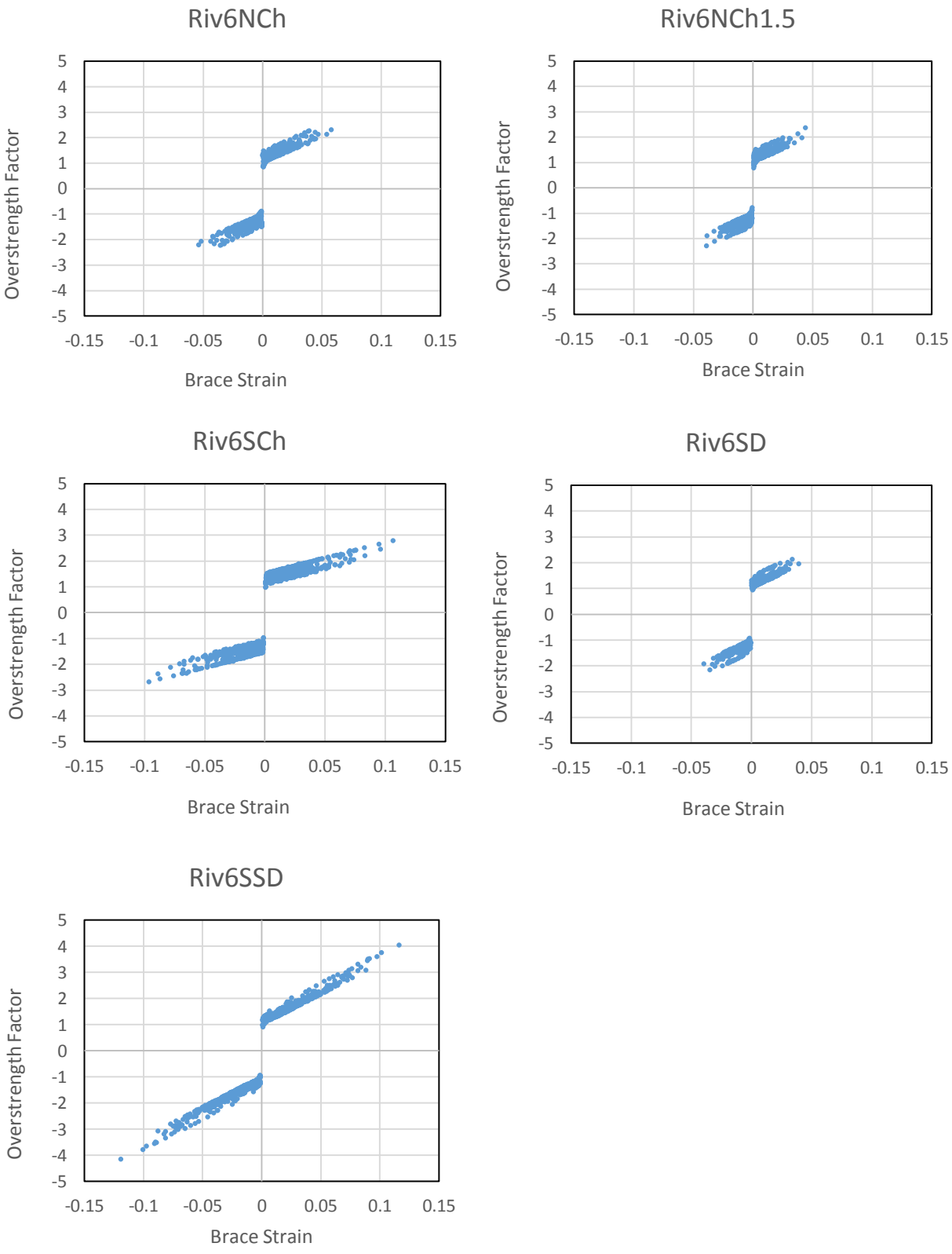

Figure 4-28: Plots of Overstrength Factors vs. Brace Strain of the Six-Story Riverside Models

4.3 Discussion on the effects on the behavior of BRBs and BRBFs

In this section, comparisons on the behavior of the BRBs are presented between models with different parameters in design. Results taken in to consideration are the average of all the ground motions. Results include Cumulative Ductility Demand, Ductility Demand, Reference Ductility Demand, Brace Strain and Normalized Brace Force. Here, ductility demand, reference ductility demand and normalized brace force are the maximum of those results in tension and in compression, since the differences are small. These results are enough to describe the behavior of BRBs.

Also, comparison on the behavior of frames is presented between models with different parameters. Results taken into consideration include story drift, residual story drift, maximum acceleration, column rotation and Column Axial stress.

4.3.1 Comparison of Normal yield length and shortened yield length

In this section, comparisons are presented between models with normal yielding length (NYL) and shortened yield length (SYL) on BRBs' behaviors in Table 4-5 and 4-6. The models included in this discussion are:

1. LA3NCh and LA3SCh
2. LA3NSD and LA3SSD
3. Riv3NCh and Riv3SCh
4. Riv3NSD and Riv3SSD
5. LA6NCh and LA6SCh
6. LA6NSD and LA6SSD
7. Riv6NCh and Riv6SCh
8. Riv6NSD and Riv6SSD

Table 4-5: Comparison of the Effect of NYL and SYL (Three-Story)

	Comparison LA3Ch		Comparison LA3SD		Comparison Riv3Ch		Comparison Riv3SD	
	NYL	SYL	NYL	SYL	NYL	SYL	NYL	SYL
Cumulative Ductility Demand	104.6	185.7	66.7	172.9	85.1	154.1	51.0	140.3
Ductility Demand	25.9	41.1	16.4	38.2	21.0	33.2	12.6	30.1
Reference Ductility Demand	24.2	33.9	15.9	31.2	19.6	28.6	12.3	25.5
Brace Strain	3.17%	4.44%	2.08%	4.09%	2.57%	3.75%	1.62%	3.34%
Normalized Brace Force	1.95	2.48	1.73	2.40	1.80	2.22	1.60	2.15
Story drift	3.7%	2.7%	4.0%	2.6%	3.0%	2.2%	3.2%	2.2%
Residual Story Drift	1.26%	0.42%	1.84%	0.44%	1.20%	0.52%	1.50%	0.49%
Total Roof Acceleration	1.780 g	1.952 g	1.626 g	2.179 g	1.161 g	1.230 g	1.116 g	1.519
Column Rotation	1.5%	1.2%	1.8%	1.1%	1.3%	1.0%	1.4%	0.9%
Column Axial Stress in Compression	19.6 ksi	23.3 ksi	30.1 ksi	38.9 ksi	15.9 ksi	17.8 ksi	23.5 ksi	28.8 ksi

Table 4-6: Comparison of the Effect of NYL and SYL (Six-Story)

	Comparison LA6Ch		Comparison LA6SD		Comparison Riv6Ch		Comparison Riv6SD	
	NYL	SYL	NYL	SYL	NYL	SYL	NYL	SYL
Cumulative Ductility Demand	108.2	271.4	82.2	249.6	84.9	185.7	69.9	220.0
Ductility Demand	25.8	64.4	19.5	52.9	19.3	39.8	14.1	42.7
Reference Ductility Demand	21.7	48.5	17.0	41.7	18.0	32.1	12.6	32.8
Brace Strain	2.84%	6.36%	2.23%	5.47%	2.36%	4.21%	1.65%	4.29%
Normalized Brace Force	1.979	2.327	1.806	2.814	1.810	2.412	1.628	2.292
Story drift	4.0%	3.6%	4.0%	3.4%	3.3%	2.5%	3.0%	2.6%
Residual Story Drift	1.03%	0.83%	1.31%	0.40%	1.73%	0.46%	1.01%	0.29%
Total Roof Acceleration	0.867 g	0.925 g	0.995 g	1.204 g	0.640 g	0.738 g	0.757 g	0.886 g
Column Rotation	1.2%	1.2%	1.3%	1.1%	1.0%	0.8 %	1.0%	0.8%
Column Axial Stress in Compression	11.4 ksi	12.3 ksi	10.8 ksi	14.3 ksi	9.8 ksi	11.6 ksi	9.1 ksi	10.4 ksi

Based on the comparison between NYL braces and SYL braces, we can see that the ductility demand of SYL braces are 2-3 times larger than that of NYL braces. The normalized brace force for SYL braces are 20-30% larger than those of NYL braces on average. Brace strains of SYL braces are approximately 2 times larger than that of NYL braces. Overstrength factors are much higher for the NYL braces, which is plotted in Figure 4-13, 4-14, 4-27 and 4-28

In the comparison of frame behavior, maximum story drift and residual drifts of models are reduced by using SYL BRBs. In other performance metrics, the column rotation is smaller and maximum acceleration and column stress are larger. Those results are within the expectation, since by using shortened yield length BRBs in design the stiffness is increased. Story drifts are distributed more at lower stories in the models with SYL BRBs. This difference is more obvious in the six-story models.

In conclusion, using shortened yield length BRBs will give us relatively smaller story drift, acceptable relatively larger roof acceleration, column force and brace force. However the huge ductility demands of the stiffened braces are not acceptable. Thus, limitations on the shortened yield length BRBs must be considered in design.

4.3.2 Comparison of models designed based on I=1.0 and I=1.5

This section provide the comparison of BRBs' behavior between those models, which are designed with an important factor of I=1.0 and I=1.5. Comparisons are presented in Table 4-7. The models included are:

1. LA3NCh and LA3NCh1.5
2. Riv3NCh and Riv3NCh1.5
3. LA6NCh and LA6NCh1.5
4. Riv6NCh and Riv6NCh1.5

Table 4-7: Comparison of the Effect of I=1.0 and I=1.5

	Comparison LA3Ch		Comparison Riv3Ch		Comparison LA6Ch		Comparison Riv6Ch	
	I=1.0	I=1.5	I=1.0	I=1.5	I=1.0	I=1.5	I=1.0	I=1.5
Mean of Cumulative Ductility Demand	104.6	73.1	85.1	52.4	108.2	91.9	84.9	76.6
Mean of Maximum Ductility Demand	25.9	19.6	21.0	14.1	25.8	23.5	19.3	17.5
Mean of Maximum Reference Ductility Demand	24.2	19.1	19.6	14.1	21.7	19.6	18.0	15.2
Mean of Maximum Brace Strain	3.17%	2.50%	2.57%	1.85%	2.84%	2.57%	2.36%	1.99%
Max Normalized Brace Force	1.947	1.766	1.797	1.595	1.979	1.897	1.810	1.732
Mean of Max drift	3.7%	2.8%	3.0%	2.2%	4.0%	3.5%	3.3%	2.7%
Mean of residual drift	1.26%	1.13%	1.20%	0.91%	1.03%	1.07%	1.73%	0.83%
Mean of Maximum Acceleration	1.780 g	1.921 g	1.161 g	1.309 g	0.867 g	0.987 g	0.640 g	0.729 g
Mean of Maximum Column Rotation	1.5%	1.3%	1.3%	1.0%	1.2%	1.2%	1.0%	1.0%
Mean of Maximum Column stress	19.6 ksi	24.6 ksi	15.9 ksi	19.5 ksi	11.4 ksi	13.7 ksi	9.8 ksi	18.7 ksi

Based on the comparison between BRBs in models with I=1.0 and I=1.5, it can be seen that the ductility demand of the braces in models with I=1.5 are smaller than that of braces of models with I=1.0. Even if the models with I=1.5 are designed with stronger BRBs and the braces take more lateral resistance, the normalized brace force of those braces are still smaller than those of normal braces on average. This suggests that designing the braces stronger indeed decreases the ductility demand.

In the aspect of the behavior of the frame, story drift, residual story drift and column rotation are decreased in the models with I=1.5, since those models have relatively larger stiffness. Simultaneously, roof acceleration and column stress are relatively larger in the models with I=1.5.

In conclusion, important buildings with I=1.5, such as hospitals, are more likely to survive severe earthquakes with lower ductility demands and story drifts.

4.3.3 Comparison of chevron and single diagonal configuration

This section provides the comparison of the BRBs and the frame behavior between those models, which are designed with the chevron configuration and single diagonal configuration. Comparisons are presented in Table 4-8 and 4-9. They include:

1. LA3NCh and LA3NSD
2. LA3SCh and LA3SSD
3. Riv3NCh and Riv3NSD
4. Riv3SCh and Riv3SSD
5. LA6NCh and LA6NSD
6. LA6SCh and LA6SSD
7. Riv6NCh and Riv6NSD
8. Riv6SCh and Riv6SSD

Table 4-8: Comparison of the Effect of Chevron and Single Diagonal Configuration (Three-Story)

	Comparison LA3N		Comparison LA3S		Comparison Riv3N		Comparison Riv3S	
	Chevron	SD	Chevron	SD	Chevron	SD	Chevron	SD
Cumulative Ductility Demand	104.6	66.7	185.7	172.9	85.1	51.0	154.1	140.3
Ductility Demand	25.9	16.4	41.1	38.2	21.0	12.6	33.2	30.1
Reference Ductility Demand	24.2	15.9	33.9	31.2	19.6	12.3	28.6	25.5
Brace Strain	3.17%	2.08%	4.44%	4.09%	2.57%	1.62%	3.75%	3.34%
Normalized Brace Force	1.947	1.726	2.482	2.403	1.797	1.601	2.224	2.151
Story drift	3.7%	4.0%	2.7%	2.6%	3.0%	3.2%	2.2%	2.2%
Residual Story Drift	1.26%	1.84%	0.42%	0.44%	1.20%	1.50%	0.52%	0.49%
Total Roof Acceleration	1.780 g	1.626 g	1.952 g	2.179 g	1.161 g	1.116 g	1.230 g	1.519
Column Rotation	1.5%	1.8%	1.2%	1.1%	1.3%	1.4%	1.0%	0.9%
Column Axial Stress in Compression	19.6 ksi	30.1 ksi	23.3 ksi	38.9 ksi	15.9 ksi	23.5 ksi	17.8 ksi	28.8 ksi

Table 4-9: Comparison of the Effect of Chevron and Single Diagonal Configuration (Six-Story)

	Comparison LA6N		Comparison LA6S		Comparison Riv6N		Comparison Riv6S	
	Chevron	SD	Chevron	SD	Chevron	SD	Chevron	SD
Cumulative Ductility Demand	108.2	82.2	271.4	249.6	84.9	69.9	185.7	220.0
Ductility Demand	25.8	19.5	64.4	52.9	19.3	14.1	39.8	42.7
Reference Ductility Demand	21.7	17.0	48.5	41.7	18.0	12.6	32.1	32.8
Brace Strain	2.84%	2.23%	6.36%	5.47%	2.36%	1.65%	4.21%	4.29%
Normalized Brace Force	1.979	1.806	2.327	2.814	1.810	1.628	2.412	2.292
Story drift	4.0%	4.0%	3.6%	3.4%	3.3%	3.0%	2.5%	2.6%
Residual Story Drift	1.03%	1.31%	0.83%	0.40%	1.73%	1.01%	0.46%	0.29%
Total Roof Acceleration	0.867 g	0.995 g	0.925 g	1.204 g	0.640 g	0.757 g	0.738 g	0.886 g
Column Rotation	1.2%	1.3%	1.2%	1.1%	1.0%	1.0%	0.8 %	0.8%
Column Axial Stress in Compression	11.4 ksi	10.8 ksi	12.3 ksi	14.3 ksi	9.8 ksi	9.1 ksi	11.6 ksi	10.4 ksi

In the comparison of the chevron and single diagonal configurations with normal yield length BRBs, ductility demands of BRBs in single diagonal configuration models are smaller by around 20-30%; reference ductility demands of BRBs in single diagonal configuration models are smaller by around 10-15%; cumulative ductility demands of BRBs in single diagonal configuration models are smaller by around 20-30%; the maximum drift of single diagonal configuration model is 10% larger and the column stress of single diagonal configuration model is 30% larger on average.

In the comparison of models with shortened yield length of BRBs, the results of chevron configuration and single diagonal configuration models are close. The reason for this discordance is that the yield length of BRBs in chevron configuration models are shortened by 50%-60% and the yield length of BRBs in single diagonal configuration models are shortened by 70% on average.

This shows that with normal yield length BRBs, single diagonal configuration models have less ductility demand for BRBs but the frame shows larger story drift and column rotation. This give us a hint on further research that shortening yield length of BRBs in single diagonal configuration models to a certain degree may provide a good balance between ductility demand and story drift. It is probable that single diagonal configuration models with slightly shortened yield length BRBs will provide better performance than chevron configuration models.

As shown in Figure 4-15 and 4-16, story drifts of chevron configuration models and single diagonal configuration models are roughly the same at lower stories. However, story drift of single diagonal configuration models are larger in higher stories. This difference is more obvious in the six-story models. This shows the configuration will affect the story distribution.

4.3.4 Comparison of LA and Riverside

This section provides the comparison of the BRBs and the frame behavior between those models which are designed at LA and Riverside. Comparisons are presented in Tables 4-10 and 4-11. The models included are:

1. LA3NCh and Riv3NCh
2. LA3NCh1.5 and Riv3NCh1.5
3. LA6NCh and Riv6NCh
4. LA6NCh1.5 and Riv6NCh1.5
5. LA3NSD and Riv3NSD
6. LA6NSD and Riv6NSD

The comparisons show that cumulative ductility demands, ductility demands and reference ductility demands of the models at LA are larger than those at Riverside by 20-30%. Also, the story drifts and column rotations of the models at LA are larger than those at Riverside by 20% on average. Maximum accelerations of the three-story models at LA are larger than those at Riverside by 30%. Maximum accelerations of the six-story models at LA are larger than those at Riverside by 25%.

Generally, models at LA are more vulnerable than those at Riverside under the effect of earthquakes. This difference between models at LA and Riverside is more obvious on the three-story models. This is probably because the BRBs in LA models are designed with larger cross section area and the LA models have relatively smaller fundamental period.

Table 4-10: Comparison of the Effect of LA and Riverside (Chevron Configuration)

	Comparison 3NCh		Comparison 3NCh1.5		Comparison 6NCh		Comparison 6NCh1.5	
	LA	Riv	LA	Riv	LA	Riv	LA	Riv
Cumulative Ductility Demand	104.6	85.1	73.1	52.4	108.2	84.9	91.9	76.6
Ductility Demand	25.9	21.0	19.6	14.1	25.8	19.3	23.5	17.5
Reference Ductility Demand	24.2	19.6	19.1	14.1	21.7	18.0	19.6	15.2
Brace Strain	3.17%	2.57%	2.50%	1.85%	2.84%	2.36%	2.57%	1.99%
Normalized Brace Force	1.947	1.797	1.766	1.595	1.979	1.810	1.897	1.732
Story drift	3.7%	3.0%	2.8%	2.2%	4.0%	3.3%	3.5%	2.7%
Residual Story Drift	1.26%	1.20%	1.13%	0.91%	1.03%	1.73%	1.07%	0.83%
Total Roof Acceleration	1.780 g	1.161 g	1.921 g	1.309 g	0.867 g	0.640 g	0.987 g	0.729 g
Column Rotation	1.5%	1.3%	1.3%	1.0%	1.2%	1.0%	1.2%	1.0%
Column Axial Stress in Compression	19.6 ksi	15.9 ksi	24.6 ksi	19.5 ksi	11.4 ksi	9.8 ksi	13.7 ksi	18.7 ksi

Table 4-11: Comparison of the Effect of LA and Riverside (Single Diagonal Configuration)

	Comparison 3NSD		Comparison 6NSD	
	LA	Riv	LA	Riv
Cumulative Ductility Demand	66.7	51.0	82.2	69.9
Ductility Demand	16.4	12.6	19.5	14.1
Reference Ductility Demand	15.9	12.3	17.0	12.6
Brace Strain	2.08%	1.62%	2.23%	1.65%
Normalized Brace Force	1.726	1.601	1.806	1.628
Story drift	4.0%	3.2%	4.0%	3.0%
Residual Story Drift	1.84%	1.50%	1.31%	1.01%
Total Roof Acceleration	1.626 g	1.116 g	0.995 g	0.757 g
Column Rotation	1.8%	1.4%	1.3%	1.0%
Column Axial Stress in Compression	30.1 ksi	23.5 ksi	10.8 ksi	9.1 ksi

4.4 Investigating the effect of the stiffness of the BRBs in models

In the modeling procedure, the stiffness of the BRBs are required by Perform 3D. The change of stiffness will have an effect on the behavior of the structure. Here, we are interested in how much the 10% change of the elastic stiffness of the BRBs will affect the nonlinear behavior of the structures. The interest here is that engineers are estimating the braced stiffness with much more precision than other lateral systems. It is not clear that this need be the case as many of the estimates may not be as accurate as believed.

A six-story chevron configuration model with normal yield length BRBs with I=1.0 at LA and a six-story single diagonal configuration model with normal yield length BRBs with I=1.0 at LA are chosen to present the results of the 10% difference on the stiffness of BRBs. In each comparison, a model with BRBs having 90% the calculated elastic stiffness, a model with BRBs of calculated elastic stiffness and a model with BRBs having 110% the calculated elastic stiffness are taken into consideration. The strength and post-yield behavior of the braces remains the same.

The comparisons are presented in Table 4-12. For each configuration, mean value and mean plus standard deviation value of the ground motion suite are presented. The difference between results of normal BRB stiffness model and results of models with 90% and 110% BRB stiffness are presented. Results of individual ground motion are presented in detail in the Appendix A.

As Table 4-12 shows, the difference of each comparison set are all around 1%, which suggests with all the other parameter kept constant, changing BRBs' stiffness by 10% will only result in small changes in the nonlinear behavior. Thus, the error caused by the inaccuracy of modeling BRBs' elastic stiffness, if any, is minimal.

Table 4-12: Six-story Comparison Variation of BRB Stiffness LA Models with Normal Yield Length

			Story Drift	Residual Story Drift	Roof Acceleration (g)	Normalized Brace Force Tension	Normalized Brace Force Compression	Tensile Ductility	Compressive Ductility	Brace Strain	Cumulative Ductility	Reference Tensile Ductility	Reference Compressive Ductility	Column Rotation	Column Stress in Tension (ksi)	Column Stress in Compression (ksi)	Column Uplift Force (kips)
Chevron Configuration	Calculated Stiffness	μ	4.0%	1.03%	0.867	1.979	1.951	25.8	25.0	2.85%	108.2	21.7	19.8	1.2%	4.7	11.4	293.4
		μ+σ	5.8%	1.69%	1.078	2.300	2.246	38.6	37.9	4.13%	162.0	31.5	28.6	1.6%	5.9	12.6	365.1
	90% Calculated	μ	4.0%	1.05%	0.857	1.985	1.957	25.7	25.0	2.86%	106.6	21.9	19.9	1.2%	4.8	11.5	296.2
		μ+σ	5.8%	1.71%	1.068	2.309	2.255	38.6	38.0	4.15%	160.0	31.7	28.8	1.6%	5.9	12.6	367.3
	110% Calculated	μ	3.9%	1.00%	0.882	1.972	1.945	25.8	25.1	2.81%	108.6	21.4	19.5	1.2%	4.7	11.4	290.8
		μ+σ	5.7%	1.67%	1.099	2.289	2.236	38.4	37.7	4.07%	162.5	31.1	28.3	1.6%	5.9	12.5	363.7
	Percentage difference of 90% Calculated & Calculated	μ	0.6%	1.7%	-1.1%	0.3%	0.3%	-0.6%	-0.2%	0.5%	-1.5%	0.8%	0.7%	-0.1%	1.0%	0.4%	1.0%
		μ+σ	0.6%	0.9%	-0.9%	0.4%	0.4%	0.1%	0.2%	0.6%	-1.2%	0.7%	0.7%	-0.4%	0.6%	0.3%	0.6%
	Percentage difference of 110% Calculated & Calculated	μ	-1.1%	-2.7%	1.8%	-0.3%	-0.3%	0.1%	0.1%	-1.3%	0.4%	-1.2%	-1.2%	-0.4%	-0.9%	-0.4%	-0.9%
		μ+σ	-1.1%	-1.5%	2.0%	-0.5%	-0.5%	-0.5%	-0.5%	-1.4%	0.4%	-1.1%	-1.1%	-1.2%	-0.4%	-0.2%	-0.4%
Single Diagonal Configuration	Calculated Stiffness	μ	4.0%	1.30%	0.995	1.796	1.806	19.5	19.5	2.23%	82.2	17.0	16.9	1.3%	2.5	10.8	157.9
		μ+σ	5.9%	2.28%	1.248	2.068	2.078	29.5	29.4	3.29%	123.0	25.1	24.9	1.8%	3.4	11.6	208.4
	90% Calculated	μ	4.1%	1.31%	0.978	1.800	1.810	19.4	19.3	2.25%	82.2	17.2	17.1	1.3%	2.6	10.8	160.8
		μ+σ	6.0%	2.30%	1.236	2.076	2.086	29.5	29.4	3.33%	123.7	25.3	25.2	1.8%	3.4	11.6	211.3
	110% Calculated	μ	4.0%	1.30%	1.020	1.792	1.802	19.6	19.5	2.21%	82.2	16.8	16.8	1.3%	2.5	10.7	155.6
		μ+σ	5.8%	2.25%	1.285	2.060	2.070	29.4	29.4	3.25%	122.2	24.8	24.7	1.7%	3.3	11.5	205.7
	Percentage difference of 90% Calculated & Calculated	μ	1.3%	0.2%	-1.7%	0.2%	0.2%	-0.7%	-0.7%	0.8%	0.0%	0.9%	0.9%	1.8%	1.8%	0.4%	1.8%
		μ+σ	1.2%	0.9%	-1.0%	0.4%	0.4%	0.1%	0.1%	1.2%	0.6%	1.1%	1.1%	1.3%	1.4%	0.4%	1.4%
	Percentage difference of 110% Calculated & Calculated	μ	-1.2%	-0.6%	2.5%	-0.2%	-0.3%	0.4%	0.4%	-1.2%	0.1%	-1.0%	-0.9%	-1.8%	-1.5%	-0.4%	-1.5%
		μ+σ	-1.3%	-1.0%	3.0%	-0.4%	-0.4%	-0.2%	-0.2%	-1.0%	-0.7%	-1.1%	-1.1%	-2.1%	-1.3%	-0.4%	-1.3%

4.5. Summary

In this chapter, analytical results of the three-story models and the six-story models are presented. Statistical data of the ground motions suites are presented for each model. Mean value and mean value plus standard deviation are calculated. Besides the statistical results, a case study of response to the FEMA P659 FF19-2 record is presented and discussed for each model. Similarities and difference are discussed. Comparisons of several performance metrics are provided for system-level behavior study. Plots of overstrength factors versus brace strain are provided. General comparison based on model variation are presented and discussed. In addition, the effect of BRB stiffness in modeling procedure on the non-linear behavior is investigated.

Chapter 5 Conclusion and Recommendation

5.1 Summary

In this thesis, the behavior of BRBs in BRBF systems was investigated under nonlinear seismic time-history analysis. A literature review on previous BRBs research was provided. The development background and the advantages of the BRBs was discussed. Numerical and experimental research on BRB assemblies was introduced, which provided a solid understanding of the ductility demand of the BRBs and verified the stable hysteresis behavior of the BRBs. Further research on system-level seismic behavior of the BRBF system was introduced. Introduction to the design specifications and process of the BRBs was provided for a better understanding of the design of BRBFs.

In order to explore further understanding of seismic induced behaviors of the BRBs, three-story and six-story building prototypes braced by BRBs were studied. Two configurations of the braced frame were chosen: chevron braced configuration and single diagonal braced configuration. Considering the design of important building, chevron configuration frames were also designed with an important factor of I=1.5. Two types of BRB yielding core were chosen: core with normal yielding length and core with shortened yielding length. Two locations were chosen for the seismic site condition: Los Angeles, CA and Riverside, CA. Gravity load design of the buildings were at the same manner as Sabelli's design [Sabelli, 2001]. Seismic load design of the buildings were conducted in SAP2000 [CSI, 2012] using the ELF method.

Perform 3D [CSI, 2011] was used to build the models and run time-history analysis. Parameters used to model the BRBs were provided by CoreBrace. An introduction to the modeling procedure in Perform 3D was provided in detail. Ground motions were chosen from

the SAC ground motions and FEMA P695 ground motions. Ground motions were scaled to the hazard curve with a 2% probability of exceedance in 50 years.

Results of the time history analysis were extracted from the Perform 3D and reduced. Results include story drift, residual story drift, nodal absolute acceleration, normalized brace force, brace ductility demand ratio, brace strain, brace cumulative ductility demand ratio, reference ductility demand ratio, column rotation, column stress and column uplift force. Behaviors of the BRBs and the BRBF systems were investigated between different models. Comparisons and discussion were generated.

5.2 Conclusion

Conclusions in detail are presented in Chapter 4. In general, BRBs with shortened yielding length were found to have significantly higher ductility demand than BRBs with normal yielding length. Brace strain and brace force of BRBs with SYL are significantly higher than BRBs with NYL. Story drift in BRBF system with SYL BRB is reduced and residual story drift is significantly reduced. Column rotation and column stress in BRBF system with SYL BRB are slightly higher.

BRBF with important factor of 1.5 were found to have less ductility demand, brace strain and normalized brace force. Story drift and residual story drift are also reduced in BRBF systems with an important factor of 1.5. Maximum acceleration were found higher in models with I=1.5. Column rotation ratio is less in BRBF systems with I=1.5 and column stress is higher in BRBF system with I=1.5.

BRBFs in a chevron configuration were found to have higher ductility demand than frames with a single diagonal configuration. The chevron configuration frames were found to have lower maximum roof acceleration. Other results of these frames with different configuration are roughly the same.

BRBF buildings in LA were found to have higher story drift, residual story drift, roof acceleration, column rotation and column stress than those in Riverside models. BRBs in LA models were also found to have higher ductility demand.

Other specific conclusions are listed as follows:

(a) When modeling the stiffness of the BRBs in Perform 3D, a 10% change of the initial stiffness only results in about 1% difference in the nonlinear time-history results.

(b) The maximum individual story drift always occur at the first story although the maximum brace strain sometimes occurs at the second story instead of the first story.

(c) The BRBs with the same direction (be tensed or compressed simultaneously) at the same level behaved almost identically.

(d) The minimum of the individual story drift occured in the second level in three-story models and in the fifth level in six-story models respectively, instead of occurring at the roof. This is probably because of the relatively larger mass at the roof, since the penthouse mass was counted in the roof mass.

5.3 Recommendations

This paper provides a study on the seismic induced behavior of the BRBs in various BRBF systems. The building heights were limited to three stories and six stories. Further research on the BRBs in BRBF systems with more stories, such as nine-story and twenty-story buildings, are desirable.

BRBs with SYL worked well in reducing the residual story drift. There should be a balance point, where the ductility demand of BRBs with a reduced yield length is acceptable where the residual drift is reduced. Further research is required on the BRBs with SYL shortened to different degrees.

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Appendix A

Table A-1: SAC Results / LA3NCh

Ground motion	Story Drift	Residual Story Drift	Roof Acceleration (g)	Normalized Brace Force Tension	Normalized Brace Force Compression	Tensile Ductility	Compressive Ductility	Brace Strain in Tension	Brace Strain in Compression	Cumulative Ductility	Reference Tensile Ductility	Reference Compressive Ductility	Column Rotation	Column Stress in Tension (ksi)	Column Stress in Compression (ksi)	Column Uplift Force (kips)
LA21	4.6%	1.70%	1.834	2.133	2.084	33.7	31.0	3.95%	3.37%	102.0	30.2	25.7	1.8%	13.5	21.3	381.1
LA22	4.8%	2.50%	1.647	2.023	1.964	29.8	27.8	4.04%	3.55%	108.2	30.8	27.1	1.5%	13.9	21.7	390.9
LA23	2.7%	1.10%	1.834	1.802	1.815	19.1	18.0	2.22%	1.84%	116.9	16.9	14.0	1.3%	12.2	20.0	344.0
LA24	3.9%	0.68%	1.357	2.169	2.138	30.0	28.7	3.45%	3.15%	180.6	26.3	24.1	1.6%	14.1	21.9	397.4
LA25	3.7%	2.50%	1.914	2.065	2.023	30.5	27.8	3.04%	2.71%	63.5	23.2	20.7	1.2%	10.2	18.1	287.5
LA26	4.0%	0.62%	1.915	2.189	2.142	43.5	42.0	3.52%	3.29%	104.8	26.9	25.1	2.0%	12.2	20.2	344.0
LA27	6.3%	2.60%	1.867	2.535	2.423	38.4	34.9	5.67%	5.01%	131.0	43.2	38.3	1.9%	13.5	21.3	380.5
LA28	2.8%	0.60%	1.831	1.645	1.647	16.8	15.8	2.39%	2.26%	44.3	18.2	17.3	1.6%	9.5	17.5	267.6
LA29	3.1%	1.30%	2.063	1.684	1.658	11.1	10.6	2.28%	2.10%	100.3	17.4	16.0	1.0%	11.4	19.3	320.6
LA30	2.8%	0.17%	2.219	1.712	1.678	12.4	11.7	2.41%	2.23%	86.0	18.4	17.0	1.3%	10.3	18.3	289.6
LA31	2.0%	0.51%	1.852	1.732	1.712	15.3	14.7	1.76%	1.48%	89.2	13.4	11.3	1.2%	9.9	17.8	279.7
LA32	3.6%	1.50%	1.720	1.845	1.793	20.7	21.2	3.10%	2.84%	99.0	23.6	21.7	1.0%	12.1	20.1	340.8
LA33	4.1%	1.70%	2.255	1.918	1.855	22.9	22.9	3.56%	3.29%	101.4	27.2	25.1	1.6%	10.1	18.1	283.8
LA34	2.5%	1.10%	2.023	1.912	1.909	16.3	15.5	2.00%	1.67%	89.9	15.3	12.7	1.3%	12.3	20.1	348.2
LA35	6.1%	0.68%	1.745	2.589	2.506	69.3	67.9	5.37%	4.93%	170.7	41.0	37.6	3.0%	15.9	23.7	447.9
LA36	5.9%	0.47%	2.260	2.423	2.349	62.8	62.0	5.20%	4.76%	178.2	39.7	36.3	2.7%	14.2	22.0	399.9
μ	3.9%	1.23%	1.896	2.023	1.981	29.5	28.3	3.37%	3.03%	110.4	25.7	23.1	1.6%	12.2	20.1	344.0
$\mu+\sigma$	5.2%	1.99%	2.124	2.314	2.247	46.1	44.5	4.56%	4.12%	147.5	34.8	31.4	2.2%	14.0	21.8	395.2

Table A-2: FEMA P695 Results (i) / LA3NCh

Ground motion	Story Drift	Residual Story Drift	Roof Acceleration (g)	Normalized Brace Force Tension	Normalized Brace Force Compression	Tensile Ductility	Compressive Ductility	Brace Strain in Tension	Brace Strain in Compression	Cumulative Ductility	Reference Tensile Ductility	Reference Compressive Ductility	Column Rotation	Column Stress in Tension (ksi)	Column Stress in Compression (ksi)	Column Uplift Force (kips)
FF01-1	3.3%	0.78%	1.528	1.901	1.865	25.5	24.0	2.98%	2.54%	143.9	22.7	19.4	1.4%	10.8	18.8	305.5
FF01-2	2.5%	0.50%	1.421	1.667	1.668	14.6	14.2	2.11%	1.93%	87.9	16.1	14.8	0.7%	9.8	17.8	277.7
FF02-1	4.4%	0.76%	2.265	2.061	1.993	30.3	31.2	3.87%	3.51%	131.7	29.6	26.8	1.1%	11.0	19.0	311.1
FF02-2	2.1%	0.42%	1.405	1.701	1.699	14.5	12.6	1.76%	1.68%	62.1	13.4	12.8	1.3%	10.5	18.5	296.5
FF03-1	2.3%	1.30%	1.486	1.486	1.464	8.3	8.1	1.69%	1.56%	53.5	12.9	11.9	1.0%	9.9	17.9	278.6
FF03-2	4.1%	2.00%	1.180	2.014	1.955	29.8	27.5	3.60%	3.23%	55.1	27.4	24.7	1.3%	12.7	20.6	358.4
FF09-1	1.7%	0.44%	1.341	1.631	1.616	12.7	11.9	1.43%	1.19%	41.6	10.9	9.1	0.9%	8.9	16.8	250.8
FF09-2	2.4%	0.84%	2.088	1.885	1.873	22.8	20.6	2.24%	1.85%	74.2	17.1	14.1	1.5%	11.6	19.5	327.6
FF16-1	4.6%	3.00%	1.732	2.088	2.016	32.5	29.9	4.10%	3.70%	57.4	31.3	28.3	2.2%	9.5	17.4	269.0
FF16-2	2.4%	1.60%	1.955	1.713	1.685	18.9	17.6	2.11%	1.85%	42.8	16.1	14.1	0.6%	8.4	16.4	235.5
FF18-1	3.6%	1.90%	1.764	1.830	1.790	23.2	21.8	3.15%	2.78%	74.1	24.1	21.2	1.6%	9.8	17.8	276.1
FF18-2	1.5%	0.42%	1.534	1.419	1.415	7.8	7.6	1.02%	0.96%	35.6	7.8	7.3	1.0%	8.7	16.8	245.7
FF19-1	3.4%	1.50%	1.791	1.877	1.847	15.3	14.4	3.06%	2.54%	174.9	23.4	19.4	1.1%	10.9	18.7	306.8
FF19-2	6.1%	1.50%	1.728	2.415	2.314	34.2	32.2	5.55%	4.88%	172.9	42.4	37.3	2.0%	15.8	23.5	444.3
NF02-1	4.8%	1.30%	1.924	2.175	2.108	35.3	33.7	4.33%	3.86%	107.4	33.0	29.5	2.7%	13.6	21.5	382.8
NF02-2	7.3%	0.85%	1.817	2.491	2.358	49.8	51.3	6.34%	5.75%	114.9	48.4	43.9	2.8%	17.1	24.9	482.0
NF04-1	6.6%	2.80%	1.586	2.546	2.428	36.7	34.6	6.00%	5.30%	116.9	45.8	40.4	1.2%	16.6	24.3	467.9
NF04-2	2.4%	0.73%	1.542	1.729	1.731	17.0	16.5	2.11%	1.84%	80.4	16.1	14.0	0.9%	11.4	19.4	322.1
NF06-1	4.9%	2.10%	1.813	2.143	2.063	34.6	31.7	4.33%	3.94%	81.0	33.1	30.1	1.5%	13.4	21.3	377.8
NF06-2	6.6%	1.40%	1.315	2.570	2.449	41.8	38.4	5.54%	5.07%	93.2	42.3	38.7	2.2%	16.8	24.6	473.0
NF07-1	3.3%	1.70%	1.343	1.768	1.720	21.2	19.8	2.87%	2.68%	127.8	21.9	20.4	0.9%	11.2	19.2	315.6
NF07-2	3.0%	0.80%	1.596	1.644	1.632	17.8	16.8	2.53%	2.39%	68.5	19.3	18.3	1.4%	10.6	18.6	299.7

Table A-3: FEMA P695 Results (ii) / LA3NCh

Ground motion	Story Drift	Residual Story Drift	Roof Acceleration (g)	Normalized Brace Force Tension	Normalized Brace Force Compression	Tensile Ductility	Compressive Ductility	Brace Strain in Tension	Brace Strain in Compression	Cumulative Ductility	Reference Tensile Ductility	Reference Compressive Ductility	Column Rotation	Column Stress in Tension (ksi)	Column Stress in Compression (ksi)	Column Uplift Force (kips)
NF09-1	3.4%	2.20%	2.062	2.167	2.122	36.8	34.8	2.78%	2.50%	72.3	21.2	19.1	1.5%	10.7	18.6	301.8
NF09-2	2.3%	0.62%	2.329	1.856	1.854	22.2	19.9	1.92%	1.73%	80.8	14.6	13.2	1.3%	11.3	19.1	318.3
NF10-1	3.7%	2.20%	1.353	1.971	1.918	22.3	21.3	3.27%	2.94%	62.3	24.9	22.4	1.2%	12.4	20.3	348.7
NF10-2	2.2%	1.30%	1.554	1.613	1.620	12.6	12.0	1.83%	1.74%	32.6	13.9	13.3	1.5%	10.4	18.4	294.0
NF12-1	4.3%	1.70%	1.564	2.208	2.170	32.4	31.3	3.73%	3.44%	308.8	28.4	26.3	1.7%	13.5	21.2	379.4
NF12-2	4.5%	0.79%	1.387	2.153	2.082	29.0	27.9	4.03%	3.61%	270.5	30.7	27.6	2.2%	13.0	20.9	367.9
NF15-1	2.0%	0.42%	2.250	1.685	1.714	17.1	15.2	1.80%	1.34%	106.6	13.7	10.3	1.3%	10.1	18.2	285.8
NF15-2	1.5%	0.21%	1.840	1.528	1.520	11.9	11.1	1.08%	1.00%	55.5	8.3	7.6	0.9%	10.3	18.3	290.9
NF22-1	2.9%	1.30%	2.263	1.668	1.627	17.6	16.5	2.51%	2.34%	35.2	19.1	17.9	1.6%	10.1	18.1	284.0
NF22-2	1.9%	0.90%	1.611	1.488	1.462	11.1	10.4	1.53%	1.43%	34.5	11.6	10.9	1.4%	7.8	15.9	220.4
NF23-1	3.7%	1.30%	1.992	2.075	2.031	30.8	28.0	3.03%	2.73%	70.0	23.1	20.9	1.1%	10.4	18.3	293.3
NF23-2	2.1%	1.10%	2.704	1.591	1.567	11.1	11.1	1.81%	1.61%	60.9	13.8	12.3	1.0%	10.8	18.8	304.4
NF24-1	2.4%	0.88%	2.076	1.776	1.756	19.6	17.8	1.82%	1.62%	124.0	13.9	12.4	1.6%	10.4	18.4	292.4
NF24-2	2.1%	0.52%	1.354	1.702	1.701	12.0	11.3	1.75%	1.65%	73.6	13.4	12.6	1.2%	10.1	18.0	285.5
NF26-1	4.9%	0.62%	1.895	2.137	2.058	36.9	38.0	4.37%	3.95%	159.3	33.4	30.2	1.9%	12.8	20.8	361.1
NF26-2	2.9%	1.40%	1.660	1.682	1.641	18.1	16.9	2.45%	2.28%	74.5	18.7	17.4	1.8%	8.7	16.8	246.7
NF27-1	5.0%	2.40%	1.655	2.109	2.032	23.9	25.9	4.46%	4.02%	265.8	34.0	30.7	1.3%	10.7	18.6	302.8
NF27-2	4.4%	1.50%	1.772	1.977	1.913	17.4	16.2	3.87%	3.50%	210.8	29.5	26.7	1.2%	10.2	18.2	286.9
NF28-1	3.9%	1.70%	1.738	2.127	2.087	39.9	39.0	3.38%	3.11%	83.5	25.8	23.7	1.9%	14.4	22.4	406.6
NF28-2	6.5%	1.40%	1.717	2.306	2.241	61.0	61.1	5.74%	5.27%	121.1	43.8	40.2	2.4%	13.8	21.6	388.4
μ	3.6%	1.26%	1.736	1.918	1.876	24.5	23.4	3.09%	2.78%	102.4	23.6	21.2	1.5%	11.5	19.4	322.9
$\mu+\sigma$	5.1%	1.93%	2.060	2.214	2.142	36.1	35.0	4.48%	4.03%	167.0	34.2	30.8	2.0%	13.7	21.6	386.0

Table A-4: SAC Results / LA3NCh1.5

Ground motion	Story Drift	Residual Story Drift	Roof Acceleration (g)	Normalized Brace Force Tension	Normalized Brace Force Compression	Tensile Ductility	Compressive Ductility	Brace Strain in Tension	Brace Strain in Compression	Cumulative Ductility	Reference Tensile Ductility	Reference Compressive Ductility	Column Rotation	Column Stress in Tension (ksi)	Column Stress in Compression (ksi)	Column Uplift Force (kips)
LA21	5.4%	2.60%	1.659	2.140	2.044	29.1	28.1	4.87%	4.47%	94.2	37.2	34.1	2.1%	19.5	27.4	551.1
LA22	3.9%	2.00%	1.932	2.089	2.041	32.3	29.0	3.65%	2.91%	103.8	27.9	22.2	1.5%	20.5	28.3	579.5
LA23	2.4%	0.71%	1.902	1.817	1.801	21.3	19.3	2.24%	1.59%	112.8	17.1	12.2	1.0%	17.8	25.6	502.3
LA24	3.6%	0.78%	1.844	1.957	1.927	25.9	27.0	3.54%	2.62%	183.7	27.0	20.0	1.8%	19.8	27.5	559.5
LA25	3.8%	2.20%	2.150	1.950	1.888	27.9	25.5	3.36%	3.03%	45.4	25.6	23.1	1.3%	16.1	24.1	454.6
LA26	3.6%	1.30%	2.275	2.253	2.192	36.7	33.8	3.24%	2.75%	83.5	24.7	21.0	1.3%	17.7	25.5	498.0
LA27	5.0%	2.10%	1.809	2.257	2.167	27.6	25.3	4.57%	4.05%	102.2	34.9	30.9	1.8%	19.7	27.6	555.8
LA28	2.3%	1.40%	2.130	1.635	1.628	12.1	10.7	1.75%	1.65%	38.9	13.3	12.6	1.2%	15.3	23.2	430.9
LA29	2.3%	0.99%	2.011	1.568	1.540	13.9	13.1	1.96%	1.72%	64.4	15.0	13.1	1.4%	15.0	22.9	421.7
LA30	2.2%	0.84%	2.015	1.566	1.539	8.1	7.6	1.87%	1.65%	52.3	14.3	12.6	1.3%	14.2	22.2	400.1
LA31	2.3%	1.30%	1.828	1.715	1.683	14.2	13.0	2.01%	1.75%	66.1	15.3	13.3	1.1%	15.4	23.3	432.9
LA32	2.2%	1.10%	2.355	1.734	1.713	19.7	18.1	2.02%	1.57%	64.9	15.4	12.0	0.9%	17.1	24.9	481.4
LA33	3.2%	1.30%	2.067	1.776	1.731	21.5	19.9	2.87%	2.55%	75.0	21.9	19.4	1.8%	15.3	23.4	431.7
LA34	2.3%	0.80%	2.089	1.754	1.730	14.2	13.1	2.15%	1.69%	80.4	16.4	12.9	1.0%	16.9	24.8	478.0
LA35	4.4%	0.43%	3.106	2.145	2.096	44.2	42.9	3.92%	3.64%	118.6	29.9	27.8	2.3%	19.1	27.0	537.3
LA36	3.1%	0.76%	2.078	2.020	1.985	32.0	30.4	2.71%	2.54%	122.8	20.7	19.4	1.8%	20.4	28.2	573.9
μ	3.3%	1.29%	2.078	1.898	1.857	23.8	22.3	2.92%	2.51%	88.0	22.3	19.2	1.5%	17.5	25.4	493.0
$\mu+\sigma$	4.3%	1.90%	2.395	2.125	2.065	33.4	31.6	3.88%	3.41%	123.2	29.6	26.1	1.9%	19.6	27.4	551.5

Table A-5: FEMA P695 Results (i) / LA3NCh1.5

Ground motion	Story Drift	Residual Story Drift	Roof Acceleration (g)	Normalized Brace Force Tension	Normalized Brace Force Compression	Tensile Ductility	Compressive Ductility	Brace Strain in Tension	Brace Strain in Compression	Cumulative Ductility	Reference Tensile Ductility	Reference Compressive Ductility	Column Rotation	Column Stress in Tension (ksi)	Column Stress in Compression (ksi)	Column Uplift Force (kips)
FF01-1	2.2%	0.66%	1.778	1.745	1.737	19.9	18.0	2.08%	1.38%	106.2	15.9	10.5	1.4%	16.9	24.8	477.8
FF01-2	1.5%	0.68%	1.769	1.529	1.512	9.2	9.3	1.32%	1.07%	72.4	10.0	8.2	0.6%	15.3	23.3	431.2
FF02-1	1.7%	0.73%	2.051	1.411	1.397	7.3	7.2	1.42%	1.25%	54.3	10.8	9.6	0.7%	14.9	23.0	419.5
FF02-2	2.5%	1.50%	1.913	1.586	1.548	13.7	12.8	2.12%	1.98%	47.9	16.2	15.1	1.3%	14.0	22.1	395.7
FF03-1	1.8%	1.00%	2.049	1.459	1.439	6.1	5.8	1.52%	1.32%	35.6	11.6	10.1	0.7%	15.2	23.2	427.9
FF03-2	3.4%	0.98%	1.351	1.809	1.754	22.9	21.1	3.01%	2.77%	47.4	23.0	21.1	1.1%	17.8	25.8	501.2
FF09-1	1.8%	0.92%	1.322	1.546	1.526	13.0	12.1	1.55%	1.29%	38.7	11.8	9.9	0.9%	14.9	22.9	420.1
FF09-2	2.4%	1.70%	2.149	1.544	1.527	12.1	12.2	2.08%	1.95%	46.8	15.8	14.9	1.4%	14.7	22.7	413.6
FF16-1	3.6%	1.80%	2.309	1.860	1.804	24.7	22.7	3.20%	2.90%	48.7	24.4	22.1	2.1%	15.7	23.7	442.0
FF16-2	2.1%	1.20%	1.660	1.605	1.576	15.2	14.1	1.79%	1.59%	28.8	13.7	12.1	0.7%	14.5	22.5	408.2
FF18-1	2.9%	1.50%	2.152	1.783	1.744	21.6	20.0	2.58%	2.25%	53.5	19.7	17.2	1.6%	15.5	23.5	437.1
FF18-2	1.3%	0.56%	1.542	1.407	1.394	7.9	7.3	1.05%	0.99%	24.3	8.0	7.5	0.8%	15.3	23.4	432.5
FF19-1	1.8%	0.74%	2.252	1.595	1.581	14.6	13.7	1.65%	1.24%	111.3	12.6	9.5	0.9%	15.2	23.0	429.3
FF19-2	3.4%	2.20%	1.530	1.914	1.863	22.7	20.8	3.01%	2.64%	86.9	23.0	20.1	1.4%	18.9	26.8	533.9
NF02-1	3.9%	0.87%	2.248	2.014	1.979	36.3	36.0	3.49%	3.17%	76.4	26.7	24.2	2.3%	19.3	27.2	543.2
NF02-2	5.4%	0.68%	2.163	2.111	2.014	40.2	40.6	4.86%	4.47%	84.1	37.1	34.1	2.4%	20.0	27.9	564.8
NF04-1	3.5%	1.20%	1.393	1.853	1.807	24.1	22.4	3.18%	2.71%	89.0	24.3	20.7	1.6%	16.9	24.7	476.2
NF04-2	1.8%	0.19%	1.593	1.612	1.604	14.3	12.7	1.48%	1.37%	55.5	11.3	10.5	1.1%	15.0	23.0	421.9
NF06-1	4.0%	1.30%	2.238	1.848	1.781	25.5	23.7	3.57%	3.32%	63.5	27.2	25.3	1.3%	17.6	25.5	495.5
NF06-2	3.6%	1.40%	1.360	1.946	1.881	23.2	21.6	3.18%	2.96%	41.7	24.3	22.6	1.3%	17.9	25.9	504.3
NF07-1	2.9%	1.20%	1.999	1.751	1.741	20.7	20.2	2.54%	2.36%	118.4	19.4	18.0	1.0%	16.7	24.7	471.6
NF07-2	2.4%	0.28%	1.286	1.750	1.740	17.9	16.8	2.09%	1.97%	54.5	15.9	15.1	1.5%	16.2	24.2	457.2

Table A-6: FEMA P695 Results (ii) / LA3NCh1.5

Ground motion	Story Drift	Residual Story Drift	Roof Acceleration (g)	Normalized Brace Force Tension	Normalized Brace Force Compression	Tensile Ductility	Compressive Ductility	Brace Strain in Tension	Brace Strain in Compression	Cumulative Ductility	Reference Tensile Ductility	Reference Compressive Ductility	Column Rotation	Column Stress in Tension (ksi)	Column Stress in Compression (ksi)	Column Uplift Force (kips)
NF09-1	4.7%	2.50%	2.179	2.117	2.035	34.0	31.0	4.24%	3.82%	61.0	32.3	29.2	1.8%	16.9	24.8	476.9
NF09-2	1.9%	0.69%	2.179	1.734	1.719	18.4	16.5	1.60%	1.52%	52.9	12.2	11.6	1.2%	16.3	24.3	460.7
NF10-1	2.7%	1.70%	1.277	1.835	1.798	14.6	14.2	2.41%	2.06%	48.0	18.4	15.7	0.8%	16.9	24.9	477.5
NF10-2	1.9%	1.20%	1.732	1.542	1.524	10.2	9.4	1.48%	1.41%	27.8	11.3	10.8	0.8%	16.3	24.3	459.1
NF12-1	4.0%	1.90%	1.561	1.876	1.811	20.0	18.6	3.55%	3.28%	150.1	27.1	25.0	1.6%	17.5	25.5	492.5
NF12-2	4.1%	1.20%	1.766	2.004	1.936	18.9	20.1	3.64%	3.28%	197.1	27.8	25.1	1.3%	19.1	27.0	537.7
NF15-1	2.3%	1.10%	2.400	1.570	1.571	11.4	11.7	1.94%	1.80%	56.5	14.8	13.8	0.9%	15.5	23.5	435.8
NF15-2	2.0%	1.20%	2.017	1.593	1.568	14.7	13.7	1.77%	1.52%	43.6	13.5	11.6	0.8%	16.0	24.0	451.2
NF22-1	2.2%	1.30%	2.473	1.566	1.556	13.2	12.1	1.70%	1.58%	24.9	12.9	12.0	1.1%	17.1	25.0	481.1
NF22-2	1.0%	0.18%	1.728	1.351	1.340	6.0	5.6	0.70%	0.63%	32.3	5.3	4.8	0.8%	14.4	22.5	406.5
NF23-1	4.2%	1.70%	1.766	1.988	1.917	29.4	26.9	3.76%	3.43%	63.7	28.7	26.2	1.8%	15.3	23.2	431.4
NF23-2	2.0%	1.10%	2.699	1.580	1.554	12.8	12.0	1.67%	1.48%	51.0	12.8	11.3	1.4%	16.2	24.2	457.7
NF24-1	1.5%	0.33%	2.489	1.561	1.548	13.2	12.4	1.24%	0.95%	90.3	9.5	7.3	1.0%	15.8	23.7	445.0
NF24-2	1.6%	0.53%	1.470	1.502	1.498	9.8	9.2	1.32%	1.23%	46.6	10.1	9.4	1.0%	15.4	23.4	435.0
NF26-1	3.5%	0.79%	2.017	1.831	1.810	23.7	21.8	3.12%	2.86%	99.2	23.8	21.9	1.7%	18.1	26.0	509.5
NF26-2	1.3%	0.07%	1.420	1.480	1.469	6.9	6.3	0.99%	0.92%	66.1	7.6	7.1	0.7%	15.1	23.1	425.7
NF27-1	3.1%	1.70%	1.885	1.737	1.694	16.0	16.1	2.77%	2.46%	106.2	21.1	18.7	1.4%	15.0	22.9	421.9
NF27-2	2.8%	0.79%	1.552	1.702	1.661	13.9	13.3	2.42%	2.19%	118.0	18.4	16.7	1.0%	16.2	24.3	458.2
NF28-1	2.1%	0.27%	1.134	1.699	1.692	16.7	14.8	1.77%	1.68%	37.4	13.5	12.8	1.2%	14.8	22.7	417.5
NF28-2	3.9%	1.30%	2.322	2.094	2.051	40.1	38.8	3.50%	3.26%	70.1	26.7	24.9	1.9%	17.5	25.4	494.3
μ	2.7%	1.07%	1.861	1.715	1.683	18.0	17.0	2.34%	2.10%	67.3	17.9	16.0	1.2%	16.3	24.2	459.0
$\mu+\sigma$	3.7%	1.62%	2.251	1.916	1.866	26.6	25.3	3.31%	3.01%	102.6	25.3	23.0	1.7%	17.7	25.7	499.4

Table A-7: SAC Results / LA3SCh

Ground motion	Story Drift	Residual Story Drift	Roof Acceleration (g)	Normalized Brace Force Tension	Normalized Brace Force Compression	Tensile Ductility	Compressive Ductility	Brace Strain in Tension	Brace Strain in Compression	Cumulative Ductility	Reference Tensile Ductility	Reference Compressive Ductility	Column Rotation	Column Stress in Tension (ksi)	Column Stress in Compression (ksi)	Column Uplift Force (kips)
LA21	3.8%	0.50%	2.282	3.022	2.926	52.9	50.3	6.61%	5.89%	190.2	50.4	44.9	1.5%	19.4	27.3	547.2
LA22	2.8%	0.34%	1.919	2.679	2.616	52.7	51.9	4.56%	4.34%	211.7	34.8	33.1	1.4%	18.7	26.7	527.4
LA23	1.9%	0.18%	2.616	2.345	2.303	40.9	39.3	3.10%	2.81%	246.8	23.6	21.4	1.1%	15.7	23.7	443.2
LA24	3.0%	0.05%	2.175	2.831	2.754	59.6	60.0	5.04%	4.59%	344.7	38.5	35.1	1.3%	18.7	26.7	528.1
LA25	3.4%	0.79%	2.362	2.791	2.717	50.8	48.1	5.44%	5.12%	160.6	41.5	39.1	0.9%	16.5	24.4	464.2
LA26	4.0%	0.42%	2.467	3.270	3.153	76.0	73.5	6.81%	6.21%	208.8	51.9	47.4	2.0%	18.9	26.8	532.7
LA27	3.8%	0.47%	1.715	3.144	3.041	47.9	45.9	6.34%	5.75%	199.5	48.4	43.9	1.5%	17.4	25.4	491.1
LA28	2.2%	0.21%	2.152	2.006	1.972	25.7	34.7	3.61%	3.49%	93.3	27.6	26.7	1.0%	11.4	19.4	322.0
LA29	2.1%	0.36%	2.026	2.185	2.150	18.1	19.5	3.46%	3.06%	175.4	26.4	23.4	0.9%	14.2	22.2	399.3
LA30	2.2%	0.44%	2.187	2.101	2.054	18.8	19.9	3.49%	3.32%	137.8	26.6	25.3	1.0%	11.7	19.8	330.9
LA31	1.7%	0.31%	1.843	2.154	2.122	28.3	26.2	2.71%	2.38%	149.2	20.7	18.1	0.7%	11.9	19.9	334.5
LA32	2.6%	0.30%	1.880	2.400	2.348	36.9	35.1	4.39%	3.93%	193.9	33.5	30.0	0.8%	15.8	23.8	444.8
LA33	3.1%	0.27%	2.045	2.539	2.472	40.7	38.9	5.15%	4.68%	199.6	39.3	35.7	1.3%	14.2	22.2	400.8
LA34	2.1%	0.36%	1.758	2.421	2.375	28.5	27.2	3.40%	3.07%	182.7	26.0	23.4	1.3%	15.8	23.8	445.3
LA35	6.0%	0.41%	2.447	4.067	3.880	95.7	94.3	10.00%	9.13%	299.5	76.3	69.7	2.2%	27.1	35.0	764.7
LA36	4.1%	0.21%	1.917	3.226	3.123	79.9	78.3	6.63%	6.08%	275.7	50.6	46.4	2.0%	21.9	29.9	617.9
μ	3.1%	0.35%	2.112	2.699	2.625	47.1	46.4	5.05%	4.61%	204.3	38.5	35.2	1.3%	16.8	24.8	474.6
$\mu+\sigma$	4.1%	0.51%	2.373	3.230	3.118	68.7	67.1	6.88%	6.29%	265.1	52.5	48.0	1.7%	20.8	28.7	585.5

Table A-8: FEMA P695 Results (i) / LA3SCh

Ground motion	Story Drift	Residual Story Drift	Roof Acceleration (g)	Normalized Brace Force Tension	Normalized Brace Force Compression	Tensile Ductility	Compressive Ductility	Brace Strain in Tension	Brace Strain in Compression	Cumulative Ductility	Reference Tensile Ductility	Reference Compressive Ductility	Column Rotation	Column Stress in Tension (ksi)	Column Stress in Compression (ksi)	Column Uplift Force (kips)
FF01-1	2.4%	0.05%	2.023	2.493	2.449	39.1	39.5	3.95%	3.36%	267.9	30.2	25.7	0.9%	14.4	22.4	405.0
FF01-2	1.5%	0.25%	1.488	1.944	1.914	22.4	22.2	2.40%	2.19%	154.1	18.3	16.7	0.6%	11.1	19.2	312.9
FF02-1	2.6%	0.29%	1.791	2.533	2.476	50.8	51.7	4.31%	3.86%	245.7	32.9	29.4	1.4%	14.8	22.8	417.8
FF02-2	2.1%	0.36%	1.861	2.010	1.966	27.0	27.0	3.33%	3.18%	123.9	25.4	24.3	1.1%	11.3	19.3	317.5
FF03-1	1.5%	0.76%	2.133	1.755	1.729	11.9	11.5	2.31%	2.16%	91.2	17.7	16.5	0.7%	11.9	20.0	336.8
FF03-2	3.1%	0.38%	1.294	2.535	2.460	40.9	38.8	5.22%	4.90%	94.4	39.8	37.4	1.1%	17.2	25.3	486.0
FF09-1	1.7%	0.59%	1.923	2.018	1.996	25.6	23.9	2.63%	2.33%	84.1	20.1	17.8	0.6%	10.5	18.5	295.6
FF09-2	2.2%	0.53%	1.867	2.353	2.316	35.1	34.1	3.55%	3.24%	129.1	27.1	24.8	1.0%	12.3	20.4	347.7
FF16-1	3.1%	0.71%	2.114	2.661	2.586	44.8	42.3	5.16%	4.74%	127.5	39.4	36.2	1.6%	13.7	21.7	385.8
FF16-2	1.9%	0.63%	1.198	2.024	1.988	25.9	24.8	2.99%	2.75%	73.5	22.8	21.0	0.8%	11.8	19.8	331.4
FF18-1	2.8%	0.44%	1.839	2.465	2.408	39.0	37.0	4.63%	4.16%	122.4	35.3	31.8	1.3%	13.2	21.2	372.2
FF18-2	1.2%	0.58%	1.843	1.655	1.655	15.1	14.3	1.84%	1.77%	70.1	14.0	13.5	0.9%	11.1	19.1	312.5
FF19-1	1.9%	0.21%	1.573	2.157	2.127	27.1	25.3	3.10%	2.61%	280.5	23.7	20.0	1.1%	12.3	20.4	348.1
FF19-2	2.7%	0.50%	1.869	2.631	2.573	42.4	39.5	4.56%	3.97%	240.2	34.8	30.3	1.3%	17.2	25.1	485.1
NF02-1	3.9%	0.51%	1.917	3.000	2.896	74.5	74.7	6.61%	6.07%	201.0	50.4	46.3	2.1%	18.5	26.5	521.9
NF02-2	5.2%	0.85%	2.106	3.492	3.364	90.3	88.5	8.52%	8.06%	190.1	65.1	61.5	2.0%	22.4	30.3	630.4
NF04-1	3.7%	0.65%	1.472	2.909	2.813	43.7	41.8	6.34%	5.80%	189.3	48.4	44.2	0.8%	18.8	26.7	528.8
NF04-2	1.5%	0.40%	2.133	2.139	2.110	29.7	29.8	2.41%	2.12%	162.6	18.4	16.2	1.0%	12.4	20.4	350.3
NF06-1	3.6%	0.40%	2.034	2.708	2.616	45.1	42.8	5.97%	5.64%	123.3	45.6	43.0	1.0%	18.4	26.4	519.5
NF06-2	4.3%	0.21%	1.312	2.897	2.799	50.8	51.5	6.96%	6.60%	121.8	53.1	50.4	1.4%	20.8	28.8	585.8
NF07-1	2.5%	0.42%	2.464	2.251	2.196	39.8	39.4	4.09%	3.88%	306.7	31.2	29.6	1.2%	15.1	23.1	424.6
NF07-2	2.6%	0.39%	1.793	2.204	2.146	40.2	39.7	4.28%	4.10%	152.1	32.7	31.3	1.1%	12.9	20.9	363.9

Table A-9: FEMA P695 Results (ii) / LA3SCh

Ground motion	Story Drift	Residual Story Drift	Roof Acceleration (g)	Normalized Brace Force Tension	Normalized Brace Force Compression	Tensile Ductility	Compressive Ductility	Brace Strain in Tension	Brace Strain in Compression	Cumulative Ductility	Reference Tensile Ductility	Reference Compressive Ductility	Column Rotation	Column Stress in Tension (ksi)	Column Stress in Compression (ksi)	Column Uplift Force (kips)
NF09-1	3.6%	0.56%	2.427	2.997	2.906	59.4	56.8	5.72%	5.34%	150.9	43.7	40.8	1.2%	17.4	25.4	490.7
NF09-2	2.2%	0.43%	2.324	2.457	2.408	43.3	41.3	3.55%	3.20%	129.0	27.1	24.4	1.4%	14.6	22.6	411.4
NF10-1	2.3%	0.59%	1.750	2.498	2.448	35.4	34.9	3.86%	3.42%	119.3	29.5	26.1	0.8%	15.5	23.5	437.7
NF10-2	1.7%	0.39%	1.832	1.900	1.884	25.1	23.9	2.68%	2.61%	68.3	20.4	19.9	0.9%	13.3	21.3	374.0
NF12-1	3.2%	0.35%	1.448	2.612	2.556	40.4	38.7	5.34%	5.07%	474.0	40.7	38.7	1.4%	15.8	23.8	445.2
NF12-2	3.2%	0.28%	2.083	2.845	2.764	38.9	38.8	5.31%	4.82%	480.7	40.5	36.8	1.2%	18.0	26.0	508.3
NF15-1	1.7%	0.26%	2.056	2.019	1.997	26.7	26.3	2.65%	2.46%	146.9	20.2	18.8	1.0%	12.0	20.0	337.5
NF15-2	1.7%	0.71%	1.812	1.951	1.922	23.6	22.8	2.71%	2.41%	99.1	20.6	18.4	0.6%	13.6	21.6	382.7
NF22-1	2.0%	0.55%	2.465	1.952	1.919	26.4	25.7	3.18%	3.06%	61.7	24.3	23.4	1.0%	13.5	21.5	380.1
NF22-2	1.5%	0.35%	1.764	1.813	1.785	19.5	18.7	2.34%	2.19%	94.0	17.8	16.7	1.0%	9.8	17.8	276.2
NF23-1	3.6%	0.28%	1.960	2.863	2.781	50.2	47.1	5.66%	5.33%	152.6	43.2	40.7	1.0%	16.3	24.3	459.7
NF23-2	2.2%	0.52%	2.290	2.174	2.131	23.7	24.6	3.56%	3.24%	112.9	27.2	24.7	1.0%	14.4	22.4	405.3
NF24-1	1.7%	0.14%	2.453	2.210	2.177	31.3	30.9	2.56%	2.26%	252.7	19.5	17.3	1.2%	13.0	21.1	367.7
NF24-2	1.6%	0.60%	1.488	1.876	1.853	20.4	19.1	2.48%	2.26%	140.6	18.9	17.2	1.0%	12.3	20.3	346.8
NF26-1	3.0%	0.23%	2.388	2.635	2.565	52.0	51.7	4.98%	4.54%	284.2	38.0	34.6	1.3%	17.2	25.2	484.2
NF26-2	2.0%	0.53%	1.579	1.942	1.902	23.1	22.2	3.13%	3.00%	168.4	23.9	22.9	0.9%	10.9	18.9	306.1
NF27-1	2.8%	0.61%	1.675	2.471	2.411	38.9	37.1	4.76%	4.30%	326.5	36.4	32.9	1.4%	12.3	20.3	347.2
NF27-2	2.9%	0.16%	1.673	2.477	2.411	34.7	33.7	4.74%	4.41%	352.3	36.2	33.6	1.1%	13.6	21.6	383.4
NF28-1	2.9%	0.54%	1.659	2.772	2.699	62.6	60.7	4.81%	4.37%	151.2	36.7	33.4	1.3%	17.9	25.8	503.4
NF28-2	4.7%	0.34%	2.228	3.484	3.354	92.7	91.3	7.67%	7.01%	186.6	58.5	53.5	1.5%	24.0	31.9	676.8
μ	2.6%	0.44%	1.891	2.400	2.344	38.8	37.8	4.21%	3.88%	178.7	32.1	29.6	1.1%	14.7	22.7	414.4
$\mu+\sigma$	3.5%	0.62%	2.221	2.837	2.754	56.3	55.0	5.78%	5.36%	277.6	44.1	40.9	1.4%	17.9	25.9	505.7

Table A-10: SAC Results / LA3NSD

Ground motion	Story Drift	Residual Story Drift	Roof Acceleration (g)	Normalized Brace Force Tension	Normalized Brace Force Compression	Tensile Ductility	Compressive Ductility	Brace Strain in Tension	Brace Strain in Compression	Cumulative Ductility	Reference Tensile Ductility	Reference Compressive Ductility	Column Rotation	Column Stress in Tension (ksi)	Column Stress in Compression (ksi)	Column Uplift Force (kips)
LA21	4.7%	2.60%	1.446	1.798	1.792	19.9	19.8	2.40%	2.31%	61.6	18.3	17.6	1.9%	20.6	31.1	580.8
LA22	5.1%	3.50%	1.628	1.779	1.762	19.8	19.5	2.63%	2.60%	61.4	20.1	19.8	1.7%	21.1	31.8	596.4
LA23	2.2%	0.70%	1.427	1.563	1.569	11.7	11.3	1.10%	1.05%	72.4	8.4	8.0	1.3%	17.8	28.4	501.8
LA24	5.0%	1.60%	1.576	1.798	1.813	20.3	20.1	2.64%	2.63%	123.5	20.2	20.1	2.0%	22.0	32.6	621.5
LA25	4.5%	2.90%	1.842	1.772	1.763	19.3	19.2	2.31%	2.28%	39.1	17.6	17.4	1.6%	20.6	31.1	579.5
LA26	3.9%	1.30%	1.763	1.855	1.916	20.7	20.7	2.06%	2.05%	67.1	15.7	15.7	2.1%	22.3	32.7	629.6
LA27	7.5%	5.10%	1.269	2.184	2.178	24.3	24.5	3.94%	3.96%	79.1	30.1	30.2	2.4%	26.9	37.1	758.3
LA28	3.0%	0.84%	2.135	1.525	1.563	10.7	10.8	1.58%	1.59%	28.0	12.1	12.1	2.3%	17.2	27.6	483.9
LA29	2.9%	1.50%	2.122	1.515	1.493	6.7	6.9	1.46%	1.49%	69.5	11.1	11.4	1.4%	16.9	27.8	476.8
LA30	3.1%	0.86%	1.807	1.552	1.566	9.0	8.7	1.61%	1.62%	65.9	12.3	12.4	1.6%	17.2	27.7	485.6
LA31	2.0%	0.52%	1.271	1.549	1.549	9.0	9.1	0.97%	0.98%	67.0	7.4	7.5	1.3%	17.3	27.9	488.8
LA32	3.7%	2.20%	1.558	1.610	1.574	13.5	13.5	1.91%	1.90%	68.9	14.6	14.5	1.4%	18.5	29.3	522.3
LA33	4.1%	2.80%	1.764	1.678	1.682	14.8	14.6	2.15%	2.17%	69.4	16.4	16.6	1.8%	19.5	30.1	550.0
LA34	2.7%	1.30%	1.609	1.665	1.673	11.6	11.7	1.32%	1.33%	68.2	10.1	10.2	1.2%	18.7	29.2	528.5
LA35	6.6%	1.70%	2.104	2.224	2.279	43.9	43.7	3.49%	3.48%	103.9	26.6	26.5	2.9%	27.4	37.5	774.0
LA36	7.3%	1.40%	1.727	2.023	2.084	39.9	40.0	3.88%	3.86%	105.9	29.6	29.5	2.8%	24.3	34.4	685.6
μ	4.3%	1.93%	1.691	1.756	1.766	18.4	18.4	2.22%	2.21%	71.9	16.9	16.8	1.9%	20.5	31.0	579.0
$\mu+\sigma$	5.9%	3.10%	1.956	1.973	1.997	28.6	28.6	3.11%	3.10%	94.6	23.8	23.7	2.4%	23.8	34.1	670.9

Table A-11: SAC Results (i) / LA3NSD

Ground motion	Story Drift	Residual Story Drift	Roof Acceleration (g)	Normalized Brace Force Tension	Normalized Brace Force Compression	Tensile Ductility	Compressive Ductility	Brace Strain in Tension	Brace Strain in Compression	Cumulative Ductility	Reference Tensile Ductility	Reference Compressive Ductility	Column Rotation	Column Stress in Tension (ksi)	Column Stress in Compression (ksi)	Column Uplift Force (kips)
FF01-1	3.3%	0.95%	1.280	1.667	1.709	15.5	15.4	1.72%	1.73%	92.4	13.2	13.2	1.8%	18.9	29.5	532.2
FF01-2	2.5%	0.31%	1.462	1.520	1.538	10.1	10.0	1.29%	1.30%	62.6	9.9	9.9	1.0%	17.0	27.6	478.7
FF02-1	2.8%	1.70%	1.617	1.502	1.472	8.0	7.9	1.43%	1.41%	45.7	10.9	10.7	0.9%	17.1	27.8	483.2
FF02-2	2.3%	0.27%	1.599	1.525	1.540	8.9	8.7	1.17%	1.17%	40.9	9.0	9.0	1.3%	17.1	27.7	481.1
FF03-1	2.4%	1.10%	2.034	1.401	1.401	5.7	5.9	1.14%	1.18%	40.2	8.7	9.0	1.5%	14.5	25.3	408.5
FF03-2	4.0%	2.70%	1.845	1.751	1.734	18.5	18.3	2.09%	2.07%	33.2	15.9	15.8	1.5%	20.2	30.8	568.6
FF09-1	1.8%	0.46%	1.330	1.464	1.463	6.9	6.8	0.91%	0.92%	31.7	7.0	7.1	0.9%	16.3	27.0	459.0
FF09-2	2.7%	0.75%	1.774	1.729	1.750	17.2	17.0	1.39%	1.41%	57.9	10.6	10.8	2.1%	19.9	30.4	562.1
FF16-1	5.0%	3.50%	1.962	1.802	1.780	20.3	20.4	2.59%	2.61%	44.4	19.8	19.9	2.6%	20.1	30.8	567.7
FF16-2	2.7%	1.70%	1.071	1.591	1.576	13.1	13.0	1.41%	1.42%	29.7	10.8	10.8	0.8%	16.7	27.6	470.9
FF18-1	3.3%	2.10%	1.623	1.605	1.586	13.6	13.7	1.70%	1.72%	47.6	13.0	13.1	1.5%	19.0	29.6	535.3
FF18-2	1.7%	0.15%	1.219	1.393	1.412	6.5	6.7	0.84%	0.82%	27.8	6.4	6.3	1.2%	13.9	24.8	391.4
FF19-1	4.2%	2.60%	1.584	1.724	1.700	9.7	9.8	2.22%	2.23%	116.5	17.0	17.0	1.5%	19.3	29.9	544.7
FF19-2	7.8%	3.30%	1.498	2.207	2.189	21.7	21.8	4.14%	4.11%	99.3	31.6	31.4	2.4%	26.8	37.0	755.4
NF02-1	4.6%	1.70%	1.972	1.992	2.048	20.4	20.4	2.43%	2.45%	61.1	18.5	18.7	2.7%	24.0	34.3	678.1
NF02-2	8.2%	2.20%	1.523	2.133	2.092	31.7	31.6	4.33%	4.32%	70.3	33.0	33.0	3.5%	24.6	35.2	693.7
NF04-1	7.0%	4.10%	1.238	2.196	2.195	29.4	29.1	3.72%	3.68%	77.0	28.4	28.1	1.7%	26.0	36.3	732.8
NF04-2	2.9%	0.87%	1.889	1.572	1.559	10.5	10.4	1.53%	1.52%	57.9	11.6	11.6	1.1%	18.2	28.9	514.0
NF06-1	5.2%	3.10%	2.064	1.849	1.823	22.0	21.7	2.72%	2.70%	43.8	20.7	20.6	2.0%	21.3	31.9	601.5
NF06-2	7.7%	3.40%	1.393	2.194	2.153	29.9	29.7	4.06%	4.04%	57.2	31.0	30.8	2.6%	25.4	23.7	715.9
NF07-1	3.3%	1.70%	1.557	1.556	1.535	12.2	12.1	1.73%	1.72%	96.6	13.2	13.2	1.4%	17.8	28.6	501.8
NF07-2	3.5%	1.80%	1.413	1.538	1.549	12.5	12.6	1.82%	1.83%	44.7	13.9	14.0	1.6%	16.9	27.6	477.0

Table A-12: FEMA P695 Results (ii) / LA3NSD

Ground motion	Story Drift	Residual Story Drift	Roof Acceleration (g)	Normalized Brace Force Tension	Normalized Brace Force Compression	Tensile Ductility	Compressive Ductility	Brace Strain in Tension	Brace Strain in Compression	Cumulative Ductility	Reference Tensile Ductility	Reference Compressive Ductility	Column Rotation	Column Stress in Tension (ksi)	Column Stress in Compression (ksi)	Column Uplift Force (kips)
NF09-1	4.2%	2.50%	1.744	1.851	1.886	20.8	20.8	2.14%	2.11%	42.4	16.3	16.1	1.6%	21.7	32.2	612.9
NF09-2	2.4%	0.43%	1.837	1.616	1.630	13.6	13.6	1.21%	1.21%	54.2	9.2	9.3	1.6%	17.9	28.5	504.9
NF10-1	4.1%	3.10%	1.528	1.736	1.716	16.4	16.2	2.14%	2.12%	45.2	16.3	16.2	1.6%	19.9	30.5	559.9
NF10-2	2.4%	0.70%	1.604	1.467	1.484	8.3	8.3	1.25%	1.26%	19.2	9.6	9.6	1.7%	16.4	27.0	463.3
NF12-1	5.5%	3.10%	1.253	2.023	2.030	21.9	21.8	2.87%	2.88%	196.7	21.9	22.0	2.0%	24.0	34.3	675.7
NF12-2	5.5%	2.70%	1.380	1.893	1.891	20.6	20.6	2.89%	2.88%	164.5	22.1	22.0	2.5%	21.6	32.2	610.4
NF15-1	2.3%	0.95%	2.151	1.582	1.594	12.7	12.7	1.14%	1.14%	68.6	8.7	8.7	1.5%	16.7	27.3	471.8
NF15-2	1.8%	0.61%	1.581	1.476	1.483	10.0	10.1	0.93%	0.93%	43.7	7.1	7.1	1.0%	15.8	26.8	446.9
NF22-1	4.1%	3.00%	2.385	1.631	1.563	14.7	14.8	2.12%	2.13%	21.2	16.2	16.3	2.2%	16.9	27.8	477.8
NF22-2	1.9%	0.86%	1.220	1.384	1.349	6.3	6.3	0.96%	0.95%	16.6	7.3	7.3	1.5%	12.5	23.4	352.6
NF23-1	4.0%	2.40%	1.696	1.774	1.774	19.4	19.3	2.05%	2.06%	46.0	15.6	15.7	1.4%	20.3	30.8	572.3
NF23-2	1.9%	0.81%	1.810	1.444	1.449	6.3	6.2	0.97%	0.97%	35.1	7.4	7.4	1.5%	15.8	26.6	446.4
NF24-1	2.1%	1.20%	2.079	1.569	1.568	12.2	12.3	1.06%	1.07%	81.6	8.1	8.1	1.5%	17.9	28.5	503.9
NF24-2	2.6%	0.53%	1.427	1.559	1.579	8.7	8.9	1.32%	1.33%	56.5	10.1	10.1	1.3%	16.9	27.4	477.0
NF26-1	4.7%	1.80%	1.460	1.862	1.856	17.8	17.6	2.44%	2.44%	88.9	18.6	18.7	1.4%	20.4	30.8	576.6
NF26-2	2.8%	1.10%	1.321	1.490	1.497	9.9	9.9	1.44%	1.44%	54.7	11.0	11.0	1.8%	15.6	26.4	440.8
NF27-1	7.1%	4.00%	1.458	2.070	2.049	16.7	16.6	3.74%	3.74%	155.9	28.5	28.6	1.8%	24.4	34.7	688.4
NF27-2	4.5%	2.30%	1.341	1.746	1.720	13.0	13.0	2.34%	2.34%	124.1	17.8	17.8	1.4%	21.0	31.5	591.6
NF28-1	4.1%	1.90%	1.353	1.946	2.000	24.3	23.9	2.12%	2.13%	56.3	16.1	16.3	2.2%	23.4	33.5	659.4
NF28-2	6.7%	1.40%	1.673	1.978	2.041	35.8	35.9	3.52%	3.51%	69.3	26.9	26.8	2.9%	24.3	34.5	686.3
μ	3.9%	1.81%	1.601	1.714	1.713	15.6	15.5	2.02%	2.02%	64.7	15.4	15.4	1.7%	19.4	29.7	547.0
$\mu+\sigma$	5.7%	2.90%	1.893	1.950	1.949	22.9	22.8	2.98%	2.97%	103.5	22.7	22.7	2.3%	22.9	33.0	645.0

Table A-13: SAC Results / LA3SSD

Ground motion	Story Drift	Residual Story Drift	Roof Acceleration (g)	Normalized Brace Force Tension	Normalized Brace Force Compression	Tensile Ductility	Compressive Ductility	Brace Strain in Tension	Brace Strain in Compression	Cumulative Ductility	Reference Tensile Ductility	Reference Compressive Ductility	Column Rotation	Column Stress in Tension (ksi)	Column Stress in Compression (ksi)	Column Uplift Force (kips)
LA21	4.0%	0.56%	1.948	2.969	2.963	51.3	50.4	6.39%	6.19%	178.8	48.8	47.3	1.8%	36.6	46.8	1031.0
LA22	3.0%	0.26%	2.568	2.639	2.712	50.0	48.9	4.59%	4.42%	214.0	35.1	33.7	1.3%	34.6	44.9	976.0
LA23	2.0%	0.15%	2.348	2.328	2.322	37.7	37.3	3.03%	2.92%	231.0	23.1	22.3	1.0%	28.0	38.5	790.7
LA24	2.8%	0.06%	2.158	2.719	2.761	55.4	56.3	4.46%	4.41%	364.5	34.1	33.6	1.2%	34.4	44.5	970.3
LA25	3.4%	0.87%	2.244	2.678	2.733	45.1	44.6	5.24%	5.21%	150.3	40.0	39.8	0.9%	33.7	43.6	949.7
LA26	3.8%	0.51%	2.181	3.152	3.200	72.9	72.0	6.20%	6.18%	194.6	47.3	47.1	1.8%	39.1	49.1	1103.0
LA27	3.5%	0.42%	2.099	3.023	3.050	47.2	46.0	5.73%	5.72%	184.0	43.8	43.6	1.4%	38.2	48.2	1078.0
LA28	2.2%	0.29%	2.052	1.996	2.018	24.2	24.4	3.41%	3.44%	86.6	26.0	26.2	1.1%	24.8	35.3	699.3
LA29	1.9%	0.43%	2.384	2.107	2.109	16.8	16.8	2.98%	2.97%	157.5	22.8	22.7	0.9%	24.8	35.4	699.3
LA30	1.9%	0.35%	2.882	1.970	1.952	16.1	16.5	2.90%	2.95%	132.1	22.1	22.5	1.2%	22.7	33.1	640.8
LA31	1.7%	0.23%	1.912	2.135	2.144	24.4	24.1	2.48%	2.45%	151.5	19.0	18.7	0.8%	25.6	36.2	721.9
LA32	2.5%	0.24%	2.413	2.285	2.282	32.6	32.5	3.80%	3.74%	175.7	29.0	28.6	0.8%	28.7	39.1	810.5
LA33	2.9%	0.41%	2.186	2.379	2.355	34.7	34.8	4.65%	4.64%	191.2	35.5	35.4	1.2%	29.9	40.2	842.4
LA34	2.0%	0.28%	1.955	2.385	2.436	27.1	27.5	3.12%	3.10%	163.5	23.8	23.6	1.3%	27.6	37.8	777.3
LA35	6.0%	0.14%	2.506	3.703	3.871	91.2	92.2	8.54%	9.10%	275.8	65.2	69.5	2.0%	49.0	50.0	1382.0
LA36	4.0%	0.29%	2.206	3.077	3.091	75.3	74.6	6.03%	5.95%	265.4	46.0	45.4	1.9%	41.0	50.0	1156.0
μ	3.0%	0.34%	2.253	2.597	2.625	43.9	43.7	4.60%	4.59%	194.8	35.1	35.0	1.3%	32.4	42.0	914.3
$\mu+\sigma$	4.1%	0.53%	2.502	3.069	3.129	64.9	64.7	6.21%	6.28%	258.3	47.4	47.9	1.7%	39.4	47.6	1110.4

Table A-14: FEMA P695 Results (i) / LA3SSD

Ground motion	Story Drift	Residual Story Drift	Roof Acceleration (g)	Normalized Brace Force Tension	Normalized Brace Force Compression	Tensile Ductility	Compressive Ductility	Brace Strain in Tension	Brace Strain in Compression	Cumulative Ductility	Reference Tensile Ductility	Reference Compressive Ductility	Column Rotation	Column Stress in Tension (ksi)	Column Stress in Compression (ksi)	Column Uplift Force (kips)
FF01-1	2.2%	0.11%	2.040	2.413	2.453	36.2	36.0	3.39%	3.40%	244.1	25.9	26.0	0.9%	28.8	39.2	812.1
FF01-2	1.6%	0.47%	1.849	1.910	1.912	21.1	20.4	2.36%	2.39%	149.1	18.0	18.2	0.6%	22.3	33.0	630.0
FF02-1	2.0%	0.65%	2.163	1.929	1.886	19.3	19.6	3.08%	3.08%	108.8	23.5	23.5	0.7%	22.3	33.1	629.5
FF02-2	1.9%	0.32%	2.460	1.968	1.945	26.3	25.6	3.06%	3.08%	122.8	23.4	23.5	1.0%	21.9	32.7	617.5
FF03-1	1.5%	0.72%	2.182	1.727	1.724	13.1	13.2	2.25%	2.20%	92.6	17.1	16.8	0.6%	20.8	31.5	586.2
FF03-2	3.0%	0.39%	1.928	2.458	2.423	38.0	37.5	4.81%	4.78%	90.5	36.7	36.5	0.9%	30.6	41.3	861.9
FF09-1	1.7%	0.61%	2.328	2.028	2.035	25.2	25.1	2.65%	2.63%	80.2	20.2	20.0	0.8%	23.0	33.4	647.5
FF09-2	2.4%	0.67%	2.772	2.209	2.246	30.7	30.7	3.56%	3.44%	117.1	27.2	26.2	1.1%	26.2	36.6	739.6
FF16-1	3.0%	0.80%	2.134	2.587	2.600	41.7	41.8	4.67%	4.71%	111.5	35.6	36.0	1.3%	30.2	40.7	852.7
FF16-2	1.8%	0.66%	1.600	2.017	2.022	25.1	24.5	2.52%	2.51%	71.4	19.3	19.2	0.6%	24.6	35.2	692.4
FF18-1	2.8%	0.55%	2.258	2.396	2.389	35.8	35.9	4.38%	4.38%	120.5	33.4	33.4	1.4%	28.5	38.7	804.6
FF18-2	1.1%	0.52%	1.428	1.717	1.749	16.7	16.9	1.60%	1.66%	66.0	12.2	12.7	0.7%	18.6	29.4	523.8
FF19-1	1.9%	0.26%	2.357	2.117	2.140	24.7	24.6	2.79%	2.75%	230.8	21.3	21.0	0.9%	25.8	36.2	728.4
FF19-2	2.6%	0.54%	1.998	2.581	2.602	38.6	37.8	4.13%	4.09%	214.3	31.5	31.2	1.1%	31.8	42.0	896.2
NF02-1	3.8%	0.49%	2.090	2.872	2.873	71.7	71.4	6.04%	6.07%	183.6	46.1	46.3	2.2%	34.4	44.5	969.2
NF02-2	5.3%	0.71%	2.156	3.441	3.409	88.9	87.5	8.29%	8.32%	195.5	63.3	63.5	1.9%	38.0	48.7	1072.0
NF04-1	3.7%	0.63%	1.730	2.853	2.832	42.6	42.0	6.09%	6.06%	177.5	46.5	46.3	0.8%	35.4	45.8	997.2
NF04-2	1.5%	0.48%	2.523	2.156	2.193	28.7	28.1	2.20%	2.12%	158.7	16.8	16.1	0.9%	24.4	34.7	687.4
NF06-1	3.5%	0.45%	2.281	2.608	2.564	42.2	41.3	5.58%	5.55%	121.3	42.6	42.4	1.1%	33.0	43.7	931.8
NF06-2	4.3%	0.40%	1.229	2.841	2.832	49.3	49.3	6.74%	6.80%	118.1	51.5	51.9	1.2%	35.2	31.8	992.3
NF07-1	2.5%	0.42%	2.242	2.220	2.180	37.6	38.4	3.90%	3.88%	305.6	29.7	29.6	1.1%	26.8	37.5	755.2
NF07-2	2.5%	0.32%	2.212	2.141	2.079	37.7	36.5	3.95%	3.99%	148.3	30.1	30.5	1.2%	23.5	34.3	661.5

Table A-15: FEMA P695 Results (ii) / LA3NSD

Ground motion	Story Drift	Residual Story Drift	Roof Acceleration (g)	Normalized Brace Force Tension	Normalized Brace Force Compression	Tensile Ductility	Compressive Ductility	Brace Strain in Tension	Brace Strain in Compression	Cumulative Ductility	Reference Tensile Ductility	Reference Compressive Ductility	Column Rotation	Column Stress in Tension (ksi)	Column Stress in Compression (ksi)	Column Uplift Force (kips)
NF09-1	3.7%	0.70%	2.293	2.870	2.923	56.1	55.7	5.71%	5.65%	144.2	43.6	43.1	1.2%	36.8	46.7	1036.0
NF09-2	1.9%	0.36%	2.135	2.349	2.398	39.9	39.3	2.98%	2.94%	130.9	22.7	22.5	1.2%	26.8	37.3	756.7
NF10-1	2.3%	0.52%	2.203	2.479	2.509	34.1	33.5	3.53%	3.47%	109.3	27.0	26.5	0.8%	30.0	40.2	844.6
NF10-2	1.9%	0.35%	1.839	1.889	1.918	23.3	22.9	2.52%	2.62%	72.4	19.2	20.0	1.1%	23.3	33.6	655.7
NF12-1	3.1%	0.33%	1.852	2.523	2.547	37.2	37.3	4.98%	4.97%	424.8	38.0	37.9	1.4%	29.1	39.4	820.4
NF12-2	3.0%	0.24%	1.854	2.717	2.727	36.7	37.2	4.75%	4.67%	422.7	36.2	35.6	1.3%	33.7	44.0	949.0
NF15-1	1.8%	0.33%	3.065	2.009	2.041	28.2	27.7	2.84%	2.84%	139.5	21.7	21.7	0.8%	23.0	33.2	648.4
NF15-2	1.6%	0.72%	1.923	1.974	2.002	23.8	24.1	2.37%	2.39%	101.1	18.1	18.3	0.9%	22.9	33.4	646.0
NF22-1	2.1%	0.59%	2.928	1.991	1.997	24.7	24.8	3.02%	3.09%	59.6	23.0	23.6	1.2%	21.7	32.2	612.0
NF22-2	1.4%	0.28%	1.977	1.803	1.785	18.5	18.2	2.07%	2.07%	66.7	15.8	15.8	1.1%	17.7	28.6	498.2
NF23-1	3.6%	0.33%	2.193	2.753	2.780	46.1	45.8	5.54%	5.49%	144.0	42.2	41.9	1.0%	34.2	44.4	965.2
NF23-2	2.1%	0.54%	2.528	2.150	2.144	23.5	22.9	3.25%	3.27%	110.6	24.8	24.9	1.0%	25.1	35.6	706.7
NF24-1	1.5%	0.32%	2.970	2.096	2.140	25.5	25.4	2.23%	2.14%	248.4	17.0	16.3	1.1%	25.1	35.4	708.8
NF24-2	1.6%	0.60%	2.024	1.864	1.862	19.8	19.4	2.27%	2.25%	137.9	17.3	17.2	0.7%	21.7	32.3	611.9
NF26-1	3.0%	0.20%	2.248	2.542	2.554	50.1	49.6	4.70%	4.73%	260.7	35.9	36.1	1.1%	31.2	41.3	878.5
NF26-2	1.9%	0.54%	2.270	1.938	1.906	21.2	21.2	2.99%	3.01%	164.7	22.8	23.0	1.0%	20.7	31.4	584.3
NF27-1	2.8%	0.63%	2.303	2.377	2.379	35.1	35.5	4.33%	4.37%	298.4	33.0	33.3	1.2%	27.7	38.3	781.1
NF27-2	2.7%	0.16%	1.926	2.396	2.396	31.7	32.2	4.37%	4.42%	328.2	33.3	33.7	0.9%	28.1	38.6	791.1
NF28-1	2.7%	0.51%	1.585	2.676	2.714	58.3	57.3	4.29%	4.22%	141.2	32.7	32.2	1.2%	32.6	42.7	918.6
NF28-2	4.5%	0.66%	2.245	3.264	3.339	90.3	91.1	6.77%	6.81%	176.3	51.7	52.0	1.4%	45.7	50.0	1290.0
μ	2.5%	0.48%	2.151	2.330	2.337	36.1	35.8	3.89%	3.89%	164.5	29.7	29.7	1.1%	27.7	37.7	780.8
$\mu+\sigma$	3.4%	0.65%	2.524	2.733	2.745	53.0	52.7	5.40%	5.40%	252.6	41.2	41.2	1.4%	33.6	43.0	946.3

Table A-16: FEMA P695 Results (i) / Riv3NCh

Ground motion	Story Drift	Residual Story Drift	Roof Acceleration (g)	Normalized Brace Force Tension	Normalized Brace Force Compression	Tensile Ductility	Compressive Ductility	Brace Strain in Tension	Brace Strain in Compression	Cumulative Ductility	Reference Tensile Ductility	Reference Compressive Ductility	Column Rotation	Column Stress in Tension (ksi)	Column Stress in Compression (ksi)	Column Uplift Force (kips)
FF01-1	2.5%	0.49%	0.942	1.738	1.747	18.9	17.9	2.10%	1.82%	103.7	16.1	13.9	1.3%	7.6	15.6	214.9
FF01-2	1.6%	0.05%	0.888	1.559	1.558	12.8	11.8	1.29%	1.21%	69.9	9.9	9.3	0.8%	6.6	14.6	186.3
FF02-1	1.8%	0.98%	0.748	1.509	1.485	8.0	8.1	1.45%	1.35%	49.6	11.0	10.3	0.7%	7.4	15.4	207.7
FF02-2	1.8%	0.23%	1.010	1.590	1.589	10.4	9.8	1.40%	1.33%	42.6	10.7	10.1	1.2%	7.1	15.1	200.9
FF03-1	1.7%	0.74%	1.019	1.418	1.407	6.3	6.2	1.18%	1.09%	39.9	9.0	8.3	0.8%	6.8	14.8	190.6
FF03-2	3.0%	1.60%	0.891	1.798	1.762	21.5	20.1	2.50%	2.27%	43.0	19.0	17.3	0.9%	8.3	16.3	234.4
FF09-1	1.7%	0.17%	1.221	1.531	1.519	9.6	9.1	1.41%	1.27%	38.3	10.7	9.7	0.8%	6.7	14.7	189.2
FF09-2	1.9%	0.63%	1.281	1.757	1.747	19.1	17.6	1.62%	1.48%	60.1	12.4	11.3	1.4%	7.9	15.8	221.4
FF16-1	3.7%	2.50%	1.183	1.869	1.819	24.0	22.5	3.14%	2.89%	45.1	23.9	22.1	1.6%	5.5	13.6	154.5
FF16-2	1.9%	1.20%	1.155	1.561	1.545	13.2	12.6	1.53%	1.35%	34.1	11.7	10.3	0.6%	5.3	13.4	149.8
FF18-1	2.7%	1.70%	1.032	1.664	1.631	16.9	15.9	2.20%	2.02%	50.0	16.8	15.4	1.2%	6.7	14.8	190.1
FF18-2	1.2%	0.25%	0.678	1.389	1.388	6.7	6.6	0.77%	0.73%	25.0	5.9	5.6	0.8%	5.7	13.8	160.8
FF19-1	2.6%	1.60%	1.413	1.633	1.598	9.1	9.4	2.17%	2.04%	85.7	16.6	15.5	1.1%	6.9	14.9	194.9
FF19-2	5.6%	2.40%	1.358	2.264	2.184	28.0	25.4	4.78%	4.29%	137.2	36.4	32.8	1.6%	10.9	18.7	306.5
NF02-1	3.4%	1.20%	1.369	2.051	2.024	23.7	22.3	2.88%	2.64%	73.6	22.0	20.1	1.7%	9.9	17.8	279.7
NF02-2	5.8%	1.40%	1.261	2.203	2.111	35.9	37.1	4.91%	4.54%	87.1	37.5	34.6	2.2%	10.9	18.8	307.8
NF04-1	6.9%	2.80%	1.120	2.712	2.625	50.6	47.0	5.55%	4.70%	142.4	42.3	35.9	1.7%	13.5	21.1	379.4
NF04-2	2.2%	0.62%	1.003	1.599	1.617	12.9	12.2	1.80%	1.63%	63.8	13.7	12.4	1.1%	8.0	16.0	225.2
NF06-1	3.8%	2.20%	1.348	1.899	1.846	25.2	23.4	3.18%	2.94%	54.8	24.2	22.4	1.3%	8.6	16.6	243.5
NF06-2	6.5%	1.70%	1.117	2.795	2.690	82.6	78.1	11.35%	10.72%	168.2	86.6	81.8	2.6%	10.9	18.9	307.3
NF07-1	2.4%	1.10%	0.965	1.576	1.575	14.0	13.3	2.00%	1.89%	96.2	15.3	14.4	1.0%	7.6	15.6	214.2
NF07-2	2.5%	0.98%	0.947	1.546	1.561	13.9	13.2	2.00%	1.91%	41.6	15.3	14.6	1.3%	7.2	15.2	204.3

Table A-17: FEMA P695 Results (ii) / Riv3NCh

Ground motion	Story Drift	Residual Story Drift	Roof Acceleration (g)	Normalized Brace Force Tension	Normalized Brace Force Compression	Tensile Ductility	Compressive Ductility	Brace Strain in Tension	Brace Strain in Compression	Cumulative Ductility	Reference Tensile Ductility	Reference Compressive Ductility	Column Rotation	Column Stress in Tension (ksi)	Column Stress in Compression (ksi)	Column Uplift Force (kips)
NF09-1	3.2%	1.90%	1.220	1.972	1.947	26.4	24.3	2.33%	2.20%	50.7	17.8	16.8	1.2%	7.0	15.0	197.2
NF09-2	1.7%	0.40%	1.460	1.668	1.660	16.5	15.3	1.33%	1.25%	57.9	10.1	9.5	1.1%	7.7	15.6	215.8
NF10-1	2.9%	2.00%	0.938	1.764	1.726	17.7	17.2	2.44%	2.25%	47.5	18.6	17.1	1.0%	8.2	16.2	230.4
NF10-2	1.8%	0.73%	0.875	1.476	1.482	9.6	9.1	1.41%	1.36%	21.9	10.7	10.4	1.2%	7.0	15.0	196.9
NF12-1	4.0%	1.00%	1.473	2.286	2.235	37.9	36.5	3.38%	3.14%	360.8	25.8	23.9	2.2%	11.2	19.1	316.4
NF12-2	3.5%	1.80%	1.046	1.919	1.904	23.6	22.9	2.96%	2.73%	204.9	22.6	20.8	2.0%	8.7	16.6	246.2
NF15-1	1.8%	0.26%	1.778	1.606	1.628	14.3	13.3	1.53%	1.22%	85.4	11.7	9.3	1.2%	6.9	14.9	194.4
NF15-2	1.3%	0.14%	1.260	1.465	1.460	9.7	9.3	0.84%	0.79%	42.5	6.4	6.0	0.8%	7.2	15.2	202.6
NF22-1	2.9%	1.80%	1.525	1.627	1.588	16.8	15.9	2.39%	2.28%	26.3	18.3	17.4	1.7%	6.7	14.7	188.1
NF22-2	1.6%	0.85%	0.743	1.425	1.405	8.7	8.3	1.27%	1.21%	20.6	9.7	9.2	1.1%	5.2	13.2	145.4
NF23-1	2.9%	1.70%	1.103	1.847	1.812	23.3	21.7	2.44%	2.20%	52.4	18.6	16.8	0.9%	7.0	15.0	196.7
NF23-2	1.7%	0.73%	1.445	1.457	1.451	7.4	7.6	1.35%	1.27%	43.5	10.3	9.7	0.8%	7.2	15.2	202.7
NF24-1	1.8%	0.86%	1.368	1.630	1.613	14.2	13.6	1.43%	1.27%	79.9	10.9	9.7	1.0%	6.7	14.7	187.6
NF24-2	1.8%	0.18%	0.989	1.616	1.613	10.8	10.0	1.43%	1.37%	51.1	10.9	10.5	1.1%	7.0	15.0	197.2
NF26-1	3.2%	1.00%	1.231	1.877	1.839	22.9	23.2	2.69%	2.42%	116.4	20.5	18.5	1.0%	8.7	16.7	245.6
NF26-2	2.0%	0.60%	0.751	1.508	1.495	11.6	11.0	1.59%	1.48%	52.5	12.1	11.3	1.4%	5.6	13.6	158.1
NF27-1	5.6%	2.40%	1.339	2.300	2.226	27.7	30.8	4.83%	4.26%	308.4	36.9	32.5	1.5%	8.1	15.9	227.4
NF27-2	2.9%	1.40%	1.202	1.767	1.734	15.3	14.5	2.47%	2.23%	159.7	18.8	17.0	1.0%	7.6	15.6	214.0
NF28-1	3.9%	2.10%	1.595	2.304	2.251	44.5	43.3	3.36%	2.98%	117.5	25.6	22.7	2.4%	12.2	20.0	343.2
NF28-2	6.2%	1.80%	1.488	2.309	2.256	58.8	58.5	5.25%	4.86%	122.6	40.0	37.1	2.6%	10.0	17.9	281.6
μ	3.0%	1.20%	1.161	1.797	1.770	21.0	20.1	2.57%	2.35%	85.1	19.6	18.0	1.3%	7.9	15.9	222.6
$\mu+\sigma$	4.4%	1.93%	1.414	2.138	2.086	36.1	34.7	4.39%	4.04%	155.3	33.5	30.8	1.8%	9.8	17.7	275.0

Table A-18: FEMA P695 Results (i) / Riv3NCh1.5

Ground motion	Story Drift	Residual Story Drift	Roof Acceleration (g)	Normalized Brace Force Tension	Normalized Brace Force Compression	Tensile Ductility	Compressive Ductility	Brace Strain in Tension	Brace Strain in Compression	Cumulative Ductility	Reference Tensile Ductility	Reference Compressive Ductility	Column Rotation	Column Stress in Tension (ksi)	Column Stress in Compression (ksi)	Column Uplift Force (kips)
FF01-1	1.9%	0.72%	1.277	1.595	1.580	14.7	13.8	1.64%	1.34%	67.9	12.5	10.2	1.1%	11.6	19.6	328.1
FF01-2	1.0%	0.42%	1.121	1.385	1.371	5.4	4.9	0.79%	0.72%	44.5	6.0	5.5	0.5%	10.6	18.7	299.3
FF02-1	1.4%	0.76%	1.056	1.380	1.364	6.7	6.4	1.19%	1.06%	35.2	9.1	8.1	0.7%	10.9	18.9	307.1
FF02-2	1.6%	0.69%	1.189	1.411	1.415	8.5	8.2	1.31%	1.26%	40.0	10.0	9.6	0.9%	9.4	17.5	265.7
FF03-1	1.0%	0.28%	1.181	1.344	1.338	3.7	3.6	0.75%	0.67%	26.6	5.7	5.1	0.6%	10.6	18.6	299.0
FF03-2	2.4%	0.79%	1.076	1.592	1.557	15.0	14.1	2.08%	1.94%	26.2	15.9	14.8	0.7%	11.9	20.0	336.5
FF09-1	1.3%	0.50%	0.921	1.436	1.420	8.7	8.1	1.05%	0.93%	21.3	8.0	7.1	0.7%	9.7	17.8	274.2
FF09-2	1.5%	0.70%	1.379	1.427	1.413	8.8	8.3	1.24%	1.07%	33.0	9.5	8.2	1.0%	9.2	17.2	259.3
FF16-1	2.7%	1.60%	1.306	1.690	1.653	18.4	17.1	2.31%	2.10%	30.6	17.6	16.0	1.6%	10.9	18.9	306.5
FF16-2	1.3%	0.59%	1.039	1.409	1.393	8.2	7.7	0.97%	0.87%	15.2	7.4	6.6	0.4%	9.4	17.5	264.8
FF18-1	2.2%	1.40%	1.570	1.599	1.572	15.1	14.1	1.90%	1.71%	39.0	14.5	13.0	1.1%	11.0	19.1	310.7
FF18-2	1.0%	0.19%	0.890	1.362	1.356	6.3	6.0	0.67%	0.63%	16.7	5.1	4.8	0.6%	10.2	18.2	286.4
FF19-1	2.5%	1.40%	1.823	1.681	1.654	13.4	12.6	2.23%	1.92%	121.1	17.0	14.6	1.2%	11.6	19.5	327.0
FF19-2	2.4%	1.60%	1.159	1.713	1.684	14.1	13.1	2.07%	1.82%	51.2	15.8	13.9	0.8%	12.8	20.8	360.6
NF02-1	3.0%	0.22%	1.809	1.839	1.825	24.2	23.5	2.58%	2.38%	55.2	19.7	18.2	1.6%	13.3	21.2	373.9
NF02-2	4.2%	1.20%	1.486	1.867	1.802	29.0	28.9	3.65%	3.41%	58.4	27.9	26.0	1.8%	13.7	21.7	386.8
NF04-1	4.3%	1.80%	1.144	2.026	1.962	24.5	24.1	3.84%	3.42%	96.5	29.3	26.1	1.4%	14.8	22.7	416.4
NF04-2	1.3%	0.45%	1.200	1.524	1.513	12.2	11.3	1.06%	0.88%	35.0	8.1	6.7	0.7%	10.6	18.6	298.3
NF06-1	2.5%	0.61%	1.608	1.642	1.643	15.3	13.6	2.19%	1.97%	35.0	16.7	15.1	1.2%	11.6	19.6	326.8
NF06-2	3.3%	1.90%	1.037	1.738	1.689	20.4	19.0	2.83%	2.63%	34.6	21.6	20.1	1.5%	12.5	20.5	352.3
NF07-1	2.0%	0.79%	1.498	1.581	1.584	12.8	11.4	1.63%	1.56%	80.0	12.4	11.9	0.6%	11.9	19.8	334.9
NF07-2	1.4%	0.48%	1.059	1.570	1.555	13.8	12.7	1.16%	1.00%	34.1	8.9	7.6	0.8%	11.5	19.5	323.4

Table A-19: FEMA P695 Results (ii) / Riv3NCh1.5

Ground motion	Story Drift	Residual Story Drift	Roof Acceleration (g)	Normalized Brace Force Tension	Normalized Brace Force Compression	Tensile Ductility	Compressive Ductility	Brace Strain in Tension	Brace Strain in Compression	Cumulative Ductility	Reference Tensile Ductility	Reference Compressive Ductility	Column Rotation	Column Stress in Tension (ksi)	Column Stress in Compression (ksi)	Column Uplift Force (kips)
NF09-1	3.3%	1.70%	1.196	1.843	1.795	24.0	22.1	2.88%	2.62%	38.9	22.0	20.0	1.2%	10.6	18.6	299.7
NF09-2	2.0%	0.89%	1.188	1.596	1.570	15.0	13.9	1.66%	1.50%	31.2	12.6	11.4	1.3%	11.5	19.5	325.0
NF10-1	2.1%	1.10%	1.137	1.634	1.609	11.2	10.7	1.81%	1.61%	35.8	13.8	12.2	0.6%	11.8	19.8	333.0
NF10-2	1.4%	0.72%	1.155	1.381	1.370	7.2	6.6	0.99%	0.94%	15.6	7.6	7.2	0.5%	11.1	19.2	313.8
NF12-1	4.4%	2.40%	1.437	1.911	1.841	22.2	20.7	3.87%	3.60%	210.4	29.5	27.5	1.8%	14.6	22.6	412.4
NF12-2	3.1%	1.50%	1.576	1.730	1.685	12.9	12.1	2.66%	2.46%	138.1	20.3	18.8	1.1%	12.7	20.7	358.7
NF15-1	1.4%	0.34%	1.945	1.471	1.466	10.2	9.6	1.03%	0.93%	42.9	7.8	7.1	1.0%	11.0	19.1	311.4
NF15-2	1.3%	0.48%	1.202	1.407	1.390	7.5	7.0	1.00%	0.92%	31.5	7.6	7.0	0.5%	11.3	19.3	317.9
NF22-1	1.8%	1.10%	1.680	1.436	1.415	9.0	8.5	1.29%	1.22%	12.4	9.8	9.3	0.8%	11.8	19.9	332.8
NF22-2	1.1%	0.28%	1.238	1.360	1.346	6.5	6.1	0.85%	0.79%	21.6	6.5	6.0	0.8%	9.8	17.9	277.7
NF23-1	3.1%	1.60%	1.375	1.760	1.714	21.0	19.5	2.69%	2.48%	39.9	20.5	18.9	1.5%	11.0	19.0	310.5
NF23-2	1.4%	0.66%	1.749	1.448	1.430	6.2	5.9	1.17%	1.05%	35.8	8.9	8.0	1.2%	11.5	19.6	324.9
NF24-1	1.6%	0.80%	1.335	1.501	1.480	9.1	8.9	1.33%	1.21%	58.9	10.1	9.2	0.9%	11.0	19.1	310.8
NF24-2	1.2%	0.23%	1.011	1.372	1.369	5.8	5.4	0.91%	0.85%	33.3	7.0	6.5	0.6%	10.5	18.5	296.3
NF26-1	2.6%	0.55%	1.325	1.666	1.666	16.8	15.7	2.23%	2.07%	54.9	17.0	15.8	1.2%	12.2	20.2	343.9
NF26-2	1.4%	0.51%	1.099	1.390	1.371	7.7	7.2	1.09%	1.02%	40.0	8.3	7.8	0.9%	10.4	18.4	292.9
NF27-1	3.3%	1.70%	1.311	1.769	1.733	19.1	18.2	2.97%	2.56%	144.7	22.6	19.5	1.4%	11.2	19.2	317.0
NF27-2	2.0%	0.82%	1.094	1.555	1.531	12.0	11.7	1.67%	1.50%	86.9	12.7	11.5	1.0%	10.6	18.6	299.8
NF28-1	2.9%	0.40%	1.428	1.864	1.847	24.5	23.3	2.43%	2.30%	52.3	18.6	17.5	1.8%	13.1	21.0	368.7
NF28-2	4.6%	1.30%	1.677	2.093	2.055	43.5	43.5	4.13%	3.72%	78.7	31.5	28.4	2.1%	13.9	21.8	392.7
μ	2.2%	0.91%	1.309	1.595	1.572	14.1	13.3	1.85%	1.68%	52.4	14.1	12.8	1.0%	11.5	19.5	323.3
$\mu+\sigma$	3.2%	1.45%	1.567	1.789	1.753	21.8	21.0	2.78%	2.53%	91.6	21.2	19.3	1.5%	12.8	20.8	360.2

Table A-20: FEMA P695 Results (i) / Riv3SCh

Ground motion	Story Drift	Residual Story Drift	Roof Acceleration (g)	Normalized Brace Force Tension	Normalized Brace Force Compression	Tensile Ductility	Compressive Ductility	Brace Strain in Tension	Brace Strain in Compression	Cumulative Ductility	Reference Tensile Ductility	Reference Compressive Ductility	Column Rotation	Column Stress in Tension (ksi)	Column Stress in Compression (ksi)	Column Uplift Force (kips)
FF01-1	2.2%	0.23%	1.106	2.220	2.187	31.4	33.3	3.75%	3.27%	216.2	28.6	24.9	1.0%	9.3	17.3	262.3
FF01-2	1.3%	0.31%	0.933	1.799	1.775	17.8	17.2	2.06%	1.92%	124.6	15.7	14.7	0.5%	7.4	15.5	209.3
FF02-1	1.8%	0.75%	1.169	1.857	1.821	15.0	15.2	2.89%	2.80%	97.7	22.1	21.3	0.6%	9.0	17.0	253.0
FF02-2	1.6%	0.27%	1.156	1.896	1.883	21.3	21.2	2.47%	2.38%	93.2	18.8	18.2	1.0%	7.7	15.8	217.5
FF03-1	1.1%	0.47%	0.937	1.600	1.587	10.3	10.0	1.62%	1.46%	76.4	12.3	11.2	0.6%	7.9	16.0	223.6
FF03-2	2.7%	0.63%	0.817	2.304	2.245	33.7	32.3	4.55%	4.31%	79.7	34.7	32.9	0.9%	11.0	19.0	309.3
FF09-1	1.3%	0.50%	0.972	1.863	1.843	19.4	18.3	2.10%	1.85%	64.7	16.0	14.1	0.7%	6.7	14.8	189.7
FF09-2	1.8%	0.67%	1.013	2.102	2.076	28.1	26.6	3.07%	2.69%	111.3	23.4	20.5	0.7%	8.1	16.1	228.3
FF16-1	2.7%	0.86%	1.176	2.432	2.372	38.2	36.3	4.53%	4.24%	79.8	34.6	32.4	1.1%	8.0	16.1	226.5
FF16-2	1.3%	0.61%	1.031	1.756	1.735	18.0	17.2	2.00%	1.88%	55.5	15.3	14.4	0.4%	6.6	14.7	186.6
FF18-1	2.2%	0.72%	1.165	2.181	2.144	30.3	29.3	3.70%	3.34%	106.0	28.3	25.5	1.1%	7.9	16.0	223.7
FF18-2	0.9%	0.43%	1.026	1.592	1.591	13.4	12.7	1.35%	1.31%	51.0	10.3	10.0	0.6%	7.2	15.3	203.7
FF19-1	1.4%	0.51%	1.049	1.800	1.783	15.8	15.8	2.26%	1.95%	150.5	17.2	14.9	0.7%	7.5	15.5	211.7
FF19-2	2.4%	0.66%	1.297	2.517	2.472	33.9	31.8	4.12%	3.62%	196.7	31.4	27.6	0.9%	11.7	19.6	328.8
NF02-1	3.2%	0.56%	1.490	2.662	2.586	57.5	58.0	5.50%	5.13%	156.5	42.0	39.1	1.5%	11.6	19.6	327.1
NF02-2	4.0%	0.94%	1.505	2.882	2.775	71.6	71.4	6.91%	6.54%	147.0	52.7	49.9	1.6%	14.0	22.0	394.0
NF04-1	4.1%	0.63%	1.085	3.258	3.149	47.7	45.6	7.10%	6.41%	221.8	54.2	48.9	0.8%	16.6	24.5	468.6
NF04-2	1.3%	0.44%	1.154	2.046	2.031	25.8	24.2	2.08%	1.78%	116.2	15.8	13.6	0.8%	8.6	16.6	241.7
NF06-1	2.9%	0.48%	1.266	2.432	2.364	37.8	36.0	4.93%	4.70%	107.9	37.6	35.8	0.9%	11.7	19.8	331.3
NF06-2	6.5%	1.70%	1.117	2.795	2.690	82.6	78.1	11.35%	10.72%	168.2	86.6	81.8	2.6%	10.9	18.9	307.3
NF07-1	2.1%	0.69%	1.530	2.012	1.970	30.6	29.9	3.41%	3.29%	216.0	26.1	25.1	0.7%	9.6	17.7	271.1
NF07-2	1.8%	0.13%	1.034	1.869	1.857	27.2	26.1	2.89%	2.81%	107.6	22.1	21.5	0.9%	9.0	17.0	253.9

Table A-21: FEMA P695 Results (ii) / Riv3SCh

Ground motion	Story Drift	Residual Story Drift	Roof Acceleration (g)	Normalized Brace Force Tension	Normalized Brace Force Compression	Tensile Ductility	Compressive Ductility	Brace Strain in Tension	Brace Strain in Compression	Cumulative Ductility	Reference Tensile Ductility	Reference Compressive Ductility	Column Rotation	Column Stress in Tension (ksi)	Column Stress in Compression (ksi)	Column Uplift Force (kips)
NF09-1	2.6%	0.88%	1.431	2.669	2.608	49.7	47.4	4.39%	4.01%	108.5	33.5	30.6	0.9%	9.8	17.8	277.3
NF09-2	1.5%	0.16%	1.506	2.189	2.160	30.3	28.7	2.47%	2.20%	100.9	18.9	16.8	0.9%	9.7	17.7	272.4
NF10-1	2.0%	0.69%	0.869	2.253	2.215	27.2	26.7	3.34%	3.03%	96.3	25.5	23.1	0.5%	10.3	18.3	290.8
NF10-2	1.5%	0.60%	1.319	1.782	1.752	14.9	13.8	2.37%	2.29%	45.1	18.1	17.5	0.8%	8.7	16.8	245.9
NF12-1	3.3%	0.02%	1.273	2.838	2.764	55.5	54.9	5.64%	5.34%	662.1	43.0	40.8	2.0%	13.7	21.7	385.7
NF12-2	2.7%	0.14%	1.157	2.489	2.427	30.8	29.4	4.59%	4.29%	396.0	35.0	32.7	1.2%	11.1	19.1	312.7
NF15-1	1.2%	0.05%	1.807	1.903	1.901	21.8	20.5	1.97%	1.68%	115.6	15.0	12.8	1.0%	8.2	16.2	230.0
NF15-2	1.1%	0.46%	1.259	1.752	1.734	15.2	14.9	1.67%	1.51%	84.3	12.7	11.5	0.5%	8.6	16.7	243.6
NF22-1	1.7%	0.64%	1.556	1.848	1.815	20.1	19.3	2.72%	2.62%	45.5	20.7	20.0	0.8%	9.1	17.2	257.6
NF22-2	1.4%	0.40%	1.143	1.791	1.764	18.7	18.0	2.35%	2.23%	69.6	17.9	17.0	0.9%	6.5	14.6	183.6
NF23-1	2.5%	0.36%	1.337	2.521	2.465	40.5	38.1	4.24%	3.90%	111.4	32.4	29.7	0.7%	9.3	17.3	262.0
NF23-2	1.6%	0.60%	1.518	1.913	1.884	15.6	15.7	2.62%	2.44%	85.3	20.0	18.6	0.9%	9.4	17.5	265.4
NF24-1	1.5%	0.38%	1.581	2.030	2.002	23.7	23.3	2.46%	2.23%	180.8	18.8	17.0	0.9%	8.2	16.3	232.3
NF24-2	1.0%	0.32%	1.010	1.787	1.771	16.8	15.7	1.52%	1.39%	104.2	11.6	10.6	0.6%	8.0	16.1	226.8
NF26-1	2.5%	0.17%	1.282	2.344	2.306	45.0	44.4	4.15%	3.89%	208.3	31.7	29.7	1.0%	11.1	19.1	313.7
NF26-2	1.6%	0.45%	1.200	1.847	1.815	20.3	19.5	2.66%	2.55%	127.1	20.3	19.4	0.9%	7.2	15.2	202.3
NF27-1	2.8%	0.63%	1.220	2.503	2.447	39.9	40.5	4.80%	4.34%	481.1	36.6	33.1	1.0%	9.4	17.4	265.0
NF27-2	2.3%	0.42%	1.045	2.175	2.132	25.7	25.8	3.81%	3.53%	300.6	29.0	26.9	0.7%	8.0	16.0	224.2
NF28-1	3.6%	0.74%	1.632	3.124	3.027	77.9	76.5	6.22%	5.70%	194.2	47.5	43.5	1.6%	15.8	23.8	445.1
NF28-2	5.2%	0.55%	1.475	3.783	3.631	97.8	97.5	8.86%	8.15%	212.1	67.6	62.2	1.7%	19.2	27.2	542.6
μ	2.2%	0.52%	1.230	2.224	2.180	33.2	32.3	3.75%	3.47%	154.1	28.6	26.5	1.0%	9.7	17.8	274.9
$\mu+\sigma$	3.4%	0.81%	1.456	2.701	2.627	53.1	51.9	5.79%	5.38%	272.3	44.2	41.0	1.4%	12.5	20.5	351.7

Table A-22: FEMA P695 Results (i) / Riv3NSD

Ground motion	Story Drift	Residual Story Drift	Roof Acceleration (g)	Normalized Brace Force Tension	Normalized Brace Force Compression	Tensile Ductility	Compressive Ductility	Brace Strain in Tension	Brace Strain in Compression	Cumulative Ductility	Reference Tensile Ductility	Reference Compressive Ductility	Column Rotation	Column Stress in Tension (ksi)	Column Stress in Compression (ksi)	Column Uplift Force (kips)
FF01-1	2.0%	0.40%	1.124	1.529	1.542	11.7	11.8	0.99%	0.99%	62.3	7.5	7.5	1.2%	12.4	23.0	350.1
FF01-2	2.0%	0.12%	0.783	1.417	1.429	8.2	8.2	0.98%	0.98%	48.6	7.5	7.5	1.0%	11.1	21.6	311.9
FF02-1	1.9%	0.96%	0.858	1.397	1.395	5.6	5.9	0.90%	0.91%	32.3	6.9	7.0	0.7%	11.0	21.7	309.1
FF02-2	1.8%	0.26%	0.959	1.400	1.413	6.3	6.2	0.91%	0.91%	29.9	7.0	6.9	1.0%	11.4	22.0	320.2
FF03-1	1.9%	0.64%	1.099	1.367	1.368	5.2	5.4	0.90%	0.94%	25.9	6.9	7.1	1.1%	9.6	20.4	271.6
FF03-2	2.8%	1.80%	1.019	1.559	1.557	12.8	12.7	1.43%	1.42%	24.3	10.9	10.8	1.2%	13.1	23.7	368.4
FF09-1	1.8%	0.25%	0.766	1.372	1.381	5.0	5.0	0.88%	0.89%	23.0	6.7	6.8	0.8%	11.1	21.7	312.2
FF09-2	2.4%	0.09%	1.135	1.591	1.601	14.0	13.9	1.20%	1.20%	41.1	9.1	9.2	1.6%	13.1	23.7	369.8
FF16-1	3.4%	2.50%	1.233	1.607	1.602	14.2	14.2	1.74%	1.74%	28.9	13.3	13.3	2.0%	13.0	23.6	367.2
FF16-2	1.5%	0.67%	0.781	1.398	1.397	7.5	7.4	0.75%	0.75%	16.2	5.7	5.7	0.6%	10.6	21.3	299.9
FF18-1	2.5%	1.60%	1.104	1.471	1.467	9.8	9.9	1.26%	1.27%	31.9	9.6	9.7	1.0%	12.5	23.1	352.7
FF18-2	1.2%	0.22%	1.058	1.333	1.343	5.0	5.2	0.54%	0.53%	19.3	4.1	4.1	1.1%	8.7	19.3	244.0
FF19-1	5.0%	2.80%	1.364	1.750	1.738	9.5	9.6	2.56%	2.56%	118.9	19.5	19.6	1.4%	15.0	25.5	423.0
FF19-2	6.3%	3.50%	0.977	1.999	1.998	16.8	16.7	3.25%	3.24%	78.6	24.8	24.7	1.5%	17.8	28.3	503.0
NF02-1	3.5%	2.20%	1.492	1.849	1.867	13.2	12.5	1.78%	1.77%	41.8	13.6	13.5	1.5%	15.9	26.5	449.3
NF02-2	6.2%	2.10%	1.203	1.864	1.849	22.9	22.8	3.20%	3.20%	48.5	24.5	24.4	2.5%	15.7	26.2	442.8
NF04-1	7.7%	4.50%	1.157	2.324	2.336	37.5	37.1	3.96%	3.92%	92.3	30.2	29.9	2.3%	20.7	30.9	583.8
NF04-2	2.8%	1.10%	0.888	1.496	1.511	9.2	9.2	1.40%	1.40%	44.2	10.7	10.7	1.0%	12.3	22.9	345.6
NF06-1	3.8%	2.70%	1.549	1.630	1.621	15.1	15.0	1.95%	1.93%	26.7	14.9	14.8	2.0%	13.7	24.3	386.0
NF06-2	6.6%	4.10%	1.068	1.951	1.932	24.1	24.1	3.40%	3.39%	41.2	25.9	25.8	2.3%	16.7	18.9	472.3
NF07-1	2.4%	1.10%	0.943	1.402	1.392	7.9	7.7	1.20%	1.18%	62.5	9.2	9.0	1.1%	11.5	22.3	323.2
NF07-2	2.7%	1.20%	1.014	1.421	1.409	9.1	9.2	1.37%	1.38%	32.5	10.4	10.5	1.3%	11.0	21.7	310.3

Table A-23: FEMA P695 Results (ii) / Riv3NSD

Ground motion	Story Drift	Residual Story Drift	Roof Acceleration (g)	Normalized Brace Force Tension	Normalized Brace Force Compression	Tensile Ductility	Compressive Ductility	Brace Strain in Tension	Brace Strain in Compression	Cumulative Ductility	Reference Tensile Ductility	Reference Compressive Ductility	Column Rotation	Column Stress in Tension (ksi)	Column Stress in Compression (ksi)	Column Uplift Force (kips)
NF09-1	3.9%	2.20%	1.023	1.687	1.694	17.1	17.1	1.90%	1.87%	29.7	14.5	14.3	1.5%	14.2	24.8	400.8
NF09-2	1.7%	0.33%	1.221	1.473	1.484	10.0	10.1	0.85%	0.86%	34.5	6.5	6.6	1.1%	11.8	22.3	331.6
NF10-1	2.9%	2.10%	1.015	1.535	1.529	11.6	11.5	1.45%	1.45%	29.4	11.1	11.1	1.2%	12.8	23.5	361.1
NF10-2	2.0%	0.28%	0.986	1.384	1.397	6.5	6.6	0.99%	0.99%	15.3	7.6	7.6	1.3%	10.3	21.1	291.2
NF12-1	4.8%	2.40%	1.155	1.984	2.009	23.0	23.0	2.47%	2.44%	208.5	18.8	18.6	2.2%	17.7	28.1	498.5
NF12-2	4.4%	2.90%	1.161	1.690	1.725	15.2	15.3	2.26%	2.26%	115.5	17.3	17.2	1.4%	14.7	25.2	413.3
NF15-1	1.7%	0.86%	1.668	1.475	1.485	10.0	10.1	0.84%	0.84%	47.5	6.4	6.4	1.2%	11.5	22.1	323.8
NF15-2	1.4%	0.20%	1.109	1.375	1.381	6.7	6.8	0.65%	0.65%	32.2	4.9	4.9	0.9%	10.0	20.8	283.4
NF22-1	2.7%	1.60%	1.450	1.421	1.407	9.1	9.1	1.37%	1.37%	12.0	10.4	10.4	1.6%	10.5	21.1	295.9
NF22-2	1.9%	0.93%	0.877	1.358	1.348	6.2	6.1	0.93%	0.92%	11.7	7.1	7.0	1.1%	9.5	20.2	268.9
NF23-1	3.2%	1.90%	1.212	1.594	1.593	14.0	13.9	1.63%	1.64%	34.8	12.4	12.5	1.2%	13.2	23.7	371.2
NF23-2	1.5%	0.57%	1.512	1.379	1.387	4.3	4.4	0.69%	0.72%	25.9	5.3	5.5	1.3%	10.2	20.9	288.4
NF24-1	1.7%	0.45%	1.219	1.420	1.425	8.1	8.2	0.79%	0.80%	47.2	6.1	6.1	1.3%	11.8	22.5	332.6
NF24-2	1.9%	0.12%	0.933	1.457	1.467	7.1	7.1	0.94%	0.95%	40.5	7.2	7.3	1.0%	11.2	21.8	315.1
NF26-1	2.6%	0.51%	0.959	1.601	1.620	13.7	13.7	1.30%	1.31%	67.3	9.9	10.0	1.0%	13.5	24.0	381.0
NF26-2	2.3%	0.65%	1.001	1.406	1.418	7.8	7.8	1.15%	1.15%	32.6	8.8	8.8	1.5%	10.8	21.3	303.2
NF27-1	7.1%	4.00%	1.407	2.079	2.079	17.2	17.2	3.62%	3.62%	160.4	27.6	27.6	1.7%	18.7	29.0	526.5
NF27-2	2.8%	1.60%	0.898	1.520	1.519	8.3	8.2	1.39%	1.39%	92.2	10.6	10.6	0.8%	13.0	23.6	367.3
NF28-1	5.3%	3.10%	1.093	2.089	2.110	27.0	26.8	2.68%	2.68%	66.7	20.5	20.4	2.6%	18.7	29.1	528.3
NF28-2	6.7%	1.70%	1.392	1.980	2.022	36.1	36.2	3.44%	3.43%	68.9	26.3	26.2	2.9%	18.0	28.5	507.5
μ	3.2%	1.50%	1.116	1.596	1.601	12.6	12.6	1.62%	1.61%	51.0	12.3	12.3	1.4%	13.1	23.5	369.2
$\mu+\sigma$	5.0%	2.70%	1.332	1.842	1.850	20.3	20.2	2.53%	2.53%	90.5	19.3	19.3	1.9%	16.0	26.3	450.2

Table A-24: FEMA P695 Results (i) / Riv3SSD

Ground motion	Story Drift	Residual Story Drift	Roof Acceleration (g)	Normalized Brace Force Tension	Normalized Brace Force Compression	Tensile Ductility	Compressive Ductility	Brace Strain in Tension	Brace Strain in Compression	Cumulative Ductility	Reference Tensile Ductility	Reference Compressive Ductility	Column Rotation	Column Stress in Tension (ksi)	Column Stress in Compression (ksi)	Column Uplift Force (kips)
FF01-1	2.1%	0.35%	1.437	2.117	2.126	29.8	29.7	3.25%	3.29%	192.1	24.8	25.1	1.0%	18.3	28.8	515.0
FF01-2	1.3%	0.35%	1.234	1.721	1.735	15.6	15.3	1.94%	1.96%	115.5	14.8	15.0	0.5%	14.5	25.1	407.9
FF02-1	1.7%	0.78%	1.508	1.806	1.773	13.8	14.1	2.71%	2.74%	94.0	20.7	20.9	0.6%	15.1	26.0	424.9
FF02-2	1.4%	0.49%	1.494	1.787	1.832	18.1	17.9	2.14%	2.15%	84.2	16.3	16.4	0.7%	14.8	25.3	418.4
FF03-1	1.2%	0.53%	1.546	1.612	1.613	11.1	11.6	1.64%	1.66%	70.7	12.5	12.7	0.5%	13.2	23.8	372.4
FF03-2	2.5%	0.49%	0.987	2.178	2.164	30.1	29.9	3.97%	3.96%	70.1	30.3	30.2	0.8%	19.3	29.9	543.5
FF09-1	1.3%	0.51%	1.619	1.778	1.787	18.6	18.3	1.95%	1.97%	53.6	14.9	15.0	0.6%	14.8	25.5	416.2
FF09-2	1.9%	0.68%	1.631	1.929	1.938	22.7	22.9	2.73%	2.68%	95.4	20.8	20.4	0.8%	16.3	26.9	460.6
FF16-1	2.6%	0.90%	1.411	2.271	2.279	33.2	33.4	4.12%	4.18%	69.3	31.5	31.9	1.2%	19.7	30.1	555.1
FF16-2	1.5%	0.66%	1.219	1.778	1.770	18.4	17.9	2.05%	2.04%	46.1	15.6	15.6	0.4%	15.3	25.9	432.2
FF18-1	2.2%	0.69%	1.502	2.085	2.083	27.4	27.5	3.44%	3.45%	88.7	26.2	26.3	1.2%	17.9	28.3	503.8
FF18-2	1.0%	0.28%	1.011	1.601	1.636	13.5	13.9	1.32%	1.30%	47.8	10.0	9.9	0.6%	11.9	22.6	335.1
FF19-1	1.9%	0.28%	1.612	2.292	2.317	25.4	25.2	2.94%	2.93%	286.0	22.4	22.4	0.9%	20.7	31.0	582.7
FF19-2	2.4%	0.68%	1.177	2.420	2.434	30.3	29.8	3.75%	3.73%	166.5	28.6	28.4	0.9%	21.7	32.2	611.1
NF02-1	3.1%	0.56%	1.501	2.547	2.550	53.6	53.1	5.06%	5.09%	136.0	38.6	38.8	1.6%	21.6	31.9	610.0
NF02-2	3.8%	0.89%	1.327	2.728	2.694	66.4	67.1	6.33%	6.28%	147.5	48.3	47.9	1.4%	24.4	35.0	687.9
NF04-1	4.0%	0.59%	1.489	3.110	3.113	44.3	43.7	6.60%	6.55%	190.7	50.4	50.0	0.8%	29.6	40.0	834.3
NF04-2	1.2%	0.44%	1.884	1.948	1.972	23.0	22.7	1.76%	1.78%	110.2	13.5	13.6	0.7%	16.0	26.5	450.1
NF06-1	2.7%	0.53%	1.646	2.270	2.253	32.9	32.7	4.37%	4.36%	97.5	33.3	33.3	0.9%	20.7	31.4	584.4
NF06-2	3.7%	0.36%	1.035	2.582	2.586	41.8	41.7	5.70%	5.77%	105.7	43.5	44.0	1.2%	29.0	19.5	819.1
NF07-1	2.0%	0.63%	1.490	1.948	1.931	27.9	27.9	3.18%	3.18%	205.2	24.3	24.2	0.8%	16.9	27.5	475.2
NF07-2	1.6%	0.14%	1.833	1.837	1.875	23.9	23.6	2.47%	2.50%	105.0	18.9	19.0	0.8%	15.9	26.4	447.2

Table A-25: FEMA P695 Results (ii) / Riv3SSD

Ground motion	Story Drift	Residual Story Drift	Roof Acceleration (g)	Normalized Brace Force Tension	Normalized Brace Force Compression	Tensile Ductility	Compressive Ductility	Brace Strain in Tension	Brace Strain in Compression	Cumulative Ductility	Reference Tensile Ductility	Reference Compressive Ductility	Column Rotation	Column Stress in Tension (ksi)	Column Stress in Compression (ksi)	Column Uplift Force (kips)
NF09-1	2.5%	0.66%	1.527	2.482	2.524	43.8	43.8	3.86%	3.84%	95.9	29.5	29.3	0.9%	23.4	33.8	660.6
NF09-2	1.4%	0.18%	1.600	2.085	2.106	27.2	26.7	2.12%	2.12%	97.3	16.2	16.2	0.8%	17.5	28.0	494.0
NF10-1	1.9%	0.56%	1.123	2.142	2.161	24.2	24.0	2.94%	2.93%	81.3	22.4	22.4	0.7%	18.9	29.3	531.6
NF10-2	1.8%	0.63%	1.161	1.793	1.819	13.7	13.6	2.43%	2.57%	41.8	18.5	19.6	1.1%	14.7	25.3	415.1
NF12-1	3.2%	0.11%	1.742	2.728	2.757	50.4	50.4	5.15%	5.11%	591.1	39.3	39.0	1.9%	25.0	35.4	704.3
NF12-2	2.6%	0.21%	1.425	2.321	2.322	28.0	27.7	4.06%	4.05%	330.8	31.0	30.9	1.3%	20.2	30.7	568.5
NF15-1	1.4%	0.16%	1.904	1.869	1.888	21.2	20.9	1.99%	2.01%	101.5	15.2	15.3	0.9%	15.7	26.1	443.2
NF15-2	1.1%	0.47%	1.225	1.715	1.732	15.2	15.5	1.56%	1.58%	76.6	11.9	12.0	0.7%	14.6	25.2	413.0
NF22-1	1.9%	0.79%	1.919	1.866	1.869	20.9	21.3	2.78%	2.84%	40.0	21.2	21.7	1.2%	14.8	25.4	418.1
NF22-2	1.4%	0.43%	1.493	1.725	1.712	16.8	16.5	2.11%	2.10%	49.2	16.1	16.0	1.0%	11.7	22.6	330.4
NF23-1	2.5%	0.52%	1.488	2.406	2.420	37.2	37.1	3.92%	3.89%	96.2	29.9	29.7	0.8%	21.3	31.7	601.2
NF23-2	1.6%	0.51%	1.945	1.901	1.908	15.6	15.1	2.47%	2.50%	73.6	18.9	19.0	0.9%	16.1	26.8	454.5
NF24-1	1.4%	0.50%	2.347	1.887	1.896	21.2	21.3	2.10%	2.11%	173.8	16.0	16.1	1.0%	16.2	26.8	455.4
NF24-2	1.1%	0.41%	1.397	1.726	1.737	16.0	15.6	1.45%	1.46%	93.6	11.0	11.1	0.6%	14.0	24.6	394.3
NF26-1	2.5%	0.26%	1.868	2.245	2.245	40.9	40.7	4.02%	4.06%	182.9	30.7	31.0	1.1%	19.9	30.4	560.8
NF26-2	1.7%	0.46%	1.922	1.809	1.802	18.7	18.7	2.58%	2.60%	106.8	19.7	19.8	0.9%	14.2	24.8	400.3
NF27-1	2.7%	0.62%	1.608	2.369	2.375	37.7	37.4	4.33%	4.35%	428.0	33.0	33.2	1.0%	21.0	31.5	591.9
NF27-2	2.1%	0.39%	1.272	2.069	2.063	22.0	22.1	3.39%	3.40%	269.9	25.9	26.0	0.7%	17.9	28.5	506.1
NF28-1	3.4%	0.65%	1.418	2.952	2.974	74.1	73.2	5.53%	5.48%	181.2	42.2	41.9	1.6%	27.3	37.8	771.2
NF28-2	5.3%	0.43%	1.809	3.610	3.586	96.3	97.4	8.18%	7.96%	203.8	62.4	60.8	1.6%	36.9	47.0	1039.0
μ	2.2%	0.49%	1.519	2.144	2.151	30.1	30.0	3.34%	3.34%	140.3	25.5	25.5	0.9%	18.8	28.8	529.5
$\mu+\sigma$	3.1%	0.69%	1.806	2.573	2.577	47.4	47.4	4.87%	4.85%	247.8	37.2	37.0	1.3%	23.9	33.8	674.1

Table A-26: SAC Results / LA6NCh

Ground motion	Story Drift	Residual Story Drift	Roof Acceleration (g)	Normalized Brace Force Tension	Normalized Brace Force Compression	Tensile Ductility	Compressive Ductility	Brace Strain in Tension	Brace Strain in Compression	Cumulative Ductility	Reference Tensile Ductility	Reference Compressive Ductility	Column Rotation	Column Stress in Tension (ksi)	Column Stress in Compression (ksi)	Column Uplift Force (kips)
LA21	2.7%	0.23%	0.985	1.833	1.839	21.5	20.5	1.99%	1.67%	89.6	15.2	12.8	1.1%	4.3	11.0	267.1
LA22	4.3%	2.10%	0.964	1.950	1.906	21.4	21.0	3.06%	2.84%	97.7	23.4	21.6	1.6%	5.4	12.1	333.0
LA23	3.8%	1.40%	1.043	2.193	2.164	33.9	32.5	2.71%	2.41%	125.3	20.7	18.4	1.1%	5.4	12.1	335.2
LA24	6.3%	2.80%	0.672	2.321	2.247	38.1	35.4	4.49%	4.10%	141.4	34.2	31.3	1.5%	6.0	12.7	373.5
LA25	4.7%	1.50%	0.905	1.860	1.804	23.7	22.3	3.33%	3.14%	65.0	25.4	24.0	1.6%	3.8	10.5	232.7
LA26	2.8%	0.19%	0.708	1.888	1.894	19.9	19.1	1.96%	1.87%	68.4	14.9	14.3	1.1%	4.9	11.6	306.3
LA27	5.7%	0.21%	1.024	2.460	2.431	41.0	38.2	4.20%	3.60%	180.7	32.1	27.5	1.6%	5.3	11.9	331.6
LA28	4.1%	1.30%	0.996	1.763	1.716	21.3	21.3	2.89%	2.75%	71.5	22.1	20.9	1.5%	3.9	10.6	241.1
LA29	2.3%	0.59%	0.881	1.680	1.664	14.7	14.2	1.63%	1.49%	132.4	12.4	11.3	0.9%	4.5	11.2	276.1
LA30	4.8%	0.93%	0.859	2.307	2.271	32.4	30.0	3.46%	3.05%	137.3	26.4	23.3	1.2%	5.5	12.2	338.2
LA31	3.1%	2.00%	0.996	1.988	1.979	19.2	18.1	2.27%	1.97%	82.2	17.4	15.0	1.1%	3.9	10.6	240.7
LA32	2.2%	0.72%	0.900	1.734	1.743	17.9	17.0	1.54%	1.43%	75.5	11.7	10.9	1.1%	4.0	10.7	247.4
LA33	4.5%	0.93%	1.042	2.168	2.142	34.6	34.0	3.15%	2.98%	116.2	24.1	22.8	1.8%	4.7	11.5	293.7
LA34	4.2%	1.20%	0.920	1.989	1.978	31.5	30.9	2.93%	2.78%	116.0	22.4	21.2	1.4%	4.9	11.6	304.5
LA35	9.6%	0.66%	0.920	2.881	2.740	54.9	53.5	6.90%	6.21%	132.8	52.7	47.4	2.3%	8.2	14.8	509.1
LA36	7.8%	0.84%	0.807	2.485	2.381	47.8	49.5	5.53%	5.07%	127.9	42.2	38.7	2.4%	5.7	12.3	351.9
LA37	4.9%	1.90%	0.948	2.368	2.322	38.3	36.1	3.49%	3.11%	105.2	26.7	23.7	1.3%	6.6	13.3	410.6
LA38	5.2%	2.10%	0.663	2.418	2.367	42.4	40.2	3.77%	3.63%	97.8	28.8	27.7	1.4%	6.9	13.5	425.0
LA39	5.7%	2.00%	0.912	2.093	2.025	30.5	28.4	4.03%	3.76%	79.4	30.8	28.7	1.4%	5.2	11.9	323.1
LA40	8.1%	0.75%	0.723	2.404	2.291	48.8	50.1	5.75%	5.32%	119.0	43.9	40.6	2.3%	6.4	13.1	397.9
μ	4.8%	1.22%	0.893	2.139	2.095	31.7	30.6	3.45%	3.16%	108.1	26.4	24.1	1.5%	5.3	12.0	326.9
$\mu+\sigma$	6.8%	1.94%	1.011	2.445	2.373	43.0	42.0	4.83%	4.41%	137.4	36.8	33.7	1.9%	6.4	13.0	396.3

Table A-27: FEMA P695 Results (i) / LA6NCh

Ground motion	Story Drift	Residual Story Drift	Roof Acceleration (g)	Normalized Brace Force Tension	Normalized Brace Force Compression	Tensile Ductility	Compressive Ductility	Brace Strain in Tension	Brace Strain in Compression	Cumulative Ductility	Reference Tensile Ductility	Reference Compressive Ductility	Column Rotation	Column Stress in Tension (ksi)	Column Stress in Compression (ksi)	Column Uplift Force (kips)
FF01-1	2.7%	1.00%	0.714	1.570	1.542	11.6	11.3	1.87%	1.78%	63.6	14.3	13.6	0.8%	3.8	10.5	235.0
FF01-2	2.1%	0.84%	0.848	1.666	1.658	16.3	15.6	1.51%	1.34%	77.8	11.5	10.2	0.7%	3.7	10.4	229.3
FF02-1	4.6%	1.20%	1.118	2.169	2.131	28.3	29.5	3.33%	2.98%	158.2	25.4	22.7	1.5%	5.5	12.2	341.3
FF02-2	1.8%	0.72%	1.041	1.514	1.503	10.0	10.2	1.23%	1.13%	74.1	9.4	8.6	0.9%	3.7	10.4	228.8
FF03-1	3.1%	0.62%	1.254	1.772	1.745	16.7	15.8	2.16%	2.00%	86.3	16.5	15.3	0.9%	4.0	10.7	248.7
FF03-2	2.4%	0.37%	1.157	1.673	1.687	15.6	14.7	1.69%	1.61%	84.6	12.9	12.3	0.9%	3.8	10.5	236.1
FF09-1	6.6%	0.53%	1.190	2.649	2.571	59.3	58.8	4.75%	4.23%	217.4	36.2	32.3	1.8%	6.7	13.4	416.7
FF09-2	3.1%	0.45%	0.792	1.693	1.704	16.4	16.0	2.16%	2.06%	50.4	16.4	15.7	0.8%	4.2	10.9	257.9
FF16-1	4.4%	1.40%	0.943	1.937	1.895	25.3	23.8	3.08%	2.84%	101.7	23.5	21.7	1.5%	4.1	10.8	256.2
FF16-2	4.3%	0.85%	0.975	2.055	2.026	32.2	32.9	3.09%	2.75%	175.8	23.6	21.0	1.3%	5.1	11.8	315.2
FF18-1	1.8%	0.82%	0.628	1.617	1.618	13.8	13.0	1.26%	1.20%	77.8	9.6	9.2	0.7%	3.6	10.4	224.2
FF18-2	1.3%	0.54%	1.111	1.452	1.335	8.5	8.1	0.88%	0.81%	40.9	6.7	6.2	0.6%	2.8	9.5	171.6
FF19-1	6.9%	0.16%	0.882	2.697	2.613	59.4	59.0	4.96%	4.41%	318.3	37.8	33.7	1.8%	7.9	14.5	487.7
FF19-2	5.8%	0.83%	0.659	2.417	2.366	52.2	52.8	4.18%	3.71%	215.6	31.9	28.3	1.3%	6.2	12.9	386.8
NF02-1	3.2%	1.40%	0.784	1.832	1.806	19.1	19.3	2.28%	2.09%	66.5	17.4	16.0	0.8%	4.0	10.7	248.8
NF02-2	8.3%	1.20%	0.860	2.590	2.475	51.3	53.2	5.96%	5.44%	140.1	45.5	41.5	1.6%	7.1	13.8	442.7
NF04-1	3.3%	1.20%	0.632	2.002	1.991	27.3	26.9	2.36%	2.17%	87.5	18.0	16.6	1.0%	5.4	12.1	332.8
NF04-2	3.9%	1.60%	0.843	1.829	1.794	20.7	19.6	2.74%	2.54%	78.4	20.9	19.4	1.0%	4.9	11.6	304.7
NF06-1	3.5%	1.00%	1.207	2.087	2.099	28.8	27.2	2.59%	2.12%	103.1	19.7	16.2	1.6%	4.7	11.4	288.8
NF06-2	5.1%	1.90%	0.575	1.977	1.917	26.6	24.9	3.59%	3.36%	71.5	27.4	25.7	1.3%	5.3	12.0	330.4
NF07-1	3.8%	1.30%	1.270	1.790	1.751	20.3	19.2	2.65%	2.49%	145.9	20.2	19.0	1.5%	4.9	11.6	302.7
NF07-2	6.2%	2.70%	0.989	2.150	2.073	29.2	27.3	4.39%	4.08%	77.5	33.5	31.2	1.7%	3.6	10.3	224.0

Table A-28: FEMA P695 Results (ii) / LA6NCh

Ground motion	Story Drift	Residual Story Drift	Roof Acceleration (g)	Normalized Brace Force Tension	Normalized Brace Force Compression	Tensile Ductility	Compressive Ductility	Brace Strain in Tension	Brace Strain in Compression	Cumulative Ductility	Reference Tensile Ductility	Reference Compressive Ductility	Column Rotation	Column Stress in Tension (ksi)	Column Stress in Compression (ksi)	Column Uplift Force (kips)
NF09-1	1.8%	0.28%	0.505	1.449	1.457	9.2	8.7	1.21%	1.17%	29.7	9.2	9.0	0.7%	3.3	10.0	204.8
NF09-2	2.2%	0.82%	0.551	1.765	1.769	15.9	15.1	1.56%	1.47%	60.4	11.9	11.2	0.7%	4.1	10.9	254.8
NF10-1	3.1%	0.25%	0.718	1.784	1.789	18.7	18.8	2.16%	1.98%	70.4	16.5	15.1	1.1%	4.5	11.2	276.9
NF10-2	2.5%	0.49%	0.610	1.634	1.650	14.2	13.4	1.72%	1.65%	45.1	13.1	12.6	0.9%	3.9	10.7	243.9
NF12-1	3.2%	0.57%	0.653	2.033	2.052	27.1	25.8	2.39%	1.93%	214.1	18.2	14.7	1.0%	4.7	11.3	290.3
NF12-2	2.9%	0.79%	0.611	1.930	1.952	20.5	19.3	2.20%	1.78%	195.0	16.8	13.6	0.8%	4.7	11.4	293.5
NF15-1	2.6%	1.80%	0.752	1.605	1.579	10.7	10.3	1.84%	1.74%	60.6	14.0	13.2	1.0%	4.3	11.0	263.6
NF15-2	5.2%	0.20%	1.242	2.239	2.202	34.9	32.6	3.73%	3.30%	110.1	28.5	25.2	1.2%	5.1	11.8	317.0
NF22-1	4.4%	2.20%	1.317	1.798	1.749	21.6	20.5	3.05%	2.90%	40.1	23.3	22.1	1.7%	2.4	9.1	145.8
NF22-2	2.6%	0.74%	0.570	1.742	1.726	18.9	17.9	1.83%	1.66%	46.3	14.0	12.6	0.9%	3.9	10.6	243.7
NF23-1	2.7%	0.19%	0.985	1.750	1.766	13.0	12.3	1.88%	1.79%	55.8	14.4	13.7	0.9%	3.4	10.2	211.5
NF23-2	2.0%	0.17%	1.146	1.684	1.688	13.3	13.1	1.42%	1.34%	94.3	10.8	10.2	1.1%	3.8	10.5	235.2
NF24-1	3.3%	1.60%	0.944	1.774	1.763	13.6	14.7	2.40%	2.13%	198.3	18.3	16.2	0.9%	4.6	11.3	288.0
NF24-2	2.7%	0.78%	0.930	1.783	1.802	16.6	15.5	1.90%	1.76%	86.4	14.5	13.5	1.0%	4.5	11.2	276.7
NF26-1	6.1%	2.40%	0.650	2.228	2.157	31.4	29.7	4.34%	3.99%	180.9	33.2	30.5	1.8%	3.6	10.2	220.8
NF26-2	3.1%	0.85%	0.623	2.044	2.039	16.1	15.2	2.29%	1.95%	100.5	17.5	14.9	0.8%	5.3	11.9	326.3
NF27-1	2.2%	0.32%	0.664	1.659	1.679	15.5	14.8	1.54%	1.38%	113.8	11.8	10.5	0.8%	3.8	10.6	238.3
NF27-2	3.6%	0.78%	0.916	1.866	1.836	14.6	14.1	2.57%	2.35%	169.2	19.6	18.0	1.2%	4.3	11.0	263.5
NF28-1	2.8%	0.53%	0.516	1.893	1.900	22.3	21.1	1.96%	1.85%	73.5	15.0	14.2	1.0%	5.2	11.9	323.0
NF28-2	3.4%	1.30%	0.485	2.096	2.084	29.2	27.3	2.45%	2.12%	88.6	18.7	16.2	0.8%	3.6	10.3	222.7
μ	3.6%	0.94%	0.854	1.902	1.880	23.0	22.4	2.55%	2.32%	108.2	19.5	17.7	1.1%	4.5	11.2	277.4
$\mu+\sigma$	5.1%	1.55%	1.096	2.202	2.162	35.5	35.0	3.67%	3.33%	170.3	28.0	25.4	1.5%	5.6	12.2	344.6

Table A-29: SAC Results / LA6NCh1.5

Ground motion	Story Drift	Residual Story Drift	Roof Acceleration (g)	Normalized Brace Force Tension	Normalized Brace Force Compression	Tensile Ductility	Compressive Ductility	Brace Strain in Tension	Brace Strain in Compression	Cumulative Ductility	Reference Tensile Ductility	Reference Compressive Ductility	Column Rotation	Column Stress in Tension (ksi)	Column Stress in Compression (ksi)	Column Uplift Force (kips)
LA21	2.5%	0.46%	1.081	1.772	1.769	19.9	18.8	1.94%	1.57%	87.9	14.8	12.0	1.0%	7.2	13.8	446.2
LA22	3.7%	2.00%	1.207	1.847	1.800	19.2	19.1	2.75%	2.53%	95.7	21.0	19.3	1.3%	8.2	14.9	506.4
LA23	3.3%	1.60%	1.090	2.047	2.021	28.2	26.1	2.54%	2.16%	108.7	19.4	16.5	1.2%	7.7	14.4	479.3
LA24	4.8%	1.70%	0.628	2.094	2.045	30.4	28.5	3.67%	3.22%	108.3	28.0	24.6	1.4%	7.4	14.1	459.9
LA25	3.9%	0.28%	1.155	1.743	1.691	20.0	18.8	2.83%	2.66%	59.3	21.6	20.3	1.5%	5.7	12.4	353.5
LA26	2.5%	0.42%	0.856	1.827	1.823	19.8	18.6	1.92%	1.71%	76.1	14.6	13.0	1.1%	7.6	14.2	468.6
LA27	4.1%	1.60%	1.179	2.266	2.220	37.0	37.4	3.09%	2.71%	164.0	23.6	20.7	1.5%	7.6	14.2	469.5
LA28	3.7%	0.88%	1.314	1.739	1.740	20.6	20.1	2.71%	2.56%	71.8	20.7	19.5	1.5%	6.2	12.9	384.0
LA29	2.3%	0.72%	1.486	1.687	1.670	14.0	13.6	1.71%	1.49%	107.3	13.0	11.4	1.0%	6.5	13.2	400.4
LA30	4.3%	0.64%	1.023	2.009	1.955	26.7	24.6	3.22%	2.92%	117.8	24.6	22.3	1.2%	7.4	14.1	457.6
LA31	3.4%	1.90%	0.954	1.899	1.867	17.5	16.6	2.59%	2.28%	82.9	19.8	17.4	1.0%	6.0	12.7	369.4
LA32	2.7%	1.00%	1.296	1.756	1.739	19.4	18.5	2.06%	1.79%	65.1	15.8	13.6	1.6%	6.4	13.1	397.2
LA33	4.5%	1.50%	1.245	2.336	2.280	35.6	33.7	3.38%	2.96%	107.7	25.8	22.6	1.8%	7.7	14.3	475.9
LA34	3.3%	0.45%	1.047	2.122	2.094	30.1	27.9	2.50%	2.12%	106.1	19.1	16.2	1.3%	7.5	14.2	465.2
LA35	8.7%	0.43%	1.048	2.700	2.552	56.0	58.0	6.52%	5.86%	128.7	49.8	44.7	2.0%	11.4	18.0	708.8
LA36	7.0%	0.73%	0.909	2.349	2.239	47.6	48.7	5.25%	4.80%	118.8	40.0	36.6	2.1%	8.4	15.1	521.3
LA37	3.8%	1.80%	0.993	2.217	2.174	33.6	31.6	2.85%	2.48%	81.4	21.7	18.9	1.0%	9.0	15.7	560.7
LA38	5.6%	2.80%	0.776	2.502	2.433	42.9	39.1	4.27%	3.68%	81.1	32.6	28.1	1.3%	10.0	16.6	618.9
LA39	4.3%	0.95%	0.956	1.842	1.786	22.4	21.2	3.13%	2.93%	57.8	23.9	22.3	1.3%	7.0	13.7	434.3
LA40	6.4%	1.80%	0.960	2.306	2.253	54.4	54.0	4.77%	4.41%	105.4	36.4	33.7	1.8%	8.5	15.2	528.5
μ	4.2%	1.18%	1.060	2.053	2.007	29.8	28.7	3.18%	2.84%	96.6	24.3	21.7	1.4%	7.7	14.3	475.3
μ+σ	5.8%	1.86%	1.254	2.335	2.264	41.9	41.3	4.37%	3.93%	121.9	33.3	30.0	1.7%	9.0	15.7	558.3

Table A-30: FEMA P695 Results (i) / LA6NCh1.5

Ground motion	Story Drift	Residual Story Drift	Roof Acceleration (g)	Normalized Brace Force Tension	Normalized Brace Force Compression	Tensile Ductility	Compressive Ductility	Brace Strain in Tension	Brace Strain in Compression	Cumulative Ductility	Reference Tensile Ductility	Reference Compressive Ductility	Column Rotation	Column Stress in Tension (ksi)	Column Stress in Compression (ksi)	Column Uplift Force (kips)
FF01-1	2.4%	0.53%	0.623	1.547	1.563	11.4	10.5	1.72%	1.63%	59.5	13.1	12.4	0.8%	6.2	12.9	383.0
FF01-2	2.3%	0.83%	0.929	1.651	1.635	15.9	15.2	1.73%	1.51%	62.9	13.2	11.5	0.8%	6.5	13.2	400.6
FF02-1	4.7%	1.50%	1.350	2.035	1.972	31.7	32.1	3.51%	3.21%	131.6	26.8	24.5	1.5%	8.0	14.7	495.0
FF02-2	1.8%	0.83%	1.273	1.488	1.476	9.9	9.9	1.33%	1.17%	58.7	10.2	9.0	0.9%	6.5	13.2	402.6
FF03-1	2.6%	0.63%	1.483	1.722	1.739	17.3	16.2	1.91%	1.75%	69.6	14.6	13.3	1.0%	6.1	12.8	377.4
FF03-2	1.9%	0.64%	1.333	1.642	1.644	15.4	14.4	1.36%	1.23%	61.9	10.4	9.4	0.9%	6.5	13.2	401.8
FF09-1	4.2%	0.92%	1.510	2.286	2.236	39.3	39.4	3.16%	2.76%	156.0	24.1	21.0	1.4%	9.0	15.6	555.6
FF09-2	2.3%	0.86%	0.860	1.804	1.789	20.6	19.1	1.71%	1.46%	46.8	13.1	11.1	0.7%	6.9	13.6	426.9
FF16-1	3.7%	0.11%	1.215	1.856	1.814	22.8	21.3	2.72%	2.48%	82.1	20.8	18.9	1.4%	6.2	12.9	385.5
FF16-2	3.6%	0.52%	1.141	2.111	2.079	32.1	32.8	2.75%	2.34%	142.3	21.0	17.8	1.4%	7.6	14.2	469.0
FF18-1	1.7%	0.51%	0.814	1.640	1.633	13.3	12.5	1.24%	1.17%	62.4	9.5	8.9	0.6%	6.2	12.9	382.0
FF18-2	1.5%	0.46%	1.259	1.494	1.478	9.0	8.5	1.07%	0.97%	45.3	8.2	7.4	0.6%	4.6	11.3	284.8
FF19-1	5.9%	1.60%	0.846	2.583	2.496	47.5	46.7	4.49%	3.93%	227.7	34.3	30.0	1.6%	10.5	17.1	651.3
FF19-2	3.7%	1.00%	0.791	2.197	2.156	35.4	35.9	2.83%	2.40%	128.6	21.6	18.3	1.3%	8.4	15.1	522.1
NF02-1	2.3%	0.82%	0.728	1.661	1.675	16.4	15.4	1.70%	1.54%	50.0	13.0	11.8	1.0%	6.8	13.5	422.0
NF02-2	6.7%	2.00%	1.022	2.346	2.245	43.0	44.4	4.98%	4.53%	115.9	38.0	34.6	1.4%	9.4	16.1	583.8
NF04-1	3.0%	0.84%	0.693	2.059	2.032	28.2	27.5	2.22%	2.02%	88.2	17.0	15.4	1.0%	8.0	14.7	496.1
NF04-2	3.8%	1.70%	0.968	1.821	1.776	20.1	18.9	2.80%	2.58%	76.3	21.4	19.7	1.1%	7.2	13.9	448.6
NF06-1	1.7%	0.65%	0.727	1.540	1.529	12.3	11.6	1.26%	1.15%	47.2	9.6	8.8	0.7%	5.9	12.7	367.7
NF06-2	4.6%	1.60%	0.675	1.937	1.875	25.5	23.7	3.37%	3.12%	53.0	25.7	23.8	1.3%	7.7	14.4	474.8
NF07-1	3.0%	1.20%	1.503	1.708	1.674	17.9	16.8	2.18%	2.00%	144.3	16.6	15.3	1.3%	7.1	13.8	438.0
NF07-2	5.4%	2.20%	1.267	1.995	1.919	28.4	26.4	3.96%	3.70%	66.4	30.3	28.2	1.6%	5.4	12.1	334.5

Table A-31: FEMA P695 Results (ii) / LA6NCh1.5

Ground motion	Story Drift	Residual Story Drift	Roof Acceleration (g)	Normalized Brace Force Tension	Normalized Brace Force Compression	Tensile Ductility	Compressive Ductility	Brace Strain in Tension	Brace Strain in Compression	Cumulative Ductility	Reference Tensile Ductility	Reference Compressive Ductility	Column Rotation	Column Stress in Tension (ksi)	Column Stress in Compression (ksi)	Column Uplift Force (kips)
NF09-1	1.3%	0.51%	0.456	1.506	1.497	11.2	10.5	0.94%	0.91%	28.0	7.2	7.0	0.6%	4.3	11.1	269.0
NF09-2	1.9%	0.69%	0.632	1.683	1.681	13.6	13.0	1.39%	1.28%	55.4	10.6	9.8	0.7%	6.1	12.9	380.8
NF10-1	3.0%	1.80%	0.744	1.762	1.737	19.6	18.6	2.23%	1.97%	54.8	17.0	15.1	0.8%	7.0	13.7	434.0
NF10-2	2.1%	0.14%	0.684	1.572	1.579	12.7	11.7	1.53%	1.47%	39.0	11.7	11.2	0.9%	6.0	12.7	369.4
NF12-1	2.7%	0.31%	0.541	1.869	1.852	18.1	17.5	2.05%	1.74%	170.3	15.6	13.2	0.8%	6.6	13.3	411.7
NF12-2	3.0%	0.94%	0.667	1.855	1.847	20.5	20.3	2.20%	2.00%	205.5	16.8	15.2	0.9%	7.3	14.0	452.4
NF15-1	2.1%	1.30%	0.841	1.612	1.601	14.5	13.9	1.61%	1.38%	54.2	12.3	10.6	0.6%	6.7	13.4	413.7
NF15-2	4.2%	0.84%	1.198	2.054	2.017	29.3	30.7	3.20%	2.76%	97.2	24.4	21.1	1.3%	8.1	14.8	501.7
NF22-1	3.8%	2.70%	1.633	1.756	1.709	19.6	18.4	2.76%	2.59%	26.5	21.0	19.7	1.4%	4.1	10.9	257.1
NF22-2	3.1%	1.30%	0.710	1.677	1.638	16.8	15.8	2.26%	2.12%	30.4	17.3	16.2	1.1%	5.5	12.2	341.3
NF23-1	2.8%	0.31%	1.127	1.696	1.700	15.8	15.2	2.06%	1.96%	46.9	15.7	14.9	1.1%	5.4	12.1	333.3
NF23-2	1.8%	0.55%	1.355	1.579	1.566	9.8	9.2	1.34%	1.17%	79.1	10.2	9.0	0.9%	5.7	12.4	351.5
NF24-1	3.5%	1.40%	0.991	1.862	1.839	15.4	17.2	2.67%	2.29%	181.6	20.4	17.5	1.0%	7.6	14.3	473.1
NF24-2	3.0%	0.87%	0.999	1.776	1.774	18.3	17.1	2.19%	2.02%	101.5	16.7	15.4	1.1%	6.7	13.5	416.9
NF26-1	4.5%	1.70%	0.911	1.923	1.864	23.5	22.4	3.30%	3.06%	150.8	25.2	23.3	1.4%	5.6	12.3	344.1
NF26-2	2.9%	1.20%	0.790	1.918	1.897	14.5	13.5	2.22%	1.89%	68.1	16.9	14.5	1.0%	7.7	14.4	475.7
NF27-1	2.0%	0.41%	0.643	1.664	1.676	16.1	15.1	1.49%	1.27%	122.4	11.3	9.7	1.0%	6.3	12.9	388.6
NF27-2	3.0%	1.10%	0.896	1.778	1.746	13.5	13.3	2.21%	2.00%	167.2	16.9	15.3	1.0%	6.9	13.6	429.2
NF28-1	2.9%	1.40%	0.559	1.902	1.880	23.3	21.6	2.20%	1.88%	61.0	16.8	14.4	0.9%	7.7	14.4	479.3
NF28-2	2.6%	1.40%	0.590	1.959	1.944	25.1	23.1	2.02%	1.68%	50.9	15.4	12.8	0.9%	5.9	12.7	367.9
μ	3.1%	1.02%	0.952	1.822	1.797	20.6	19.9	2.28%	2.05%	89.7	17.4	15.6	1.0%	6.8	13.5	418.9
$\mu+\sigma$	4.3%	1.59%	1.258	2.062	2.018	29.6	29.2	3.18%	2.86%	140.6	24.3	21.8	1.3%	8.0	14.7	497.7

Table A-32: SAC Results / LA6SCh

Ground motion	Story Drift	Residual Story Drift	Roof Acceleration (g)	Normalized Brace Force Tension	Normalized Brace Force Compression	Tensile Ductility	Compressive Ductility	Brace Strain in Tension	Brace Strain in Compression	Cumulative Ductility	Reference Tensile Ductility	Reference Compressive Ductility	Column Rotation	Column Stress in Tension (ksi)	Column Stress in Compression (ksi)	Column Uplift Force (kips)
LA21	2.6%	0.69%	0.910	2.223	2.197	52.1	51.3	4.61%	4.09%	237.2	35.2	31.2	1.1%	5.2	11.9	321.6
LA22	3.0%	0.67%	1.046	2.299	2.267	65.4	64.9	5.19%	4.63%	315.7	39.6	35.4	1.3%	5.9	12.7	368.3
LA23	3.5%	0.85%	1.121	2.428	2.385	82.4	79.5	6.19%	5.56%	348.6	47.3	42.4	1.1%	6.5	13.2	401.1
LA24	4.8%	1.50%	0.708	2.658	2.593	83.3	80.8	8.55%	7.73%	320.3	65.2	59.0	1.3%	6.5	13.2	403.6
LA25	4.3%	0.64%	0.961	2.115	2.050	55.1	52.2	7.47%	7.09%	173.8	57.0	54.1	1.5%	4.3	11.1	268.6
LA26	2.7%	1.10%	0.893	2.212	2.186	56.8	56.5	4.60%	4.42%	213.4	35.1	33.7	1.1%	6.0	12.7	372.0
LA27	4.9%	0.55%	1.007	2.756	2.682	103.4	101.6	8.73%	7.87%	460.1	66.6	60.0	1.7%	6.6	13.3	410.7
LA28	3.9%	0.71%	1.145	2.037	1.978	61.2	60.2	6.86%	6.53%	179.1	52.3	49.8	1.5%	4.3	11.0	264.3
LA29	2.1%	0.57%	1.155	2.005	1.996	37.6	38.3	3.78%	3.34%	298.8	28.9	25.5	0.9%	5.3	12.0	328.0
LA30	4.3%	0.49%	0.897	2.602	2.543	70.8	66.3	7.54%	6.78%	355.5	57.5	51.8	1.2%	6.2	12.9	381.7
LA31	3.4%	1.40%	0.967	2.400	2.359	45.8	44.6	5.97%	5.35%	226.9	45.6	40.8	1.1%	4.6	11.3	284.0
LA32	2.7%	0.86%	1.109	2.202	2.194	46.6	44.2	4.83%	4.07%	165.2	36.9	31.0	1.5%	4.7	11.4	289.4
LA33	4.0%	0.61%	1.147	2.539	2.486	88.5	86.5	7.05%	6.50%	307.0	53.8	49.6	1.7%	5.3	12.0	329.1
LA34	3.6%	0.55%	0.891	2.243	2.215	78.4	76.6	6.32%	6.02%	309.1	48.2	45.9	1.4%	5.9	12.6	364.9
LA35	8.4%	0.89%	0.983	3.592	3.414	130.0	129.1	15.20%	13.56%	318.5	116.0	103.5	2.2%	10.1	16.6	623.8
LA36	7.2%	0.52%	0.868	3.048	2.912	121.8	125.2	12.84%	11.73%	305.8	98.0	89.5	2.1%	7.1	13.8	441.4
LA37	4.4%	1.10%	0.876	2.633	2.570	94.9	90.8	7.77%	6.99%	263.2	59.3	53.4	1.3%	7.7	14.4	476.7
LA38	5.4%	1.30%	0.685	2.863	2.777	108.0	102.9	9.56%	8.60%	252.1	72.9	65.6	1.6%	8.1	14.7	501.2
LA39	4.7%	0.98%	0.847	2.313	2.239	62.7	59.0	8.18%	7.68%	181.1	62.5	58.6	1.3%	5.6	12.4	350.1
LA40	7.1%	1.30%	0.840	2.793	2.659	129.1	130.4	12.71%	11.83%	285.4	97.0	90.2	2.1%	7.3	14.0	455.3
μ	4.4%	0.86%	0.953	2.498	2.435	78.7	77.1	7.70%	7.02%	275.8	58.7	53.6	1.5%	6.2	12.9	381.8
μ+σ	6.0%	1.18%	1.087	2.875	2.776	106.3	105.0	10.62%	9.68%	348.0	81.0	73.9	1.8%	7.5	14.2	467.8

Table A-33: FEMA P695 Results (i) / LA6SCh

Ground motion	Story Drift	Residual Story Drift	Roof Acceleration (g)	Normalized Brace Force Tension	Normalized Brace Force Compression	Tensile Ductility	Compressive Ductility	Brace Strain in Tension	Brace Strain in Compression	Cumulative Ductility	Reference Tensile Ductility	Reference Compressive Ductility	Column Rotation	Column Stress in Tension (ksi)	Column Stress in Compression (ksi)	Column Uplift Force (kips)
FF01-1	2.8%	0.81%	0.718	1.859	1.820	29.5	29.5	4.80%	4.57%	168.9	36.6	34.9	1.0%	4.5	11.3	280.2
FF01-2	2.1%	0.52%	0.810	2.034	2.049	38.0	36.5	3.77%	2.94%	172.2	28.7	22.4	0.7%	4.9	11.6	301.7
FF02-1	4.3%	0.77%	1.459	2.605	2.546	84.1	85.8	7.56%	6.80%	346.4	57.7	51.9	1.5%	6.7	13.4	417.8
FF02-2	2.0%	0.77%	1.136	1.823	1.805	28.3	28.1	3.44%	3.12%	169.1	26.3	23.8	0.8%	5.2	11.9	320.4
FF03-1	2.3%	0.60%	1.194	2.134	2.115	39.7	36.7	3.92%	3.45%	191.6	29.9	26.3	1.2%	4.9	11.6	305.0
FF03-2	2.2%	0.87%	1.337	1.938	1.932	40.9	41.3	3.82%	3.40%	174.0	29.2	25.9	1.0%	4.9	11.6	301.6
FF09-1	6.4%	0.40%	1.231	3.121	3.005	134.4	132.3	11.56%	10.38%	517.3	88.2	79.2	1.6%	7.3	14.0	451.2
FF09-2	2.5%	0.26%	0.770	2.016	2.005	50.5	48.6	4.22%	4.06%	142.5	32.2	31.0	0.7%	4.9	11.7	305.6
FF16-1	3.4%	0.46%	1.184	2.348	2.329	56.0	50.8	6.08%	5.19%	235.5	46.4	39.6	1.0%	4.7	11.4	290.9
FF16-2	3.8%	0.89%	0.936	2.491	2.442	89.5	89.8	6.68%	6.00%	432.1	51.0	45.8	1.4%	6.3	13.0	388.3
FF18-1	1.8%	0.68%	0.695	2.009	1.999	34.3	32.8	3.07%	2.93%	183.7	23.4	22.3	0.7%	4.3	11.0	263.8
FF18-2	1.2%	0.36%	1.319	1.791	1.800	20.5	18.2	1.95%	1.89%	115.5	14.9	14.4	0.5%	3.6	10.3	221.4
FF19-1	7.2%	0.10%	0.754	3.290	3.153	149.8	147.3	12.86%	11.53%	755.1	98.2	88.0	1.7%	9.7	16.3	600.3
FF19-2	5.2%	1.00%	0.761	2.819	2.737	124.7	124.3	9.21%	8.29%	460.6	70.3	63.3	1.4%	7.4	14.1	461.0
NF02-1	2.1%	0.82%	0.754	2.093	2.077	40.1	37.3	3.60%	3.15%	154.3	27.5	24.1	0.7%	5.4	12.1	333.0
NF02-2	6.7%	0.26%	0.896	3.096	2.977	126.6	129.6	11.99%	10.79%	338.4	91.5	82.4	1.2%	8.2	14.8	505.5
NF04-1	3.4%	1.10%	0.708	2.402	2.361	72.3	72.0	5.99%	5.37%	231.9	45.7	40.9	1.1%	6.6	13.3	410.1
NF04-2	3.8%	1.10%	0.778	2.303	2.282	54.5	50.9	6.92%	5.95%	211.3	52.8	45.4	1.1%	5.8	12.4	358.1
NF06-1	3.6%	0.91%	1.093	2.450	2.405	74.5	73.3	6.36%	5.71%	287.3	48.6	43.6	1.8%	5.8	12.5	357.7
NF06-2	4.4%	1.60%	0.546	2.368	2.301	63.7	59.3	7.80%	7.23%	147.6	59.5	55.2	1.2%	6.0	12.7	373.7
NF07-1	3.2%	0.71%	1.649	2.109	2.077	47.8	44.4	5.58%	5.05%	326.5	42.6	38.5	1.3%	5.5	12.2	337.9
NF07-2	5.5%	1.60%	1.046	2.470	2.378	73.0	68.4	9.78%	9.16%	199.2	74.6	69.9	1.6%	4.3	11.0	265.6

Table A-34: FEMA P695 Results (ii) / LA6SCh

Ground motion	Story Drift	Residual Story Drift	Roof Acceleration (g)	Normalized Brace Force Tension	Normalized Brace Force Compression	Tensile Ductility	Compressive Ductility	Brace Strain in Tension	Brace Strain in Compression	Cumulative Ductility	Reference Tensile Ductility	Reference Compressive Ductility	Column Rotation	Column Stress in Tension (ksi)	Column Stress in Compression (ksi)	Column Uplift Force (kips)
NF09-1	1.6%	0.41%	0.522	1.759	1.764	24.7	23.1	2.69%	2.62%	76.6	20.5	20.0	0.7%	3.6	10.3	221.5
NF09-2	2.1%	0.65%	0.554	2.017	2.006	39.3	39.4	3.63%	3.31%	157.6	27.7	25.3	0.7%	4.5	11.3	281.1
NF10-1	2.4%	1.30%	0.754	2.158	2.137	52.5	53.2	4.11%	3.63%	171.5	31.3	27.7	1.0%	5.8	12.5	357.6
NF10-2	2.4%	0.28%	0.731	1.801	1.804	36.3	35.0	4.00%	3.86%	118.3	30.5	29.4	0.9%	4.5	11.2	278.7
NF12-1	2.6%	0.46%	0.521	2.223	2.197	56.3	56.6	4.61%	4.09%	563.2	35.2	31.2	1.1%	5.2	12.0	324.2
NF12-2	2.6%	0.61%	0.651	2.223	2.197	57.1	55.1	4.60%	4.09%	564.0	35.1	31.2	0.9%	5.7	12.4	352.9
NF15-1	2.7%	1.70%	0.749	1.900	1.879	36.9	35.4	4.76%	4.29%	170.9	36.3	32.7	0.8%	4.8	11.6	300.6
NF15-2	4.4%	0.93%	1.256	2.646	2.582	82.0	84.3	7.88%	7.09%	271.4	60.1	54.1	1.3%	6.3	13.0	391.8
NF22-1	4.0%	2.10%	1.492	2.112	2.056	51.9	49.3	6.90%	6.54%	94.1	52.7	49.9	1.3%	2.1	8.8	127.6
NF22-2	2.5%	0.84%	0.728	2.079	2.058	42.2	38.7	4.42%	3.92%	102.3	33.7	29.9	0.8%	4.4	11.1	272.3
NF23-1	3.0%	0.16%	1.040	1.854	1.827	40.9	40.8	5.12%	4.85%	150.7	39.1	37.0	1.1%	3.8	10.5	234.2
NF23-2	1.5%	0.35%	1.467	1.950	1.944	25.8	24.9	2.49%	2.12%	207.7	19.0	16.2	0.9%	4.5	11.2	277.2
NF24-1	3.3%	1.20%	0.957	2.291	2.288	41.1	47.0	6.09%	5.03%	563.4	46.5	38.4	0.8%	5.5	12.2	342.4
NF24-2	2.3%	0.92%	0.986	2.094	2.078	45.4	43.8	4.09%	3.62%	273.5	31.2	27.6	0.9%	5.1	11.8	314.5
NF26-1	5.2%	1.30%	0.748	2.556	2.478	66.3	63.5	9.14%	8.37%	453.4	69.8	63.9	1.3%	4.6	11.3	283.8
NF26-2	3.4%	0.46%	0.674	2.404	2.363	40.0	39.5	6.01%	5.38%	214.0	45.9	41.1	1.1%	6.7	13.4	412.3
NF27-1	2.6%	0.62%	0.665	1.963	1.988	42.2	43.7	4.58%	4.04%	330.8	35.0	30.8	1.0%	4.9	11.6	304.9
NF27-2	2.7%	1.20%	0.916	2.235	2.208	35.6	35.5	4.70%	4.18%	467.2	35.9	31.9	1.0%	5.3	12.0	326.5
NF28-1	2.6%	1.10%	0.553	2.212	2.187	60.3	57.7	4.52%	4.04%	190.0	34.5	30.8	0.9%	6.3	13.0	391.5
NF28-2	2.8%	1.00%	0.577	2.265	2.235	67.1	64.5	4.93%	4.39%	209.4	37.6	33.5	1.0%	3.8	10.5	235.6
μ	3.3%	0.81%	0.912	2.245	2.211	57.5	56.4	5.72%	5.15%	269.3	43.6	39.3	1.1%	5.3	12.0	330.5
$\mu+\sigma$	4.6%	1.25%	1.210	2.603	2.538	87.3	86.4	8.25%	7.44%	425.4	62.9	56.8	1.4%	6.7	13.4	413.0

Table A-35: SAC Results / LA6NSD

Ground motion	Story Drift	Residual Story Drift	Roof Acceleration (g)	Normalized Brace Force Tension	Normalized Brace Force Compression	Tensile Ductility	Compressive Ductility	Brace Strain in Tension	Brace Strain in Compression	Cumulative Ductility	Reference Tensile Ductility	Reference Compressive Ductility	Column Rotation	Column Stress in Tension (ksi)	Column Stress in Compression (ksi)	Column Uplift Force (kips)
LA21	2.1%	0.20%	1.172	1.585	1.609	13.5	13.6	1.17%	1.13%	70.9	8.9	8.6	1.2%	2.3	10.5	144.7
LA22	4.5%	2.30%	1.286	1.819	1.816	18.1	18.1	2.47%	2.47%	67.8	18.8	18.8	1.6%	2.6	11.0	163.7
LA23	3.7%	0.79%	1.162	1.951	1.996	24.6	24.7	2.06%	2.05%	88.4	15.8	15.7	1.0%	2.9	11.2	182.7
LA24	6.5%	3.80%	0.872	2.156	2.156	31.8	31.6	3.62%	3.60%	102.6	27.6	27.5	1.5%	3.4	11.6	209.4
LA25	4.8%	2.10%	0.914	1.732	1.712	18.8	18.6	2.68%	2.65%	45.9	20.4	20.2	1.7%	1.9	10.2	119.1
LA26	2.8%	1.30%	0.856	1.687	1.718	15.2	15.2	1.54%	1.53%	49.2	11.7	11.7	1.1%	2.4	10.6	148.2
LA27	6.9%	1.60%	1.073	2.218	2.214	33.3	33.0	3.85%	3.82%	131.1	29.4	29.2	2.1%	2.6	11.0	163.6
LA28	4.1%	1.40%	1.135	1.647	1.627	15.7	15.7	2.31%	2.28%	54.3	17.6	17.4	1.6%	2.3	10.6	143.9
LA29	2.2%	0.12%	1.143	1.613	1.620	10.7	10.5	1.21%	1.19%	103.8	9.2	9.1	1.1%	1.8	10.1	111.6
LA30	5.6%	1.10%	0.992	2.091	2.103	26.3	26.1	3.14%	3.14%	97.9	23.9	24.0	1.9%	3.6	11.8	224.2
LA31	3.5%	2.10%	1.006	1.742	1.761	14.3	14.4	1.76%	1.77%	75.9	13.4	13.5	1.1%	2.5	10.8	157.8
LA32	2.6%	0.27%	1.063	1.542	1.576	11.6	11.7	1.46%	1.43%	76.2	11.1	10.9	1.0%	1.9	10.1	115.5
LA33	4.7%	0.32%	1.184	1.903	1.947	24.7	24.5	2.60%	2.59%	86.6	19.8	19.8	1.3%	3.3	11.4	203.0
LA34	4.4%	1.50%	0.947	1.821	1.865	23.3	23.4	2.45%	2.44%	87.2	18.7	18.6	1.2%	2.7	11.0	168.0
LA35	9.7%	1.90%	1.139	2.550	2.541	44.3	43.9	5.42%	5.39%	116.2	41.4	41.1	2.3%	4.6	12.8	286.5
LA36	7.8%	2.30%	1.002	2.231	2.220	34.3	34.4	4.37%	4.35%	98.7	33.3	33.2	2.4%	3.1	11.3	192.4
LA37	5.3%	3.30%	0.887	2.201	2.226	32.2	31.9	2.92%	2.91%	74.8	22.3	22.2	1.6%	3.9	12.0	239.7
LA38	6.5%	3.20%	0.829	2.153	2.197	31.4	31.4	3.13%	3.16%	68.6	23.9	24.1	1.8%	3.6	11.9	222.4
LA39	5.9%	2.80%	1.108	1.916	1.900	23.9	23.7	3.31%	3.29%	76.7	25.2	25.1	1.5%	2.6	10.8	161.0
LA40	8.1%	0.53%	0.822	2.172	2.150	36.4	36.5	4.57%	4.55%	79.3	34.9	34.7	2.8%	3.3	11.5	203.5
μ	5.1%	1.65%	1.030	1.936	1.948	24.2	24.1	2.80%	2.79%	82.6	21.4	21.3	1.6%	2.9	11.1	178.0
$\mu+\sigma$	7.1%	2.72%	1.163	2.203	2.210	33.4	33.3	3.93%	3.91%	103.7	30.0	29.9	2.1%	3.6	11.8	221.8

Table A-36: FEMA P695 Results (i) / LA6NSD

Ground motion	Story Drift	Residual Story Drift	Roof Acceleration (g)	Normalized Brace Force Tension	Normalized Brace Force Compression	Tensile Ductility	Compressive Ductility	Brace Strain in Tension	Brace Strain in Compression	Cumulative Ductility	Reference Tensile Ductility	Reference Compressive Ductility	Column Rotation	Column Stress in Tension (ksi)	Column Stress in Compression (ksi)	Column Uplift Force (kips)
FF01-1	2.1%	0.72%	0.736	1.459	1.452	9.1	9.1	1.19%	1.19%	80.1	9.1	9.1	0.9%	1.6	9.9	99.9
FF01-2	1.9%	0.56%	0.924	1.495	1.508	10.5	10.7	1.02%	1.06%	93.7	7.8	8.1	0.9%	1.5	9.8	94.5
FF02-1	4.4%	2.20%	1.576	1.951	1.958	18.9	19.3	2.47%	2.44%	99.8	18.9	18.6	1.3%	2.6	10.7	161.5
FF02-2	1.7%	0.36%	1.323	1.479	1.474	7.9	7.8	0.87%	0.84%	53.9	6.6	6.4	1.1%	1.3	9.7	83.1
FF03-1	3.2%	1.20%	1.354	1.665	1.662	13.6	13.4	1.78%	1.76%	69.0	13.6	13.5	1.1%	2.0	10.3	126.6
FF03-2	2.0%	0.47%	1.164	1.547	1.554	12.3	12.0	1.10%	1.12%	61.8	8.4	8.6	0.8%	1.6	9.8	98.8
FF09-1	6.5%	1.30%	1.312	2.426	2.459	48.1	48.3	3.64%	3.62%	170.0	27.8	27.6	2.3%	5.3	13.4	326.0
FF09-2	2.9%	1.30%	0.884	1.521	1.529	11.2	11.3	1.63%	1.64%	37.2	12.5	12.5	0.8%	1.9	10.1	116.1
FF16-1	3.9%	1.20%	1.260	1.753	1.752	18.7	18.7	2.20%	2.19%	62.4	16.8	16.7	1.3%	2.0	10.2	126.9
FF16-2	4.2%	0.14%	1.007	1.847	1.893	23.1	23.3	2.33%	2.31%	105.0	17.8	17.6	1.1%	2.9	11.1	177.7
FF18-1	2.5%	0.80%	0.941	1.496	1.520	10.0	10.1	1.18%	1.15%	54.6	9.0	8.8	1.1%	2.0	10.3	125.2
FF18-2	1.3%	0.36%	1.440	1.382	1.385	6.1	5.9	0.63%	0.65%	46.1	4.8	4.9	1.0%	1.4	9.6	84.5
FF19-1	6.2%	0.37%	0.985	2.274	2.300	43.1	43.0	3.45%	3.43%	256.4	26.4	26.2	2.2%	4.2	12.4	260.3
FF19-2	6.5%	0.89%	0.817	2.171	2.172	40.3	40.5	3.61%	3.58%	165.7	27.6	27.3	1.2%	4.0	12.2	246.2
NF02-1	3.5%	1.90%	0.817	1.724	1.729	16.7	16.7	1.94%	1.94%	47.3	14.8	14.8	0.8%	2.1	10.3	129.7
NF02-2	8.6%	2.70%	0.966	2.319	2.301	36.8	36.4	4.81%	4.77%	100.8	36.7	36.4	1.6%	4.0	12.3	249.6
NF04-1	3.5%	0.91%	0.760	1.816	1.854	19.4	19.3	1.93%	1.94%	59.7	14.8	14.8	1.1%	2.8	11.0	171.7
NF04-2	3.5%	1.70%	0.866	1.643	1.637	13.5	13.5	1.95%	1.96%	71.4	14.9	15.0	1.0%	2.3	10.6	145.1
NF06-1	3.3%	1.60%	1.257	1.841	1.851	21.1	20.8	1.86%	1.85%	74.3	14.2	14.1	1.2%	2.3	10.5	144.1
NF06-2	4.9%	2.70%	0.579	1.791	1.781	19.9	19.9	2.73%	2.73%	47.8	20.8	20.8	1.4%	2.7	11.0	169.6
NF07-1	3.9%	1.50%	1.357	1.702	1.683	17.0	16.6	2.18%	2.14%	132.7	16.7	16.3	1.5%	2.0	10.3	121.0
NF07-2	6.3%	3.90%	1.175	1.957	1.938	22.6	22.6	3.50%	3.47%	67.2	26.7	26.5	2.2%	3.2	11.4	195.8

Table A-37: FEMA P695 Results (ii) / LA6NSD

Ground motion	Story Drift	Residual Story Drift	Roof Acceleration (g)	Normalized Brace Force Tension	Normalized Brace Force Compression	Tensile Ductility	Compressive Ductility	Brace Strain in Tension	Brace Strain in Compression	Cumulative Ductility	Reference Tensile Ductility	Reference Compressive Ductility	Column Rotation	Column Stress in Tension (ksi)	Column Stress in Compression (ksi)	Column Uplift Force (kips)
NF09-1	1.7%	0.39%	0.543	1.347	1.362	6.1	6.0	0.96%	0.95%	17.6	7.3	7.3	0.6%	1.2	9.5	76.5
NF09-2	1.8%	0.58%	0.657	1.522	1.537	10.6	10.6	1.02%	1.01%	40.4	7.8	7.7	0.8%	2.0	10.3	124.8
NF10-1	3.0%	0.35%	0.775	1.614	1.619	14.1	14.2	1.68%	1.69%	52.7	12.8	12.9	1.0%	2.0	10.3	124.0
NF10-2	2.4%	0.72%	0.845	1.475	1.495	9.8	9.6	1.32%	1.33%	29.8	10.1	10.1	0.8%	1.9	10.2	118.1
NF12-1	4.0%	1.60%	0.715	1.931	1.949	24.0	23.9	2.22%	2.21%	131.6	16.9	16.9	1.2%	3.1	11.3	189.2
NF12-2	2.6%	0.06%	0.767	1.666	1.681	12.1	11.9	1.29%	1.28%	118.4	9.9	9.8	0.8%	2.6	10.8	160.8
NF15-1	2.9%	1.90%	0.786	1.587	1.582	10.8	10.6	1.61%	1.60%	47.0	12.3	12.2	0.9%	2.2	10.5	137.0
NF15-2	5.3%	1.10%	1.189	1.965	1.972	25.2	25.1	2.94%	2.93%	78.9	22.4	22.4	1.1%	2.9	10.9	179.5
NF22-1	3.7%	2.10%	1.622	1.616	1.611	14.3	14.5	2.03%	2.06%	25.2	15.5	15.7	1.3%	1.8	10.1	113.1
NF22-2	2.2%	0.76%	0.627	1.613	1.629	14.5	14.5	1.23%	1.24%	31.3	9.4	9.5	1.0%	2.2	10.4	135.0
NF23-1	2.3%	0.45%	1.038	1.612	1.640	10.5	10.8	1.28%	1.26%	45.9	9.8	9.6	0.9%	1.8	10.1	113.1
NF23-2	2.4%	0.47%	1.588	1.516	1.522	10.2	10.3	1.35%	1.31%	67.0	10.3	10.0	1.1%	1.8	10.1	109.8
NF24-1	3.0%	1.70%	1.069	1.646	1.648	10.8	10.9	1.65%	1.64%	138.5	12.6	12.5	0.8%	2.2	10.4	135.0
NF24-2	2.7%	0.21%	0.987	1.616	1.647	13.7	13.7	1.51%	1.50%	74.9	11.5	11.5	1.0%	2.3	10.6	144.8
NF26-1	6.0%	3.30%	0.700	2.026	2.027	25.4	25.4	3.33%	3.34%	107.8	25.4	25.5	1.5%	3.2	11.5	198.5
NF26-2	3.4%	1.30%	0.763	1.810	1.816	11.3	11.0	1.89%	1.87%	76.4	14.4	14.2	1.0%	2.8	11.1	173.8
NF27-1	1.8%	0.20%	0.703	1.513	1.531	11.2	11.3	1.01%	1.00%	96.7	7.7	7.6	0.7%	1.8	10.0	113.3
NF27-2	3.9%	1.30%	0.973	1.701	1.694	12.0	11.9	2.15%	2.14%	179.8	16.4	16.3	1.1%	2.0	10.3	123.7
NF28-1	3.3%	0.20%	0.550	1.772	1.802	18.3	18.0	1.80%	1.81%	59.3	13.7	13.8	1.3%	2.3	10.6	141.6
NF28-2	3.4%	0.70%	0.707	1.832	1.876	20.1	20.1	1.90%	1.89%	67.6	14.5	14.4	1.2%	2.7	10.9	165.1
μ	3.5%	1.15%	0.979	1.729	1.739	17.3	17.2	1.96%	1.95%	82.0	14.9	14.9	1.1%	2.4	10.6	148.3
$\mu+\sigma$	5.1%	2.02%	1.271	1.977	1.987	26.8	26.8	2.85%	2.84%	129.4	21.8	21.7	1.5%	3.2	11.4	199.0

Table A-38: SAC Results / LA6SSD

Ground motion	Story Drift	Residual Story Drift	Roof Acceleration (g)	Normalized Brace Force Tension	Normalized Brace Force Compression	Tensile Ductility	Compressive Ductility	Brace Strain in Tension	Brace Strain in Compression	Cumulative Ductility	Reference Tensile Ductility	Reference Compressive Ductility	Column Rotation	Column Stress in Tension (ksi)	Column Stress in Compression (ksi)	Column Uplift Force (kips)
LA21	2.2%	0.28%	1.296	2.336	2.363	41.2	41.0	3.14%	3.29%	242.0	23.9	25.1	1.0%	9.6	12.7	593.7
LA22	3.4%	0.29%	1.348	2.809	2.798	45.9	44.1	5.57%	5.49%	227.0	42.5	41.9	1.4%	7.2	14.2	445.3
LA23	3.2%	0.66%	1.363	2.869	2.888	67.7	67.6	5.21%	5.13%	294.6	39.7	39.2	1.4%	11.5	15.8	714.2
LA24	4.4%	0.43%	0.959	3.376	3.381	76.9	76.2	7.27%	7.22%	297.7	55.5	55.1	1.2%	9.8	17.7	610.5
LA25	3.9%	0.46%	1.207	2.728	2.695	45.0	44.3	6.51%	6.46%	133.6	49.7	49.3	1.2%	7.4	13.6	459.4
LA26	2.5%	0.77%	1.087	2.392	2.426	47.7	47.6	4.08%	4.05%	173.9	31.1	30.9	1.0%	8.4	15.0	519.9
LA27	5.0%	0.32%	1.298	3.646	3.648	89.9	89.0	8.32%	8.20%	382.5	63.5	62.6	1.4%	12.7	18.2	788.6
LA28	3.5%	0.33%	1.618	2.586	2.555	50.9	50.3	5.94%	5.90%	157.1	45.3	45.0	1.4%	9.3	13.1	577.1
LA29	1.8%	0.31%	1.781	2.287	2.320	29.2	29.1	2.87%	2.85%	300.2	21.9	21.7	0.8%	7.6	13.1	470.1
LA30	3.6%	0.35%	1.293	3.078	3.105	52.1	52.1	6.04%	6.01%	297.3	46.1	45.9	1.0%	13.0	15.0	808.9
LA31	2.8%	0.74%	1.280	2.608	2.630	43.3	43.8	4.33%	4.22%	221.7	33.0	32.2	1.2%	11.2	11.0	696.9
LA32	2.2%	0.29%	1.296	2.442	2.491	41.1	41.2	3.50%	3.53%	257.2	26.7	27.0	1.2%	8.6	12.2	534.4
LA33	3.8%	0.44%	1.347	3.134	3.167	82.0	81.8	6.27%	6.26%	277.9	47.8	47.8	1.5%	11.3	13.9	698.5
LA34	3.2%	0.70%	1.324	2.897	2.924	74.5	74.5	5.32%	5.28%	285.0	40.6	40.3	1.2%	10.7	13.5	663.0
LA35	9.4%	0.41%	1.384	5.340	5.300	97.9	97.9	15.10%	14.88%	267.2	115.3	113.5	2.3%	18.0	23.7	1114.0
LA36	6.1%	0.40%	1.194	3.926	3.901	97.9	97.6	10.40%	10.32%	318.1	79.4	78.8	1.8%	15.7	18.7	972.1
LA37	4.3%	0.40%	0.988	3.164	3.203	73.1	72.2	6.40%	6.67%	228.6	48.8	50.9	1.3%	8.5	18.8	528.3
LA38	6.2%	0.22%	0.943	3.963	4.063	82.0	80.4	9.59%	9.89%	205.2	73.2	75.4	1.6%	7.7	19.9	480.4
LA39	4.3%	0.14%	1.307	3.035	3.011	52.3	51.5	7.29%	7.25%	264.2	55.7	55.3	1.2%	7.2	15.9	446.0
LA40	8.8%	0.28%	1.143	5.108	5.038	97.9	97.9	14.17%	13.82%	252.3	108.2	105.5	2.3%	15.4	19.0	955.5
μ	4.2%	0.41%	1.273	3.186	3.195	64.4	64.0	6.87%	6.84%	254.2	52.4	52.2	1.4%	10.5	15.7	653.8
$\mu+\sigma$	6.2%	0.58%	1.468	4.014	4.008	85.9	85.4	10.09%	10.00%	311.3	77.0	76.3	1.8%	13.6	18.9	841.1

Table A-39: FEMA P695 Results (i) / LA6SSD

Ground motion	Story Drift	Residual Story Drift	Roof Acceleration (g)	Normalized Brace Force Tension	Normalized Brace Force Compression	Tensile Ductility	Compressive Ductility	Brace Strain in Tension	Brace Strain in Compression	Cumulative Ductility	Reference Tensile Ductility	Reference Compressive Ductility	Column Rotation	Column Stress in Tension (ksi)	Column Stress in Compression (ksi)	Column Uplift Force (kips)
FF01-1	2.2%	0.32%	0.928	2.033	2.020	25.7	25.6	3.51%	3.51%	208.3	26.8	26.8	0.7%	7.8	11.2	482.2
FF01-2	2.1%	0.38%	1.089	2.284	2.320	33.1	33.1	3.09%	3.06%	246.3	23.6	23.4	0.8%	8.6	10.9	530.2
FF02-1	3.9%	0.19%	1.514	3.195	3.182	77.9	79.3	6.51%	6.32%	342.7	49.7	48.2	1.2%	10.2	16.0	633.1
FF02-2	1.7%	0.35%	1.349	1.936	1.963	22.3	21.7	2.50%	2.53%	150.0	19.1	19.3	0.8%	7.0	11.3	432.6
FF03-1	2.4%	0.20%	1.536	2.362	2.382	34.7	33.6	3.51%	3.73%	244.6	26.8	28.5	1.2%	8.0	12.7	494.0
FF03-2	2.0%	0.36%	1.492	2.128	2.172	37.9	37.6	3.17%	3.22%	155.9	24.2	24.6	0.8%	6.7	12.5	412.5
FF09-1	5.8%	0.71%	1.576	4.005	4.019	87.2	86.2	9.76%	9.70%	403.7	74.5	74.0	1.5%	17.6	16.5	1094.0
FF09-2	2.2%	0.35%	1.200	2.165	2.205	42.4	42.2	3.66%	3.67%	108.4	27.9	28.0	0.8%	7.7	13.1	479.2
FF16-1	3.6%	0.18%	1.239	2.804	2.789	48.1	47.1	6.00%	5.95%	190.3	45.8	45.4	1.0%	7.8	14.1	483.5
FF16-2	4.0%	0.20%	0.970	3.210	3.239	84.7	85.0	6.57%	6.55%	389.6	50.2	50.0	1.1%	12.7	16.4	786.1
FF18-1	1.9%	0.32%	1.220	2.180	2.200	30.0	30.2	2.70%	2.72%	183.1	20.6	20.7	0.7%	8.8	11.2	544.6
FF18-2	1.1%	0.37%	1.548	1.774	1.801	18.7	18.5	1.57%	1.58%	141.5	12.0	12.1	0.8%	6.6	10.0	410.9
FF19-1	7.1%	0.09%	1.258	4.557	4.548	97.7	97.7	11.97%	11.83%	664.3	91.4	90.3	1.3%	14.8	24.1	914.7
FF19-2	4.8%	0.09%	1.043	3.568	3.593	92.8	92.0	8.01%	7.98%	399.6	61.1	60.9	1.0%	16.6	17.4	1030.0
NF02-1	2.0%	0.58%	0.958	2.242	2.293	32.3	32.3	3.19%	3.20%	132.1	24.4	24.4	0.9%	8.6	12.2	532.6
NF02-2	5.5%	0.90%	1.010	3.814	3.837	99.1	99.1	9.26%	9.16%	273.1	70.7	69.9	1.1%	16.6	19.6	1028.0
NF04-1	3.3%	0.51%	0.804	2.836	2.851	65.5	64.9	5.12%	5.22%	204.1	39.1	39.8	1.0%	9.3	16.3	576.5
NF04-2	3.1%	0.64%	1.138	2.556	2.550	38.8	38.7	5.04%	5.03%	236.0	38.5	38.4	0.9%	7.6	15.2	473.8
NF06-1	3.7%	0.41%	1.504	3.088	3.110	69.2	67.8	6.08%	6.03%	244.8	46.4	46.0	1.4%	11.4	14.7	708.7
NF06-2	3.9%	0.12%	0.827	2.839	2.823	57.6	58.0	6.60%	6.59%	132.5	50.4	50.3	1.1%	7.7	15.8	479.7
NF07-1	3.2%	0.17%	1.828	2.645	2.610	44.6	42.4	5.32%	5.20%	451.2	40.6	39.7	1.4%	7.3	13.2	451.1
NF07-2	4.7%	0.41%	1.370	3.139	3.120	51.5	51.3	7.83%	7.82%	225.4	59.8	59.7	1.6%	11.0	11.6	680.1

Table A-40: FEMA P695 Results (ii) / LA6SSD

Ground motion	Story Drift	Residual Story Drift	Roof Acceleration (g)	Normalized Brace Force Tension	Normalized Brace Force Compression	Tensile Ductility	Compressive Ductility	Brace Strain in Tension	Brace Strain in Compression	Cumulative Ductility	Reference Tensile Ductility	Reference Compressive Ductility	Column Rotation	Column Stress in Tension (ksi)	Column Stress in Compression (ksi)	Column Uplift Force (kips)
NF09-1	1.5%	0.37%	0.654	1.766	1.797	21.0	20.6	2.39%	2.38%	59.8	18.2	18.2	0.5%	6.7	10.3	415.3
NF09-2	1.7%	0.62%	0.895	2.228	2.257	27.2	27.3	2.65%	2.67%	131.0	20.2	20.3	0.8%	9.3	12.2	576.9
NF10-1	2.2%	0.67%	0.882	2.341	2.377	46.6	46.2	3.52%	3.56%	152.5	26.9	27.2	0.8%	7.2	14.5	447.1
NF10-2	2.1%	0.26%	0.888	1.960	1.964	32.7	32.7	3.44%	3.46%	100.9	26.2	26.4	0.8%	6.5	12.2	405.8
NF12-1	2.4%	0.21%	0.743	2.541	2.565	50.4	50.0	3.89%	3.84%	468.8	29.7	29.3	0.8%	9.8	14.3	606.9
NF12-2	2.3%	0.10%	0.788	2.513	2.539	44.1	44.0	3.78%	3.73%	442.4	28.8	28.5	0.9%	10.5	14.1	653.4
NF15-1	1.9%	1.10%	1.123	2.003	2.014	24.9	25.2	3.10%	3.06%	140.6	23.6	23.4	0.8%	7.3	12.3	451.0
NF15-2	3.7%	0.94%	1.355	3.101	3.123	72.3	72.1	6.14%	6.09%	251.8	46.8	46.4	1.1%	11.2	16.3	695.1
NF22-1	3.8%	1.10%	1.547	2.686	2.667	44.2	43.7	6.35%	6.35%	88.6	48.4	48.4	1.3%	8.7	8.9	541.7
NF22-2	2.2%	0.34%	0.846	2.340	2.368	35.0	34.9	3.41%	3.36%	99.2	26.0	25.6	0.8%	9.0	11.1	558.5
NF23-1	2.4%	0.21%	1.217	2.137	2.116	35.0	35.9	4.03%	4.00%	151.1	30.8	30.5	0.9%	7.6	11.8	472.7
NF23-2	1.6%	0.19%	1.956	2.167	2.201	28.3	29.0	2.62%	2.54%	200.1	20.0	19.4	1.0%	7.4	11.8	459.0
NF24-1	2.4%	0.36%	1.716	2.477	2.536	40.3	40.7	3.91%	3.87%	440.7	29.8	29.5	0.8%	8.2	14.2	509.6
NF24-2	2.2%	0.26%	1.267	2.286	2.299	34.0	33.3	3.61%	3.54%	277.3	27.6	27.0	0.9%	10.0	13.1	617.0
NF26-1	4.5%	0.69%	0.833	3.223	3.228	50.2	48.8	7.58%	7.58%	356.7	57.9	57.8	1.2%	11.9	11.7	740.7
NF26-2	2.7%	0.19%	1.165	2.667	2.689	36.7	36.5	4.40%	4.33%	203.6	33.6	33.1	0.8%	7.7	15.7	479.4
NF27-1	1.7%	0.20%	0.917	2.245	2.281	36.4	36.5	2.71%	2.69%	254.5	20.6	20.5	0.7%	7.3	12.4	455.0
NF27-2	2.9%	0.13%	1.420	2.613	2.610	30.2	29.9	4.69%	4.61%	503.5	35.8	35.2	0.9%	8.7	13.8	541.5
NF28-1	2.5%	0.32%	0.930	2.483	2.516	51.4	51.2	3.66%	3.70%	152.9	27.9	28.2	0.9%	6.6	14.7	411.9
NF28-2	2.9%	0.49%	0.673	2.766	2.798	59.5	59.4	4.79%	4.78%	190.8	36.6	36.4	0.8%	11.4	11.6	704.4
μ	2.9%	0.40%	1.172	2.617	2.633	47.4	47.2	4.80%	4.78%	247.5	36.6	36.5	1.0%	9.4	13.6	581.0
$\mu+\sigma$	4.2%	0.66%	1.493	3.215	3.225	68.8	68.5	7.02%	6.97%	380.7	53.6	53.2	1.2%	12.2	16.4	753.7

Table A-41: FEMA P695 Results (i) / Riv6NCh

Ground motion	Story Drift	Residual Story Drift	Roof Acceleration (g)	Normalized Brace Force Tension	Normalized Brace Force Compression	Tensile Ductility	Compressive Ductility	Brace Strain in Tension	Brace Strain in Compression	Cumulative Ductility	Reference Tensile Ductility	Reference Compressive Ductility	Column Rotation	Column Stress in Tension (ksi)	Column Stress in Compression (ksi)	Column Uplift Force (kips)
FF01-1	2.1%	1.30%	0.513	1.475	1.453	8.5	8.2	1.48%	1.42%	47.9	11.3	10.9	0.7%	2.5	9.2	154.8
FF01-2	1.5%	0.75%	0.554	1.525	1.520	11.7	11.2	1.06%	0.97%	58.8	8.1	7.4	0.6%	2.2	8.9	133.8
FF02-1	4.4%	3.50%	0.771	2.037	1.998	25.8	24.4	3.16%	2.91%	102.6	24.1	22.2	1.4%	4.1	10.8	252.5
FF02-2	1.9%	1.20%	0.824	1.561	1.548	9.5	9.6	1.35%	1.25%	63.0	10.3	9.6	0.7%	2.5	9.3	155.3
FF03-1	2.8%	1.30%	0.883	1.700	1.675	14.1	13.4	2.00%	1.88%	71.5	15.3	14.3	0.8%	3.2	9.9	198.3
FF03-2	2.0%	0.58%	0.905	1.577	1.586	11.8	11.2	1.42%	1.37%	76.1	10.8	10.5	0.8%	2.7	9.5	169.5
FF09-1	5.4%	1.50%	0.909	2.462	2.415	44.3	45.2	3.95%	3.53%	162.0	30.1	26.9	1.4%	4.6	11.3	287.7
FF09-2	2.5%	1.10%	0.443	1.513	1.532	12.2	11.7	1.78%	1.71%	38.8	13.6	13.1	0.8%	2.7	9.4	167.8
FF16-1	3.4%	2.30%	0.722	1.793	1.764	20.5	19.5	2.38%	2.22%	63.7	18.2	17.0	1.1%	2.8	9.5	170.6
FF16-2	3.1%	0.31%	0.693	1.815	1.819	20.9	20.1	2.20%	2.02%	101.8	16.8	15.4	1.0%	3.0	9.7	185.0
FF18-1	1.6%	0.58%	0.561	1.499	1.500	10.2	9.8	1.16%	1.13%	56.9	8.9	8.6	0.6%	2.5	9.2	152.6
FF18-2	1.0%	0.43%	0.751	1.407	1.400	6.4	6.2	0.70%	0.65%	33.2	5.3	5.0	0.6%	1.8	8.5	110.0
FF19-1	5.3%	1.50%	0.678	2.451	2.401	49.4	49.6	3.86%	3.47%	303.3	29.4	26.5	1.6%	5.2	11.9	325.3
FF19-2	6.2%	1.70%	0.598	2.404	2.349	40.9	42.6	4.47%	4.03%	198.1	34.1	30.8	1.5%	4.7	11.3	290.3
NF02-1	3.1%	2.10%	0.548	1.805	1.781	18.3	18.1	2.22%	2.05%	54.2	16.9	15.7	0.9%	2.8	9.5	173.1
NF02-2	8.1%	6.10%	0.653	2.513	2.406	44.3	41.0	5.80%	5.36%	107.2	44.2	40.9	1.8%	5.1	11.7	314.8
NF04-1	2.7%	0.73%	0.351	1.855	1.872	21.1	20.0	1.94%	1.81%	61.0	14.8	13.8	1.0%	3.6	10.3	222.6
NF04-2	3.1%	2.30%	0.592	1.669	1.638	15.1	14.5	2.20%	2.09%	47.5	16.8	16.0	0.7%	3.2	9.9	197.2
NF06-1	3.0%	1.90%	0.762	1.884	1.890	23.0	22.0	2.17%	1.87%	80.8	16.6	14.2	1.4%	3.1	9.8	191.3
NF06-2	4.4%	3.10%	0.404	1.840	1.791	22.1	20.9	3.11%	2.95%	49.8	23.8	22.5	1.0%	3.5	10.2	217.6
NF07-1	4.1%	3.10%	1.106	1.846	1.803	19.2	18.2	2.89%	2.73%	121.7	22.1	20.8	1.5%	3.9	10.6	240.1
NF07-2	5.7%	4.80%	0.798	2.050	1.980	23.0	21.7	4.04%	3.80%	53.3	30.8	29.0	1.4%	1.9	8.6	116.1

Table A-42: FEMA P695 Results (ii) / Riv6NCh

Ground motion	Story Drift	Residual Story Drift	Roof Acceleration (g)	Normalized Brace Force Tension	Normalized Brace Force Compression	Tensile Ductility	Compressive Ductility	Brace Strain in Tension	Brace Strain in Compression	Cumulative Ductility	Reference Tensile Ductility	Reference Compressive Ductility	Column Rotation	Column Stress in Tension (ksi)	Column Stress in Compression (ksi)	Column Uplift Force (kips)
NF09-1	2.5%	0.17%	0.503	1.501	1.504	11.8	11.3	1.73%	1.66%	35.0	13.2	12.7	0.9%	2.8	9.6	175.1
NF09-2	2.3%	0.22%	0.447	1.647	1.663	14.9	14.2	1.60%	1.52%	58.4	12.2	11.6	0.7%	3.1	9.8	190.4
NF10-1	6.3%	3.20%	0.780	2.124	2.065	30.8	29.5	4.49%	4.14%	114.2	34.3	31.6	2.0%	2.8	9.5	173.4
NF10-2	2.9%	1.60%	0.620	1.597	1.617	13.7	13.2	2.01%	1.93%	45.6	15.3	14.7	1.1%	3.1	9.8	189.8
NF12-1	3.4%	2.60%	0.423	1.931	1.931	23.2	22.2	2.48%	2.18%	171.2	18.9	16.6	1.0%	4.0	10.7	248.7
NF12-2	2.7%	0.14%	0.505	1.882	1.908	18.6	17.6	1.98%	1.74%	148.0	15.1	13.3	0.7%	3.5	10.2	215.7
NF15-1	2.7%	2.20%	0.552	1.661	1.643	9.5	9.4	1.95%	1.84%	47.4	14.9	14.0	0.8%	3.3	10.0	203.5
NF15-2	4.3%	0.70%	0.935	2.069	2.044	29.5	27.8	3.09%	2.78%	86.3	23.6	21.3	1.2%	3.4	10.1	208.9
NF22-1	3.5%	2.70%	0.921	1.696	1.660	17.4	16.5	2.48%	2.36%	30.2	18.9	18.0	1.3%	1.2	8.0	75.7
NF22-2	2.4%	1.20%	0.444	1.704	1.692	17.7	16.9	1.68%	1.53%	38.9	12.8	11.7	0.7%	2.7	9.4	164.5
NF23-1	2.3%	0.01%	0.763	1.648	1.658	10.6	10.2	1.57%	1.52%	51.8	12.0	11.6	0.8%	2.5	9.2	154.2
NF23-2	2.0%	0.83%	0.904	1.526	1.540	11.2	10.7	1.41%	1.34%	77.8	10.8	10.3	0.8%	2.9	9.7	180.5
NF24-1	2.8%	2.30%	0.566	1.621	1.599	8.7	8.8	1.98%	1.85%	107.5	15.1	14.2	0.7%	3.1	9.9	193.3
NF24-2	2.7%	1.60%	0.633	1.659	1.685	14.4	13.6	1.88%	1.76%	68.4	14.4	13.5	0.8%	3.3	10.1	207.5
NF26-1	6.5%	5.30%	0.479	2.322	2.247	28.0	26.7	4.70%	4.33%	138.7	35.8	33.1	1.6%	2.6	9.4	163.0
NF26-2	2.2%	0.92%	0.475	1.793	1.793	11.8	11.3	1.63%	1.42%	77.7	12.4	10.8	0.7%	3.4	10.1	212.4
NF27-1	2.1%	0.56%	0.573	1.619	1.622	13.6	13.1	1.51%	1.37%	95.1	11.5	10.5	0.8%	2.9	9.6	178.2
NF27-2	2.9%	1.70%	0.647	1.707	1.685	12.0	11.5	2.07%	1.92%	101.6	15.8	14.7	1.1%	3.4	10.1	210.2
NF28-1	2.1%	0.53%	0.354	1.671	1.677	16.0	15.2	1.45%	1.38%	50.9	11.0	10.5	0.9%	3.3	10.0	205.8
NF28-2	3.1%	1.90%	0.348	1.969	1.955	23.5	22.2	2.26%	2.02%	68.0	17.3	15.4	0.9%	2.1	8.8	128.0
μ	3.3%	1.73%	0.640	1.810	1.793	19.3	18.6	2.36%	2.19%	84.9	18.0	16.7	1.0%	3.1	9.8	193.0
$\mu+\sigma$	4.8%	3.10%	0.824	2.095	2.058	29.5	28.7	3.47%	3.19%	136.8	26.5	24.4	1.4%	3.9	10.6	243.8

Table A-43: FEMA P695 Results (i) / Riv6NCh1.5

Ground motion	Story Drift	Residual Story Drift	Roof Acceleration (g)	Normalized Brace Force Tension	Normalized Brace Force Compression	Tensile Ductility	Compressive Ductility	Brace Strain in Tension	Brace Strain in Compression	Cumulative Ductility	Reference Tensile Ductility	Reference Compressive Ductility	Column Rotation	Column Stress in Tension (ksi)	Column Stress in Compression (ksi)	Column Uplift Force (kips)
FF01-1	1.8%	0.35%	0.540	1.457	1.465	9.3	8.7	1.29%	1.25%	35.6	9.9	9.5	0.6%	4.4	17.8	274.7
FF01-2	1.9%	0.67%	0.628	1.525	1.509	11.6	11.1	1.42%	1.30%	49.5	10.8	9.9	0.6%	4.6	18.1	285.2
FF02-1	3.5%	1.40%	0.911	1.800	1.784	21.9	21.8	2.58%	2.41%	87.1	19.7	18.4	1.3%	5.4	19.3	332.3
FF02-2	1.9%	0.87%	0.982	1.493	1.472	9.5	9.6	1.38%	1.30%	53.5	10.5	9.9	0.8%	4.9	18.7	306.1
FF03-1	2.2%	0.43%	1.133	1.619	1.632	14.3	13.5	1.56%	1.44%	58.8	11.9	11.0	0.9%	4.4	17.8	273.6
FF03-2	1.9%	0.27%	0.991	1.559	1.568	12.6	11.9	1.37%	1.28%	60.2	10.4	9.7	0.9%	4.7	18.2	290.9
FF09-1	3.3%	0.92%	1.096	2.065	2.043	29.2	29.0	2.43%	2.18%	113.8	18.5	16.6	1.2%	6.8	20.8	390.0
FF09-2	2.0%	0.13%	0.630	1.690	1.678	17.2	16.2	1.47%	1.30%	39.6	11.2	9.9	0.7%	4.6	18.1	283.9
FF16-1	3.0%	0.13%	0.764	1.708	1.678	17.7	16.8	2.17%	2.01%	62.6	16.6	15.3	1.2%	4.4	17.8	272.5
FF16-2	2.8%	0.35%	0.747	1.875	1.884	21.7	21.0	2.03%	1.81%	106.4	15.5	13.8	1.0%	4.9	18.5	302.6
FF18-1	1.5%	0.41%	0.619	1.534	1.525	10.5	10.0	1.07%	0.96%	61.4	8.2	7.3	0.7%	4.8	18.4	296.5
FF18-2	1.5%	0.60%	0.945	1.434	1.419	7.2	6.8	1.03%	0.97%	34.6	7.9	7.4	0.6%	3.5	16.4	218.9
FF19-1	5.9%	1.40%	0.681	2.568	2.493	45.1	44.4	4.40%	3.89%	228.9	33.6	29.7	1.6%	8.3	23.9	515.1
FF19-2	4.1%	1.00%	0.575	2.145	2.116	35.9	36.3	3.07%	2.71%	122.8	23.4	20.7	1.3%	7.9	21.2	408.7
NF02-1	2.1%	0.78%	0.542	1.595	1.582	14.1	13.3	1.51%	1.39%	47.3	11.5	10.6	0.8%	5.1	18.9	315.8
NF02-2	5.6%	1.70%	0.742	2.137	2.063	32.7	33.6	4.13%	3.83%	92.8	31.6	29.2	1.2%	6.6	21.3	411.9
NF04-1	2.4%	0.52%	0.476	1.906	1.907	23.2	21.7	1.83%	1.64%	67.3	13.9	12.5	0.9%	5.7	19.8	353.3
NF04-2	2.9%	1.50%	0.585	1.638	1.606	14.0	13.1	2.09%	1.96%	46.9	15.9	14.9	0.9%	4.8	18.4	296.2
NF06-1	2.8%	1.00%	0.847	1.888	1.888	23.1	21.8	2.14%	1.78%	77.0	16.4	13.6	1.3%	5.3	18.9	316.3
NF06-2	3.6%	1.20%	0.432	1.742	1.698	18.9	17.8	2.63%	2.47%	40.1	20.0	18.9	0.9%	5.4	19.3	332.8
NF07-1	2.9%	1.50%	1.243	1.656	1.624	15.7	14.9	2.08%	1.95%	122.9	15.9	14.9	1.2%	5.5	19.6	341.1
NF07-2	4.0%	1.70%	0.954	1.764	1.714	20.5	19.4	2.90%	2.75%	47.2	22.2	21.0	1.2%	4.8	17.4	255.6

Table A-44: FEMA P695 Results (ii) / Riv6NCh1.5

Ground motion	Story Drift	Residual Story Drift	Roof Acceleration (g)	Normalized Brace Force Tension	Normalized Brace Force Compression	Tensile Ductility	Compressive Ductility	Brace Strain in Tension	Brace Strain in Compression	Cumulative Ductility	Reference Tensile Ductility	Reference Compressive Ductility	Column Rotation	Column Stress in Tension (ksi)	Column Stress in Compression (ksi)	Column Uplift Force (kips)
NF09-1	2.0%	0.22%	0.579	1.549	1.555	12.2	11.4	1.39%	1.34%	37.8	10.6	10.3	0.9%	4.0	17.2	250.0
NF09-2	2.1%	0.64%	0.591	1.715	1.718	13.8	12.9	1.53%	1.44%	54.6	11.6	11.0	0.6%	4.7	18.3	292.0
NF10-1	3.1%	0.91%	0.810	1.940	1.929	24.3	24.4	2.29%	2.04%	90.5	17.5	15.6	1.3%	6.3	20.9	393.4
NF10-2	2.4%	0.22%	0.674	1.651	1.662	14.9	13.9	1.72%	1.65%	48.9	13.1	12.6	1.0%	4.9	18.6	304.7
NF12-1	2.0%	0.21%	0.444	1.696	1.688	14.3	13.7	1.50%	1.30%	145.0	11.4	9.9	0.7%	5.1	18.4	296.6
NF12-2	2.8%	0.74%	0.496	1.832	1.839	20.1	19.2	2.01%	1.85%	180.6	15.3	14.1	0.8%	5.6	19.6	347.3
NF15-1	1.6%	0.81%	0.638	1.548	1.542	12.3	11.9	1.22%	1.06%	45.9	9.3	8.1	0.6%	4.9	18.6	303.0
NF15-2	4.0%	0.51%	0.995	1.956	1.920	25.5	26.3	2.99%	2.69%	86.6	22.8	20.5	1.3%	6.0	20.3	371.9
NF22-1	3.1%	2.20%	1.252	1.649	1.613	15.9	15.0	2.26%	2.14%	22.3	17.2	16.3	1.2%	4.2	14.4	162.6
NF22-2	2.7%	1.10%	0.634	1.619	1.588	14.8	14.0	1.98%	1.87%	27.3	15.1	14.3	1.0%	4.6	17.6	264.8
NF23-1	2.5%	0.29%	0.902	1.598	1.614	12.6	11.7	1.76%	1.68%	41.9	13.4	12.8	0.9%	3.9	17.0	241.2
NF23-2	1.7%	0.54%	1.101	1.565	1.554	8.2	7.8	1.25%	1.12%	70.8	9.6	8.6	0.9%	4.3	17.3	252.3
NF24-1	2.1%	0.69%	0.558	1.606	1.595	10.5	10.2	1.52%	1.34%	110.2	11.6	10.2	0.8%	4.7	18.3	294.3
NF24-2	2.6%	0.77%	0.787	1.731	1.747	15.6	14.7	1.87%	1.75%	82.8	14.3	13.3	1.0%	5.2	19.0	320.1
NF26-1	3.8%	1.80%	0.613	1.802	1.757	20.2	19.5	2.80%	2.61%	130.0	21.3	19.9	1.2%	4.6	17.1	243.7
NF26-2	2.4%	0.07%	0.560	1.720	1.703	11.0	10.5	1.77%	1.58%	53.6	13.5	12.1	0.8%	5.3	19.3	330.7
NF27-1	2.1%	0.41%	0.564	1.646	1.664	15.1	14.4	1.56%	1.39%	116.2	11.9	10.6	0.9%	4.8	18.4	297.4
NF27-2	1.9%	0.44%	0.619	1.554	1.566	8.8	9.0	1.38%	1.26%	123.9	10.5	9.6	0.8%	4.9	18.5	300.8
NF28-1	3.0%	1.70%	0.351	1.763	1.736	19.3	18.2	2.17%	1.98%	46.7	16.6	15.1	0.9%	5.4	19.4	337.2
NF28-2	2.9%	1.90%	0.402	1.822	1.797	21.7	20.4	2.17%	1.96%	45.4	16.6	15.0	1.0%	5.1	17.5	260.1
μ	2.7%	0.83%	0.729	1.732	1.718	17.5	16.9	1.99%	1.82%	76.6	15.2	13.9	1.0%	5.1	18.7	308.0
$\mu+\sigma$	3.7%	1.39%	0.959	1.946	1.920	25.2	24.8	2.72%	2.48%	119.6	20.8	19.0	1.2%	6.1	20.2	367.1

Table A-45: FEMA P695 Results (i) / Riv6SCh

Ground motion	Story Drift	Residual Story Drift	Roof Acceleration (g)	Normalized Brace Force Tension	Normalized Brace Force Compression	Tensile Ductility	Compressive Ductility	Brace Strain in Tension	Brace Strain in Compression	Cumulative Ductility	Reference Tensile Ductility	Reference Compressive Ductility	Column Rotation	Column Stress in Tension (ksi)	Column Stress in Compression (ksi)	Column Uplift Force (kips)
FF01-1	1.7%	0.37%	0.535	1.831	1.801	19.9	19.3	2.75%	2.87%	90.0	21.0	21.9	0.6%	3.7	10.5	231.0
FF01-2	1.5%	0.33%	0.584	1.990	1.980	24.9	23.7	2.37%	2.38%	103.1	18.1	18.2	0.5%	3.5	10.2	215.6
FF02-1	3.0%	0.47%	1.018	2.694	2.637	58.3	58.7	5.24%	4.59%	213.8	40.0	35.0	1.0%	5.6	12.3	346.9
FF02-2	1.4%	0.37%	1.026	1.837	1.828	19.8	19.7	2.26%	2.20%	135.3	17.2	16.8	0.7%	3.8	10.5	234.9
FF03-1	1.7%	0.25%	1.125	2.182	2.157	29.9	28.3	3.10%	2.62%	138.2	23.7	20.0	0.9%	4.0	10.8	248.2
FF03-2	1.8%	0.36%	1.131	2.029	2.017	32.0	31.2	2.93%	3.03%	136.5	22.4	23.1	0.7%	3.8	10.6	236.3
FF09-1	3.9%	0.19%	1.012	3.209	3.118	68.1	67.2	6.57%	6.42%	298.0	50.1	49.0	0.9%	7.4	14.1	456.4
FF09-2	1.6%	0.24%	0.553	2.124	2.107	33.1	31.8	2.64%	2.78%	89.6	20.2	21.2	0.4%	4.3	11.0	263.8
FF16-1	2.7%	0.36%	0.753	2.384	2.337	36.6	35.2	4.71%	4.16%	157.0	36.0	31.8	0.8%	4.0	10.7	245.0
FF16-2	2.5%	0.54%	0.722	2.623	2.577	55.5	55.8	4.33%	4.18%	262.5	33.0	31.9	0.9%	5.4	12.1	333.1
FF18-1	1.3%	0.45%	0.595	2.018	2.006	22.8	21.8	2.24%	1.99%	137.8	17.1	15.2	0.5%	4.6	11.3	282.9
FF18-2	1.0%	0.41%	0.895	1.719	1.707	16.1	15.3	1.51%	1.60%	86.3	11.6	12.2	0.5%	2.9	9.8	180.6
FF19-1	6.5%	0.27%	0.785	4.347	4.142	90.4	91.8	11.61%	10.20%	582.7	88.6	77.9	1.2%	10.8	17.5	672.4
FF19-2	4.3%	0.32%	0.539	3.371	3.266	87.1	86.6	7.22%	7.04%	346.9	55.1	53.7	1.0%	8.7	15.5	541.4
NF02-1	1.7%	0.55%	0.581	2.171	2.145	30.2	28.6	2.84%	2.85%	114.3	21.7	21.7	0.6%	4.0	10.7	246.2
NF02-2	4.6%	0.43%	0.598	3.275	3.159	90.0	88.7	8.13%	7.28%	239.4	62.0	55.6	0.9%	7.1	13.8	440.1
NF04-1	2.4%	0.81%	0.532	2.547	2.505	49.9	49.4	4.20%	3.60%	152.3	32.0	27.5	0.8%	5.4	12.1	333.8
NF04-2	2.5%	0.59%	0.636	2.271	2.228	30.6	29.5	4.36%	3.87%	124.7	33.2	29.5	0.7%	4.6	11.4	288.0
NF06-1	3.0%	0.44%	1.004	2.821	2.761	55.0	54.2	5.01%	4.94%	203.9	38.3	37.7	1.3%	4.9	11.6	305.0
NF06-2	3.1%	0.67%	0.495	2.480	2.415	42.9	43.1	5.41%	4.92%	101.3	41.3	37.5	0.8%	5.2	12.0	322.7
NF07-1	2.7%	0.32%	1.255	2.395	2.342	36.9	35.3	4.80%	4.31%	246.5	36.6	32.9	1.1%	4.4	11.2	275.2
NF07-2	3.7%	0.55%	0.931	2.695	2.611	43.9	42.1	6.21%	6.23%	119.8	47.4	47.5	1.1%	4.8	11.6	299.8

Table A-46: FEMA P695 Results (ii) / Riv6SCh

Ground motion	Story Drift	Residual Story Drift	Roof Acceleration (g)	Normalized Brace Force Tension	Normalized Brace Force Compression	Tensile Ductility	Compressive Ductility	Brace Strain in Tension	Brace Strain in Compression	Cumulative Ductility	Reference Tensile Ductility	Reference Compressive Ductility	Column Rotation	Column Stress in Tension (ksi)	Column Stress in Compression (ksi)	Column Uplift Force (kips)
NF09-1	2.0%	0.20%	0.627	1.905	1.868	28.3	27.5	3.42%	3.13%	88.8	26.1	23.9	0.7%	3.6	10.5	226.1
NF09-2	1.8%	0.49%	0.527	2.268	2.243	30.5	30.9	3.20%	2.83%	133.6	24.4	21.6	0.6%	4.8	11.6	298.6
NF10-1	3.1%	0.47%	0.896	2.804	2.757	58.8	60.0	5.32%	5.08%	230.6	40.6	38.7	0.9%	5.9	12.7	368.9
NF10-2	2.3%	0.15%	0.699	2.062	2.018	36.4	35.7	3.84%	3.96%	112.1	29.3	30.2	0.8%	4.1	10.9	256.1
NF12-1	1.6%	0.13%	0.435	2.232	2.209	32.2	32.2	2.70%	2.65%	336.0	20.6	20.2	0.6%	4.7	11.4	289.9
NF12-2	2.2%	0.10%	0.538	2.431	2.397	41.3	40.4	3.86%	3.32%	430.7	29.4	25.4	0.7%	5.4	12.1	332.0
NF15-1	1.7%	0.95%	0.623	1.989	1.972	24.6	24.0	3.03%	2.55%	115.4	23.2	19.4	0.6%	4.0	10.8	251.0
NF15-2	3.4%	0.99%	0.985	2.967	2.905	62.2	63.5	5.76%	5.54%	199.5	43.9	42.3	0.9%	6.0	12.8	374.0
NF22-1	3.0%	1.20%	1.207	2.384	2.325	36.3	34.9	4.93%	5.01%	66.4	37.6	38.2	1.0%	3.8	10.5	233.1
NF22-2	2.1%	0.55%	0.516	2.212	2.177	31.8	30.4	3.47%	3.50%	78.8	26.5	26.7	0.7%	4.3	11.1	267.9
NF23-1	2.3%	0.12%	0.823	2.090	2.046	32.1	31.6	4.06%	3.70%	112.4	31.0	28.2	0.7%	3.8	10.5	233.2
NF23-2	1.3%	0.21%	1.159	2.070	2.062	21.4	19.8	2.17%	2.04%	158.6	16.5	15.6	0.7%	3.8	10.6	236.9
NF24-1	1.8%	0.53%	0.573	2.044	2.025	23.8	24.7	3.29%	2.77%	250.8	25.1	21.1	0.6%	3.8	10.6	236.6
NF24-2	2.0%	0.64%	0.796	2.298	2.271	32.4	31.5	3.54%	3.09%	196.8	27.0	23.6	0.7%	5.2	12.0	321.9
NF26-1	3.6%	0.73%	0.607	2.758	2.678	43.1	42.6	6.05%	6.03%	311.7	46.2	46.0	0.9%	5.3	12.0	325.7
NF26-2	2.2%	0.19%	0.600	2.468	2.432	26.7	25.9	3.87%	3.30%	135.8	29.6	25.2	0.6%	5.4	12.1	332.8
NF27-1	1.9%	0.18%	0.611	2.186	2.166	36.0	36.8	3.34%	2.77%	248.5	25.5	21.1	0.6%	4.1	10.9	253.5
NF27-2	1.8%	0.64%	0.696	2.196	2.170	19.6	19.7	3.22%	2.73%	267.9	24.6	20.8	0.6%	4.1	10.9	257.2
NF28-1	2.0%	0.63%	0.387	2.413	2.380	37.4	35.7	3.65%	3.09%	107.8	27.8	23.6	0.5%	5.1	11.9	317.7
NF28-2	2.3%	0.79%	0.385	2.505	2.466	44.8	43.0	3.75%	3.72%	135.9	28.6	28.4	0.6%	5.3	12.1	326.9
μ	2.5%	0.46%	0.738	2.412	2.367	39.8	39.2	4.21%	3.92%	185.7	32.1	30.0	0.8%	4.9	11.6	303.3
$\mu+\sigma$	3.5%	0.70%	0.974	2.900	2.822	58.2	57.8	6.05%	5.62%	290.1	46.2	42.9	1.0%	6.3	13.1	392.9

Table A-47: FEMA P695 Results (i) / Riv6NSD

Ground motion	Story Drift	Residual Story Drift	Roof Acceleration (g)	Normalized Brace Force Tension	Normalized Brace Force Compression	Tensile Ductility	Compressive Ductility	Brace Strain in Tension	Brace Strain in Compression	Cumulative Ductility	Reference Tensile Ductility	Reference Compressive Ductility	Column Rotation	Column Stress in Tension (ksi)	Column Stress in Compression (ksi)	Column Uplift Force (kips)
FF01-1	1.5%	0.48%	0.447	1.378	1.376	6.7	6.6	0.84%	0.84%	68.3	6.4	6.4	0.7%	0.4	8.6	22.0
FF01-2	1.2%	0.18%	0.613	1.369	1.375	6.4	6.6	0.60%	0.60%	66.2	4.6	4.5	0.8%	0.2	8.5	15.4
FF02-1	3.4%	1.70%	1.046	1.717	1.716	12.3	12.3	1.89%	1.89%	62.8	14.4	14.4	1.1%	0.7	9.0	41.2
FF02-2	1.8%	0.37%	1.130	1.437	1.424	6.8	7.0	0.98%	0.96%	48.6	7.5	7.4	0.9%	0.1	8.4	5.1
FF03-1	2.1%	0.59%	0.961	1.551	1.553	10.5	10.2	1.14%	1.13%	59.6	8.7	8.6	1.0%	0.4	8.6	25.1
FF03-2	1.7%	0.27%	1.091	1.487	1.496	10.2	9.9	0.91%	0.92%	52.6	6.9	7.0	0.9%	0.4	8.7	26.0
FF09-1	5.5%	0.88%	0.862	2.176	2.193	37.3	37.5	3.04%	3.01%	127.1	23.2	23.0	1.7%	2.7	10.9	165.4
FF09-2	2.0%	0.73%	0.557	1.395	1.386	7.2	7.2	1.09%	1.10%	28.5	8.4	8.4	0.6%	0.4	8.6	25.1
FF16-1	3.2%	1.20%	0.736	1.568	1.555	12.3	12.4	1.75%	1.75%	49.1	13.4	13.3	1.0%	0.5	8.8	31.9
FF16-2	3.2%	0.21%	0.655	1.682	1.726	15.4	15.6	1.80%	1.79%	72.8	13.7	13.6	1.0%	0.9	9.2	58.0
FF18-1	2.3%	0.65%	0.791	1.464	1.453	8.0	8.0	1.14%	1.13%	53.2	8.7	8.6	0.9%	0.6	8.8	37.8
FF18-2	1.3%	0.20%	1.233	1.337	1.347	4.9	4.9	0.69%	0.69%	40.5	5.2	5.3	0.9%	0.0	8.3	2.0
FF19-1	6.1%	0.83%	0.684	2.300	2.338	37.2	37.1	3.42%	3.42%	257.3	26.1	26.1	2.0%	2.2	10.4	136.7
FF19-2	5.8%	1.90%	0.615	2.109	2.113	35.4	35.6	3.25%	3.22%	161.4	24.8	24.6	1.1%	2.1	10.4	132.4
NF02-1	2.7%	1.50%	0.618	1.622	1.627	14.3	14.2	1.51%	1.52%	38.9	11.5	11.6	0.7%	0.7	8.9	42.9
NF02-2	7.1%	3.20%	0.731	2.104	2.086	29.7	29.4	3.96%	3.93%	77.8	30.2	30.0	1.3%	1.9	10.1	116.4
NF04-1	2.9%	0.12%	0.469	1.670	1.693	15.4	15.2	1.57%	1.59%	46.3	12.0	12.1	0.7%	1.0	9.3	64.8
NF04-2	2.5%	1.10%	0.594	1.504	1.496	9.3	9.2	1.38%	1.37%	58.4	10.5	10.5	0.8%	0.7	8.9	43.0
NF06-1	2.9%	1.50%	0.875	1.704	1.708	17.1	16.9	1.61%	1.60%	63.5	12.3	12.2	0.9%	1.0	9.3	63.2
NF06-2	3.7%	2.60%	0.427	1.633	1.623	14.7	14.7	2.04%	2.04%	29.0	15.6	15.6	1.0%	1.0	9.2	60.8
NF07-1	3.5%	1.30%	1.112	1.641	1.638	15.0	14.6	1.97%	1.93%	123.5	15.0	14.7	1.4%	0.7	9.0	44.2
NF07-2	4.9%	3.40%	0.925	1.772	1.759	16.8	16.8	2.72%	2.72%	48.3	20.8	20.7	1.7%	1.3	9.5	79.5

Table A-48: FEMA P695 Results (ii) / Riv6NSD

Ground motion	Story Drift	Residual Story Drift	Roof Acceleration (g)	Normalized Brace Force Tension	Normalized Brace Force Compression	Tensile Ductility	Compressive Ductility	Brace Strain in Tension	Brace Strain in Compression	Cumulative Ductility	Reference Tensile Ductility	Reference Compressive Ductility	Column Rotation	Column Stress in Tension (ksi)	Column Stress in Compression (ksi)	Column Uplift Force (kips)
NF09-1	2.5%	0.79%	0.606	1.436	1.443	9.3	9.2	1.39%	1.38%	24.9	10.6	10.6	1.0%	0.0	8.3	-0.5
NF09-2	2.1%	0.19%	0.556	1.475	1.490	10.0	10.0	1.13%	1.13%	44.9	8.6	8.6	1.0%	0.7	9.0	44.3
NF10-1	4.5%	1.30%	0.969	1.822	1.827	20.6	20.7	2.48%	2.49%	70.6	18.9	19.0	1.3%	0.7	8.9	40.8
NF10-2	2.6%	0.80%	0.644	1.489	1.507	10.0	9.8	1.40%	1.42%	32.3	10.7	10.8	0.9%	0.7	9.0	44.6
NF12-1	3.3%	1.50%	0.463	1.787	1.797	19.8	19.7	1.84%	1.84%	100.4	14.1	14.0	1.1%	1.3	9.6	83.5
NF12-2	2.2%	0.30%	0.564	1.569	1.586	11.6	11.3	1.21%	1.20%	106.9	9.2	9.2	0.7%	1.0	9.3	62.4
NF15-1	2.6%	1.60%	0.598	1.514	1.503	8.9	8.7	1.42%	1.41%	43.1	10.8	10.8	0.9%	0.8	9.0	47.8
NF15-2	4.7%	1.70%	1.097	1.857	1.863	21.5	21.5	2.59%	2.59%	67.1	19.7	19.7	1.0%	1.3	9.5	82.9
NF22-1	2.9%	1.60%	1.199	1.510	1.507	10.9	11.1	1.56%	1.59%	22.1	11.9	12.1	1.0%	0.5	8.7	28.8
NF22-2	2.0%	0.44%	0.622	1.539	1.556	12.1	12.2	1.08%	1.07%	26.2	8.2	8.2	0.8%	0.7	8.9	40.7
NF23-1	2.0%	0.54%	0.825	1.543	1.566	9.6	9.8	1.10%	1.08%	43.9	8.4	8.2	0.8%	0.6	8.9	38.8
NF23-2	2.1%	0.43%	1.436	1.473	1.459	8.6	8.7	1.15%	1.11%	61.3	8.8	8.4	1.1%	0.5	8.8	33.6
NF24-1	1.4%	0.20%	0.644	1.400	1.389	6.6	10.4	0.69%	0.68%	71.8	5.2	5.2	0.7%	0.5	8.7	29.8
NF24-2	2.6%	0.32%	0.823	1.589	1.619	12.7	12.9	1.45%	1.43%	78.1	11.0	10.9	1.0%	0.9	9.2	57.6
NF26-1	5.1%	3.10%	0.552	1.871	1.865	19.7	19.6	2.81%	2.81%	81.4	21.5	21.5	1.3%	1.4	9.7	86.9
NF26-2	2.7%	1.10%	0.665	1.620	1.618	8.5	8.7	1.50%	1.49%	59.4	11.5	11.4	0.8%	1.0	9.3	61.5
NF27-1	1.8%	0.23%	0.639	1.474	1.474	9.0	9.1	1.01%	1.01%	122.4	7.7	7.7	0.7%	0.5	8.7	29.2
NF27-2	2.5%	0.59%	0.809	1.513	1.538	8.2	8.1	1.37%	1.37%	145.5	10.5	10.5	1.0%	0.5	8.8	32.6
NF28-1	2.6%	0.70%	0.375	1.606	1.627	13.6	13.4	1.44%	1.46%	45.8	11.0	11.1	0.9%	0.7	9.0	46.4
NF28-2	2.7%	0.24%	0.520	1.672	1.701	15.7	15.6	1.52%	1.51%	52.3	11.6	11.5	1.0%	1.0	9.2	58.9
μ	3.0%	1.01%	0.757	1.628	1.634	14.0	14.1	1.65%	1.65%	69.9	12.6	12.6	1.0%	0.8	9.1	52.1
$\mu+\sigma$	4.4%	1.86%	1.004	1.849	1.858	22.0	22.0	2.43%	2.42%	113.4	18.5	18.5	1.3%	1.4	9.6	86.9

Table A-49: FEMA P695 Results (i) / Riv6SSD

Ground motion	Story Drift	Residual Story Drift	Roof Acceleration (g)	Normalized Brace Force Tension	Normalized Brace Force Compression	Tensile Ductility	Compressive Ductility	Brace Strain in Tension	Brace Strain in Compression	Cumulative Ductility	Reference Tensile Ductility	Reference Compressive Ductility	Column Rotation	Column Stress in Tension (ksi)	Column Stress in Compression (ksi)	Column Uplift Force (kips)
FF01-1	1.5%	0.06%	0.559	1.737	1.722	20.7	19.4	2.45%	2.45%	193.2	18.7	18.7	0.6%	3.2	9.4	201.0
FF01-2	1.5%	0.20%	0.808	1.763	1.770	24.9	25.3	2.27%	2.32%	219.1	17.4	17.7	0.6%	3.1	9.2	190.9
FF02-1	3.3%	0.46%	1.319	2.602	2.579	52.5	53.4	5.43%	5.37%	229.2	41.4	41.0	1.0%	6.7	9.3	416.0
FF02-2	1.3%	0.14%	1.123	1.758	1.729	21.9	22.0	2.08%	2.05%	167.0	15.8	15.7	0.8%	3.8	9.0	234.9
FF03-1	2.3%	0.12%	1.364	2.128	2.108	33.3	33.0	3.73%	3.69%	185.5	28.4	28.1	0.9%	4.9	9.2	306.6
FF03-2	1.7%	0.07%	1.075	1.803	1.794	33.1	32.3	2.61%	2.68%	183.7	19.9	20.5	0.7%	4.2	9.1	258.2
FF09-1	5.2%	0.76%	1.171	3.479	3.458	88.2	87.2	8.40%	8.26%	335.1	64.1	63.1	1.2%	7.8	15.9	483.8
FF09-2	1.8%	0.18%	0.734	1.845	1.833	30.1	30.1	2.93%	2.94%	83.2	22.3	22.4	0.5%	4.1	9.7	254.3
FF16-1	2.8%	0.29%	0.915	2.346	2.328	41.6	41.1	4.64%	4.62%	164.9	35.4	35.2	0.9%	5.5	9.1	343.4
FF16-2	2.7%	0.25%	0.602	2.328	2.313	56.1	56.2	4.45%	4.42%	247.1	34.0	33.8	0.8%	6.2	11.0	385.6
FF18-1	1.7%	0.11%	0.908	1.808	1.801	26.9	27.1	2.52%	2.54%	165.5	19.2	19.4	0.6%	4.0	9.7	245.0
FF18-2	0.9%	0.28%	1.105	1.511	1.512	16.2	16.2	1.34%	1.33%	155.3	10.3	10.1	0.6%	2.6	9.0	161.2
FF19-1	7.3%	0.13%	0.904	4.418	4.506	97.8	97.8	11.64%	11.88%	696.0	88.8	90.7	1.3%	13.3	15.3	825.3
FF19-2	4.9%	0.08%	0.722	3.606	3.626	97.8	97.1	8.15%	8.12%	462.2	62.2	61.9	0.8%	9.1	16.9	561.7
NF02-1	2.3%	0.54%	0.666	2.130	2.129	36.6	36.7	3.70%	3.72%	126.8	28.2	28.4	0.8%	4.1	10.2	252.4
NF02-2	5.3%	0.50%	0.769	3.366	3.329	92.0	93.3	8.84%	8.77%	235.1	67.4	66.9	1.0%	10.2	14.5	629.9
NF04-1	2.5%	0.43%	0.611	2.238	2.244	52.0	51.6	3.93%	4.05%	174.7	30.0	30.9	0.9%	6.5	9.8	402.7
NF04-2	2.3%	0.21%	0.778	2.059	2.040	27.6	27.3	3.70%	3.70%	184.7	28.2	28.2	0.6%	5.8	9.0	362.4
NF06-1	2.8%	0.37%	1.004	2.482	2.474	58.5	57.5	4.52%	4.49%	200.4	34.5	34.3	1.1%	6.0	10.5	373.3
NF06-2	3.2%	0.41%	0.503	2.447	2.425	41.3	41.9	5.33%	5.32%	107.7	40.7	40.6	0.9%	6.9	9.0	427.2
NF07-1	3.0%	0.06%	1.476	2.416	2.372	41.4	40.1	4.99%	4.88%	403.7	38.1	37.3	1.1%	5.5	9.6	342.2
NF07-2	3.8%	0.75%	1.219	2.680	2.663	44.4	44.0	6.26%	6.27%	223.4	47.8	47.8	1.4%	3.4	11.3	209.3

Table A-50: FEMA P695 Results (ii) / Riv6SSD

Ground motion	Story Drift	Residual Story Drift	Roof Acceleration (g)	Normalized Brace Force Tension	Normalized Brace Force Compression	Tensile Ductility	Compressive Ductility	Brace Strain in Tension	Brace Strain in Compression	Cumulative Ductility	Reference Tensile Ductility	Reference Compressive Ductility	Column Rotation	Column Stress in Tension (ksi)	Column Stress in Compression (ksi)	Column Uplift Force (kips)
NF09-1	2.1%	0.13%	0.604	1.950	1.928	27.4	27.4	3.39%	3.37%	76.5	25.9	25.7	0.7%	4.2	8.6	258.4
NF09-2	1.6%	0.42%	0.700	1.926	1.936	32.6	32.8	2.62%	2.62%	140.3	20.0	20.0	0.7%	5.1	9.9	315.4
NF10-1	3.5%	0.11%	0.959	2.733	2.742	60.4	60.3	5.77%	5.80%	230.3	44.0	44.3	1.3%	5.3	11.1	326.5
NF10-2	2.4%	0.20%	0.787	2.090	2.079	37.5	37.1	3.95%	3.98%	107.4	30.1	30.4	1.0%	5.0	9.4	311.8
NF12-1	2.6%	0.17%	0.545	2.322	2.316	47.8	47.5	4.20%	4.17%	345.6	32.1	31.8	0.7%	6.1	9.8	379.4
NF12-2	2.2%	0.22%	0.719	2.171	2.177	38.4	37.6	3.52%	3.52%	354.4	26.9	26.9	0.7%	5.1	11.1	316.6
NF15-1	1.7%	0.61%	1.074	1.829	1.816	25.7	26.1	2.67%	2.66%	124.6	20.4	20.3	0.6%	4.6	8.8	282.6
NF15-2	3.8%	0.40%	1.340	2.814	2.808	58.3	60.6	6.29%	6.26%	232.2	48.0	47.8	0.9%	6.6	12.4	410.0
NF22-1	3.0%	0.68%	1.149	2.337	2.326	34.7	34.8	4.91%	4.94%	75.1	37.4	37.7	1.1%	2.4	10.0	147.6
NF22-2	2.0%	0.16%	0.581	2.009	2.010	35.3	35.3	3.11%	3.13%	96.6	23.7	23.9	0.7%	3.6	10.3	226.0
NF23-1	2.0%	0.21%	0.901	1.919	1.918	29.2	30.1	3.23%	3.22%	155.5	24.7	24.5	0.8%	4.7	9.4	290.8
NF23-2	1.7%	0.10%	1.272	1.824	1.813	27.2	27.6	2.74%	2.69%	193.6	20.9	20.6	0.8%	4.2	9.2	258.0
NF24-1	1.4%	0.24%	1.048	1.724	1.715	21.8	22.0	2.18%	2.16%	247.3	16.6	16.5	0.5%	4.6	9.1	284.1
NF24-2	2.0%	0.34%	0.992	2.056	2.069	36.4	36.0	3.26%	3.22%	246.7	24.9	24.6	0.8%	4.9	10.5	305.1
NF26-1	4.0%	0.59%	0.677	2.859	2.851	52.3	51.9	6.64%	6.65%	261.6	50.7	50.7	1.2%	4.4	11.8	272.7
NF26-2	2.4%	0.17%	0.913	2.277	2.268	34.6	35.0	3.97%	3.91%	211.8	30.3	29.9	0.7%	6.5	9.2	404.0
NF27-1	1.7%	0.11%	0.699	1.889	1.883	34.8	35.1	2.68%	2.66%	268.1	20.4	20.3	0.6%	4.7	9.3	288.4
NF27-2	2.4%	0.06%	0.907	2.143	2.118	27.1	26.5	3.91%	3.85%	428.7	29.8	29.4	0.7%	5.2	9.3	321.9
NF28-1	1.9%	0.20%	0.477	2.086	2.080	43.7	43.2	3.12%	3.10%	136.3	23.8	23.6	0.7%	5.7	9.0	352.2
NF28-2	2.6%	0.44%	0.529	2.365	2.371	51.7	51.8	4.25%	4.25%	161.9	32.4	32.4	0.7%	4.3	11.4	266.4
μ	2.6%	0.29%	0.886	2.292	2.285	42.7	42.6	4.29%	4.29%	220.0	32.8	32.7	0.8%	5.3	10.4	330.6
$\mu+\sigma$	3.9%	0.48%	1.148	2.865	2.866	62.7	62.6	6.35%	6.35%	337.1	48.4	48.4	1.1%	7.3	12.3	454.0

Table A-51: SAC Results / LA6NCh, 90% of Calculated BRB Stiffness

Ground motion	Story Drift	Residual Story Drift	Roof Acceleration (g)	Normalized Brace Force Tension	Normalized Brace Force Compression	Tensile Ductility	Compressive Ductility	Brace Strain in Tension	Brace Strain in Compression	Cumulative Ductility	Reference Tensile Ductility	Reference Compressive Ductility	Column Rotation	Column Stress in Tension (ksi)	Column Stress in Compression (ksi)
LA21	2.8%	0.32%	0.951	1.841	1.846	21.4	20.4	2.10%	86.1	15.8	13.4	1.1%	4.4	11.1	271.7
LA22	4.4%	2.10%	0.922	1.955	1.910	20.9	20.5	3.10%	92.9	23.5	21.8	1.6%	5.4	12.1	333.4
LA23	3.7%	1.20%	0.979	2.181	2.154	32.9	31.5	2.70%	121.3	20.3	18.0	1.0%	5.5	12.2	339.2
LA24	6.4%	2.80%	0.664	2.353	2.278	38.8	36.0	4.60%	142.1	34.8	31.7	1.5%	6.1	12.8	379.6
LA25	4.7%	1.70%	0.907	1.860	1.804	23.5	22.1	3.30%	62.8	25.4	24.0	1.6%	3.8	10.6	238.6
LA26	2.9%	0.31%	0.697	1.905	1.907	19.9	18.9	2.00%	68.0	15.1	14.4	1.1%	4.9	11.6	303.4
LA27	5.8%	0.20%	1.044	2.478	2.445	41.1	38.4	4.30%	182.1	32.5	28.0	1.7%	5.4	12.0	334.4
LA28	4.2%	1.50%	1.033	1.771	1.724	21.0	21.0	2.90%	72.8	22.4	21.2	1.5%	3.9	10.7	242.9
LA29	2.2%	0.46%	0.945	1.683	1.673	14.8	14.5	1.50%	129.9	11.7	10.5	0.9%	4.5	11.2	278.7
LA30	4.6%	0.77%	0.921	2.320	2.286	31.9	29.5	3.40%	134.0	25.6	22.5	1.1%	5.4	12.1	337.4
LA31	3.1%	2.00%	0.980	1.995	1.987	19.1	18.0	2.30%	78.4	17.2	14.9	1.1%	4.0	10.8	249.2
LA32	2.3%	0.70%	0.845	1.740	1.750	17.7	16.8	1.60%	77.5	12.0	11.1	1.1%	4.1	10.8	253.3
LA33	4.5%	0.98%	0.951	2.161	2.135	34.7	34.1	3.20%	114.9	24.2	22.9	1.7%	4.8	11.5	294.6
LA34	4.2%	1.10%	0.890	2.002	1.990	31.7	31.0	2.90%	114.0	22.5	21.3	1.4%	4.9	11.6	305.1
LA35	9.5%	0.57%	0.940	2.875	2.736	54.5	54.4	6.90%	131.6	52.3	47.1	2.3%	8.2	14.8	508.1
LA36	7.8%	0.90%	0.853	2.491	2.387	48.1	49.8	5.50%	128.2	42.3	38.7	2.3%	5.7	12.3	351.6
LA37	5.1%	2.00%	0.933	2.400	2.350	39.0	36.6	3.60%	106.9	27.7	24.7	1.3%	6.7	13.4	415.9
LA38	5.2%	2.10%	0.659	2.429	2.376	42.5	40.3	3.90%	97.5	30.1	28.9	1.5%	7.0	13.6	433.5
LA39	5.9%	2.10%	0.963	2.111	2.040	30.7	28.6	4.10%	78.5	31.6	29.4	1.4%	5.3	12.0	327.9
LA40	8.1%	0.70%	0.730	2.407	2.295	48.6	49.9	5.80%	112.6	44.0	40.7	2.3%	6.4	13.0	396.4
μ	4.9%	1.22%	0.890	2.148	2.104	31.6	30.6	3.49%	106.6	26.5	24.3	1.5%	5.3	12.0	329.7
$\mu+\sigma$	6.8%	1.97%	1.003	2.455	2.382	43.0	42.2	4.87%	136.1	37.1	33.9	1.9%	6.4	13.1	398.4

Table A-52: FEMA P695 Results (i) / LA6NCh, 90% of Calculated BRB Stiffness

Ground motion	Max Drift	Max Residual Drift	Max Acceleration	Max Normalized Brace Force Tension	Max Normalized Brace Force Compression	Max Tensile Ductility	Max Compressive Ductility	Max Brace Strain	Max Cumulative Ductility	Max Reference Tensile Ductility	Max Reference Compressive Ductility	Max Column Rotation	Max Column Stress (Tension)	Max Column Stress (Compression)	Max Column Uplift
FF01-1	2.7%	1.00%	0.732	1.571	1.543	11.4	11.1	1.90%	66.4	14.1	13.4	0.8%	3.8	10.5	236.3
FF01-2	2.1%	0.82%	0.812	1.657	1.650	15.7	15.0	1.50%	79.8	11.3	10.0	0.7%	3.8	10.5	235.9
FF02-1	4.6%	1.30%	1.258	2.199	2.164	27.6	28.9	3.30%	146.8	25.5	22.7	1.5%	5.5	12.2	341.5
FF02-2	1.8%	0.66%	0.983	1.540	1.529	9.9	10.1	1.30%	74.4	9.6	8.8	0.8%	3.7	10.5	231.0
FF03-1	3.2%	0.79%	1.244	1.776	1.748	16.6	15.7	2.20%	88.4	17.0	15.8	0.9%	4.2	10.9	258.3
FF03-2	2.4%	0.57%	1.138	1.661	1.674	15.0	14.1	1.60%	87.4	12.5	11.9	0.9%	3.9	10.6	242.8
FF09-1	6.7%	0.23%	1.203	2.664	2.584	59.6	59.1	4.80%	217.7	36.7	32.7	1.8%	6.8	13.4	420.8
FF09-2	3.0%	0.47%	0.793	1.680	1.692	15.3	15.0	2.10%	49.2	16.2	15.4	0.8%	4.2	11.0	262.6
FF16-1	4.3%	1.40%	0.887	1.955	1.913	25.6	24.0	3.10%	101.4	23.4	21.5	1.5%	4.2	10.9	259.5
FF16-2	4.5%	0.80%	1.008	2.058	2.025	32.7	33.3	3.20%	170.1	24.4	21.9	1.4%	5.1	11.8	318.4
FF18-1	1.8%	0.77%	0.668	1.592	1.593	13.2	12.5	1.40%	74.6	10.7	10.2	0.8%	3.7	10.4	227.6
FF18-2	1.3%	0.61%	1.03	1.467	1.459	8.2	7.8	0.91%	40.7	7.0	6.4	0.7%	2.8	9.6	174.7
FF19-1	7.0%	0.22%	0.772	2.719	2.632	59.7	58.8	5.10%	320.6	38.6	34.4	1.8%	7.9	14.5	490.5
FF19-2	6.0%	0.78%	0.672	2.431	2.378	53.1	53.7	4.30%	219.5	32.9	29.2	1.3%	6.2	12.9	387.3
NF02-1	3.4%	1.50%	0.755	1.856	1.829	19.1	19.2	2.40%	64.5	18.1	16.6	0.8%	4.0	10.7	248.5
NF02-2	8.4%	1.10%	0.88	2.596	2.479	51.4	53.3	6.00%	138.2	45.9	42.0	1.6%	7.1	13.7	440.2
NF04-1	3.3%	1.30%	0.588	2.017	2.004	27.4	27.0	2.40%	84.5	18.0	16.6	1.0%	5.4	12.1	336.4
NF04-2	3.9%	1.60%	0.787	1.817	1.781	20.0	18.9	2.70%	75.2	20.9	19.4	1.0%	4.9	11.6	304.9
NF06-1	3.6%	1.20%	1.113	2.095	2.104	28.7	27.2	2.70%	103.3	20.6	17.0	1.6%	4.7	11.4	288.8
NF06-2	5.2%	2.00%	0.56	1.982	1.921	26.5	24.8	3.60%	65.5	27.8	26.1	1.3%	5.4	12.1	335.2
NF07-1	3.8%	1.20%	1.283	1.802	1.763	20.5	19.3	2.70%	142.1	20.5	19.2	1.5%	5.0	11.7	307.0
NF07-2	6.2%	2.80%	0.986	2.151	2.074	29.0	27.1	4.40%	75.1	33.6	31.3	1.8%	3.7	10.4	229.8

Table A-53: FEMA P695 Results (ii) / LA6NCh, 90% of Calculated BRB Stiffness

Ground motion	Max Drift	Max Residual Drift	Max Acceleration	Max Normalized Brace Force Tension	Max Normalized Brace Force Compression	Max Tensile Ductility	Max Compressive Ductility	Max Brace Strain	Max Cumulative Ductility	Max Reference Tensile Ductility	Max Reference Compressive Ductility	Max Column Rotation	Max Column Stress (Tension)	Max Column Stress (Compression)	Max Column Uplift
NF09-1	1.8%	0.31%	0.489	1.449	1.457	8.9	8.4	1.20%	28.8	9.3	9.1	0.7%	3.5	10.3	218.6
NF09-2	2.2%	0.87%	0.576	1.771	1.774	15.1	14.6	1.50%	58.7	11.7	10.9	0.7%	4.2	10.9	257.9
NF10-1	3.2%	0.28%	0.715	1.773	1.779	18.7	18.8	2.30%	70.8	17.3	15.8	1.2%	4.5	11.2	277.4
NF10-2	2.5%	0.63%	0.632	1.642	1.655	14.1	13.2	1.70%	44.6	13.3	12.8	0.9%	3.9	10.7	243.6
NF12-1	3.4%	0.85%	0.59	2.062	2.076	27.7	26.3	2.50%	214.7	19.4	15.9	1.0%	4.8	11.5	300.5
NF12-2	2.8%	0.61%	0.603	1.933	1.962	19.4	18.2	2.10%	185.4	16.1	12.7	0.8%	4.7	11.3	290.2
NF15-1	2.6%	1.80%	0.795	1.621	1.597	10.5	10.0	1.80%	59.1	13.9	13.1	1.0%	4.3	11.0	263.6
NF15-2	4.9%	0.69%	1.16	2.197	2.164	33.1	30.9	3.50%	105.8	26.9	23.7	1.2%	5.2	11.9	321.3
NF22-1	4.3%	2.10%	1.323	1.814	1.766	21.0	19.8	3.00%	39.3	22.8	21.5	1.6%	2.3	9.1	144.8
NF22-2	2.6%	0.79%	0.531	1.758	1.744	19.2	18.1	1.80%	46.8	14.1	12.7	0.9%	4.0	10.7	250.0
NF23-1	2.6%	0.08%	0.977	1.759	1.769	12.5	11.7	1.80%	58.0	13.7	13.2	0.9%	3.5	10.3	217.7
NF23-2	2.1%	0.11%	1.182	1.698	1.703	13.1	12.9	1.50%	90.0	11.2	10.6	1.1%	4.0	10.7	245.2
NF24-1	3.2%	1.50%	0.95	1.770	1.762	13.4	19.2	2.30%	197.9	17.7	15.6	0.9%	4.5	11.2	280.2
NF24-2	2.7%	0.85%	0.876	1.775	1.795	15.9	14.9	1.90%	80.6	14.6	13.7	1.0%	4.5	11.2	279.7
NF26-1	6.1%	2.20%	0.657	2.267	2.197	32.3	30.5	4.40%	174.3	33.3	30.5	1.7%	3.5	10.3	219.0
NF26-2	3.2%	0.87%	0.647	2.036	2.031	16.2	15.3	2.30%	107.4	17.6	15.0	0.8%	5.3	12.0	330.7
NF27-1	2.2%	0.36%	0.653	1.679	1.700	15.7	15.0	1.60%	105.4	12.1	10.8	0.8%	3.9	10.6	242.3
NF27-2	3.7%	0.89%	0.858	1.859	1.829	14.9	14.3	2.60%	158.9	19.8	18.1	1.2%	4.4	11.1	270.0
NF28-1	2.9%	0.44%	0.519	1.881	1.883	21.4	20.6	2.00%	73.8	15.4	14.6	1.0%	5.2	11.9	322.4
NF28-2	3.4%	1.30%	0.448	2.102	2.090	29.0	27.0	2.40%	89.1	18.7	16.1	0.9%	3.5	10.3	219.5
μ	3.6%	0.97%	0.841	1.908	1.887	22.8	22.3	2.57%	106.5	19.6	17.8	1.1%	4.5	11.2	280.3
$\mu+\sigma$	5.2%	1.56%	1.084	2.210	2.168	35.5	35.1	3.70%	168.2	28.3	25.6	1.5%	5.6	12.3	346.9

Table A-54: SAC Results / LA6NCh, 110% of Calculated BRB Stiffness

Ground motion	Max Drift	Max Residual Drift	Max Acceleration	Max Normalized Brace Force Tension	Max Normalized Brace Force Compression	Max Tensile Ductility	Max Compressive Ductility	Max Brace Strain	Max Cumulative Ductility	Max Reference Tensile Ductility	Max Reference Compressive Ductility	Max Column Rotation	Max Column Stress (Tension)	Max Column Stress (Compression)	Max Column Uplift
LA21	2.6%	0.19%	0.978	1.827	1.834	21.5	20.5	1.90%	91.6	14.7	12.4	1.1%	4.3	11.0	266.3
LA22	4.3%	2.10%	0.957	1.945	1.901	21.8	21.4	3.00%	101.6	23.2	21.5	1.5%	5.3	12.1	330.8
LA23	3.7%	1.40%	1.071	2.186	2.158	33.8	32.5	2.70%	125.8	20.5	18.1	1.1%	5.4	12.1	333.2
LA24	6.2%	2.90%	0.650	2.290	2.217	37.4	34.8	4.40%	141.0	33.8	30.9	1.5%	6.0	12.6	370.2
LA25	4.7%	1.40%	0.914	1.856	1.801	23.7	22.3	3.30%	65.5	25.2	23.9	1.7%	3.6	10.4	225.3
LA26	2.8%	0.16%	0.720	1.885	1.892	20.2	19.5	1.90%	70.4	14.7	14.1	1.1%	4.9	11.6	303.1
LA27	5.6%	0.17%	1.073	2.445	2.413	40.8	38.4	4.10%	179.0	31.2	26.9	1.6%	5.3	11.9	329.5
LA28	4.1%	1.20%	1.039	1.756	1.726	21.8	21.7	2.90%	70.7	21.9	20.8	1.4%	3.8	10.5	234.1
LA29	2.3%	0.53%	0.897	1.690	1.674	14.5	14.1	1.70%	131.7	12.6	11.5	0.9%	4.4	11.2	275.6
LA30	4.9%	0.91%	0.837	2.289	2.250	33.1	30.5	3.50%	141.4	26.9	23.8	1.3%	5.5	12.2	338.3
LA31	3.2%	1.90%	1.028	1.976	1.967	19.2	18.1	2.30%	84.5	17.4	15.2	1.0%	3.7	10.4	228.6
LA32	2.2%	0.70%	0.927	1.730	1.739	18.1	17.2	1.50%	72.7	11.5	10.7	1.1%	3.9	10.6	240.6
LA33	4.5%	0.87%	1.132	2.175	2.148	34.6	33.9	3.10%	117.4	24.0	22.7	1.8%	4.7	11.5	293.0
LA34	4.2%	1.30%	0.875	1.976	1.967	31.4	30.7	2.90%	118.0	22.3	21.1	1.4%	4.9	11.6	305.1
LA35	9.6%	0.71%	0.973	2.885	2.742	55.2	52.5	6.90%	133.7	53.0	47.7	2.2%	8.3	14.8	511.6
LA36	7.8%	0.91%	0.814	2.479	2.374	47.4	49.1	5.50%	127.8	42.2	38.7	2.3%	5.7	12.3	352.5
LA37	4.7%	1.90%	1.001	2.348	2.304	38.1	35.9	3.40%	104.9	26.0	23.1	1.2%	6.6	13.3	409.4
LA38	5.1%	2.00%	0.643	2.410	2.360	42.4	40.2	3.70%	97.3	28.1	26.7	1.4%	6.8	13.4	419.7
LA39	5.5%	2.00%	0.947	2.067	2.001	29.9	27.9	3.90%	76.0	29.9	27.8	1.5%	5.1	11.8	318.2
LA40	8.0%	0.64%	0.734	2.397	2.286	48.9	50.4	5.70%	123.3	43.7	40.4	2.3%	6.4	13.1	398.3
μ	4.8%	1.19%	0.911	2.131	2.088	31.7	30.6	3.42%	108.7	26.1	23.9	1.5%	5.2	11.9	324.2
$\mu+\sigma$	6.7%	1.93%	1.047	2.435	2.362	42.9	41.8	4.78%	138.2	36.6	33.5	1.9%	6.4	13.0	395.5

Table A-55: FEMA P695 Results (i) / LA6NCh, 110% of Calculated BRB Stiffness

Ground motion	Max Drift	Max Residual Drift	Max Acceleration	Max Normalized Brace Force Tension	Max Normalized Brace Force Compression	Max Tensile Ductility	Max Compressive Ductility	Max Brace Strain	Max Cumulative Ductility	Max Reference Tensile Ductility	Max Reference Compressive Ductility	Max Column Rotation	Max Column Stress (Tension)	Max Column Stress (Compression)	Max Column Uplift
FF01-1	2.7%	1.10%	0.666	1.570	1.542	11.7	11.5	1.90%	60.2	14.3	13.6	0.7%	3.8	10.5	232.9
FF01-2	2.1%	0.81%	0.889	1.670	1.662	16.7	16.0	1.50%	76.9	11.5	10.2	0.7%	3.6	10.4	225.1
FF02-1	4.6%	1.10%	1.128	2.176	2.141	28.3	29.5	3.30%	158.2	24.9	22.2	1.4%	5.6	12.2	345.8
FF02-2	1.7%	0.58%	1.156	1.491	1.489	10.3	10.1	1.20%	74.6	9.2	8.1	0.9%	3.6	10.4	226.2
FF03-1	2.9%	0.48%	1.196	1.766	1.743	16.9	16.0	2.10%	83.8	15.8	14.6	1.0%	4.1	10.8	251.8
FF03-2	2.5%	0.46%	1.170	1.685	1.698	16.2	15.3	1.70%	81.8	13.1	12.5	1.0%	3.8	10.5	236.4
FF09-1	6.5%	0.66%	1.264	2.633	2.557	58.9	58.4	4.70%	215.6	35.7	31.8	1.8%	6.6	13.3	411.1
FF09-2	3.0%	0.40%	0.761	1.719	1.728	16.7	16.7	2.10%	52.2	16.0	14.9	0.8%	4.2	10.9	259.2
FF16-1	4.3%	1.20%	1.019	1.915	1.873	24.8	23.4	3.00%	101.2	23.2	21.4	1.4%	4.1	10.8	253.7
FF16-2	4.1%	0.89%	0.997	2.047	2.023	31.7	32.4	3.00%	177.1	22.7	20.1	1.3%	5.0	11.7	311.5
FF18-1	1.9%	0.75%	0.654	1.639	1.639	14.1	13.3	1.30%	78.7	9.7	9.3	0.7%	3.6	10.4	224.8
FF18-2	1.3%	0.53%	1.174	1.445	1.436	8.7	8.3	0.88%	45.4	6.7	6.2	0.6%	2.7	9.5	167.1
FF19-1	6.7%	0.15%	0.931	2.665	2.585	58.8	59.0	4.80%	316.1	36.8	32.7	1.9%	7.8	14.4	481.8
FF19-2	5.7%	0.84%	0.675	2.404	2.354	51.5	52.0	4.10%	210.1	31.1	27.6	1.2%	6.2	12.8	384.3
NF02-1	3.1%	1.30%	0.768	1.809	1.784	19.1	19.5	2.20%	66.7	16.7	15.2	0.8%	4.2	10.9	258.8
NF02-2	8.3%	1.20%	0.879	2.587	2.473	51.0	53.0	5.90%	140.0	45.1	41.2	1.6%	7.2	13.8	443.3
NF04-1	3.3%	1.10%	0.642	1.987	1.977	27.0	26.7	2.30%	89.2	17.9	16.5	1.1%	5.3	12.0	329.3
NF04-2	3.9%	1.50%	0.850	1.834	1.797	21.3	20.1	2.80%	80.1	21.3	19.7	1.0%	4.9	11.6	303.2
NF06-1	3.4%	1.00%	1.240	2.075	2.087	28.7	27.3	2.50%	104.1	19.2	15.7	1.6%	4.7	11.4	291.9
NF06-2	5.0%	1.80%	0.611	1.974	1.915	26.8	25.1	3.50%	64.6	27.0	25.3	1.3%	5.3	12.0	325.8
NF07-1	3.7%	1.40%	1.270	1.778	1.740	20.2	19.1	2.60%	143.0	19.7	18.5	1.5%	4.8	11.5	298.2
NF07-2	6.2%	2.60%	0.982	2.143	2.066	29.3	27.4	4.40%	78.5	33.3	31.0	1.7%	3.5	10.2	216.0

Table A-56: FEMA P695 Results (ii) / LA6NCh, 110% of Calculated BRB Stiffness

Ground motion	Max Drift	Max Residual Drift	Max Acceleration	Max Normalized Brace Force Tension	Max Normalized Brace Force Compression	Max Tensile Ductility	Max Compressive Ductility	Max Brace Strain	Max Cumulative Ductility	Max Reference Tensile Ductility	Max Reference Compressive Ductility	Max Column Rotation	Max Column Stress (Tension)	Max Column Stress (Compression)	Max Column Uplift
NF09-1	1.8%	0.16%	0.508	1.451	1.458	9.5	9.0	1.20%	30.1	9.1	8.8	0.7%	3.1	9.8	191.0
NF09-2	2.3%	0.76%	0.569	1.751	1.756	16.5	15.3	1.60%	61.6	12.0	11.3	0.7%	4.0	10.8	250.8
NF10-1	2.9%	0.16%	0.718	1.787	1.798	18.9	18.7	2.10%	69.9	15.8	14.4	1.1%	4.5	11.2	275.9
NF10-2	2.5%	0.38%	0.670	1.630	1.645	14.4	13.6	1.70%	45.3	13.0	12.5	0.9%	3.9	10.6	241.4
NF12-1	3.0%	0.40%	0.613	2.009	2.030	26.6	25.3	2.30%	211.4	17.3	13.8	1.0%	4.6	11.3	285.2
NF12-2	2.9%	0.88%	0.620	1.933	1.941	21.2	20.3	2.20%	202.7	16.7	14.1	0.8%	4.9	11.5	301.8
NF15-1	2.7%	1.80%	0.778	1.598	1.571	10.9	10.9	1.90%	61.7	14.3	13.6	1.0%	4.3	11.0	265.3
NF15-2	5.0%	0.11%	1.210	2.206	2.173	34.1	32.0	3.60%	110.6	27.4	24.2	1.3%	5.1	11.8	317.3
NF22-1	4.3%	2.30%	1.338	1.811	1.764	21.4	20.2	3.00%	39.7	22.9	21.6	1.6%	2.3	9.0	140.2
NF22-2	2.4%	0.56%	0.630	1.707	1.692	18.0	17.1	1.70%	44.9	13.1	11.9	0.9%	3.8	10.5	233.2
NF23-1	2.8%	0.24%	0.971	1.748	1.763	13.8	13.1	2.00%	55.6	15.1	14.3	0.9%	3.2	10.0	200.9
NF23-2	2.0%	0.28%	1.129	1.672	1.676	13.2	13.0	1.40%	95.6	10.4	9.8	1.0%	3.7	10.4	226.4
NF24-1	3.5%	1.70%	0.938	1.781	1.760	13.7	14.6	2.50%	203.3	18.9	17.1	0.8%	4.6	11.3	286.4
NF24-2	2.7%	0.84%	0.945	1.789	1.807	17.3	16.2	1.90%	91.6	14.3	13.3	1.0%	4.4	11.1	273.4
NF26-1	6.1%	2.30%	0.662	2.195	2.125	30.9	29.3	4.30%	185.2	32.8	30.3	1.7%	3.5	10.2	218.3
NF26-2	3.3%	0.84%	0.657	2.047	2.039	16.2	15.3	2.40%	95.6	18.2	15.6	0.9%	5.3	12.0	327.2
NF27-1	2.1%	0.25%	0.678	1.665	1.682	16.0	15.3	1.50%	119.8	11.5	10.3	0.8%	3.8	10.5	234.1
NF27-2	3.6%	0.70%	0.917	1.878	1.848	14.6	14.1	2.60%	176.1	19.5	17.9	1.2%	4.2	11.0	263.1
NF28-1	2.7%	0.73%	0.493	1.908	1.913	23.2	21.8	1.90%	74.0	14.5	13.8	0.9%	5.2	11.9	321.4
NF28-2	3.3%	1.20%	0.497	2.070	2.060	28.7	26.8	2.40%	85.9	18.2	15.7	0.9%	3.4	10.2	212.7
μ	3.5%	0.91%	0.868	1.896	1.877	23.0	22.4	2.52%	108.5	19.2	17.4	1.1%	4.4	11.1	274.9
$\mu+\sigma$	5.1%	1.52%	1.113	2.190	2.150	35.3	34.9	3.62%	170.8	27.6	25.0	1.4%	5.5	12.2	343.1

Table A-57: SAC Perform 3D Results / LA6NSD, 90% of Calculated BRB Stiffness

Ground motion	Max Drift	Max Residual Drift	Max Acceleration	Max Normalized Brace Force Tension	Max Normalized Brace Force Compression	Max Tensile Ductility	Max Compressive Ductility	Max Brace Strain	Max Cumulative Ductility	Max Reference Tensile Ductility	Max Reference Compressive Ductility	Max Column Rotation	Max Column Stress (Tension)	Max Column Stress (Compression)	Max Column Uplift
LA21	2.2%	0.14%	1.106	1.593	1.608	13.4	13.1	1.20%	78.5	9.1	8.8	1.2%	2.4	10.6	146.6
LA22	4.8%	2.30%	1.234	1.817	1.815	18.1	18.1	2.50%	67.2	18.8	18.8	1.5%	2.7	11.0	164.9
LA23	3.8%	0.70%	1.162	1.955	2.000	24.5	24.7	2.10%	88.0	16.0	15.8	1.0%	3.0	11.2	185.3
LA24	6.6%	3.80%	0.760	2.178	2.178	32.2	31.9	3.70%	102.7	28.1	27.9	1.5%	3.4	11.7	213.2
LA25	4.9%	2.30%	0.879	1.743	1.723	19.0	18.8	2.70%	44.9	20.8	20.6	1.7%	1.9	10.2	117.1
LA26	2.9%	1.70%	0.902	1.674	1.710	14.8	14.9	1.60%	50.7	12.3	12.2	1.3%	2.5	10.7	152.7
LA27	7.0%	1.60%	1.123	2.244	2.240	33.8	33.4	3.90%	126.5	30.1	29.9	2.2%	2.7	11.0	166.5
LA28	4.0%	1.40%	1.074	1.638	1.638	15.2	15.2	2.30%	56.4	17.3	17.1	1.6%	2.4	10.6	147.0
LA29	2.1%	0.29%	1.082	1.614	1.627	10.7	10.5	1.20%	107.8	8.8	8.8	1.1%	1.9	10.1	114.7
LA30	5.9%	1.30%	1.028	2.106	2.115	26.5	26.4	3.30%	94.6	25.2	25.2	2.0%	3.7	11.9	228.2
LA31	3.5%	2.00%	1.087	1.733	1.749	14.3	14.2	1.70%	81.5	13.0	13.0	1.1%	2.6	10.8	161.2
LA32	2.7%	0.16%	1.126	1.549	1.587	11.1	11.3	1.50%	78.4	11.4	11.2	1.1%	1.9	10.2	117.4
LA33	4.7%	0.24%	1.091	1.895	1.941	24.7	24.4	2.60%	84.9	20.1	20.0	1.4%	3.3	11.4	204.4
LA34	4.4%	1.40%	0.910	1.831	1.876	23.3	23.4	2.50%	86.2	18.7	18.6	1.2%	2.8	11.1	174.3
LA35	9.9%	1.80%	1.094	2.562	2.554	44.3	44.0	5.50%	119.9	41.8	41.6	2.4%	4.7	12.9	289.3
LA36	7.8%	2.30%	0.962	2.231	2.221	33.8	33.8	4.40%	97.8	33.4	33.3	2.3%	3.2	11.5	199.2
LA37	5.4%	3.30%	0.904	2.225	2.251	32.5	32.2	3.00%	75.3	22.8	22.7	1.7%	3.9	12.0	243.7
LA38	6.6%	3.20%	0.794	2.148	2.189	31.2	31.1	3.20%	70.5	24.2	24.4	1.8%	3.6	12.0	223.4
LA39	5.9%	2.80%	1.069	1.922	1.906	23.7	23.6	3.30%	74.6	25.3	25.2	1.5%	2.6	10.9	164.0
LA40	8.2%	0.07%	0.807	2.179	2.157	36.4	36.5	4.60%	78.5	35.1	35.0	2.8%	3.3	11.6	205.4
μ	5.2%	1.64%	1.010	1.942	1.954	24.2	24.1	2.84%	83.2	21.6	21.5	1.6%	2.9	11.2	180.9
$\mu+\sigma$	7.2%	2.75%	1.141	2.214	2.221	33.5	33.3	3.98%	103.8	30.4	30.2	2.1%	3.6	11.8	225.1

Table A-58: FEMA P695 Perform 3D Results (i) / LA6NSD, 90% of Calculated BRB Stiffness

Ground motion	Max Drift	Max Residual Drift	Max Acceleration	Max Normalized Brace Force Tension	Max Normalized Brace Force Compression	Max Tensile Ductility	Max Compressive Ductility	Max Brace Strain	Max Cumulative Ductility	Max Reference Tensile Ductility	Max Reference Compressive Ductility	Max Column Rotation	Max Column Stress (Tension)	Max Column Stress (Compression)	Max Column Uplift
FF01-1	2.1%	0.72%	0.628	1.462	1.458	9.0	9.0	1.10%	82.0	8.8	8.8	0.9%	1.7	10.0	105.2
FF01-2	1.8%	0.59%	0.876	1.483	1.494	9.8	10.0	0.96%	90.2	7.1	7.3	1.0%	1.7	9.9	103.5
FF02-1	4.4%	2.20%	1.643	1.940	1.948	18.5	18.7	2.50%	95.2	18.9	18.8	1.3%	2.4	10.6	150.8
FF02-2	1.8%	0.36%	1.331	1.476	1.472	7.6	7.5	0.86%	53.3	6.5	6.5	1.0%	1.4	9.7	85.1
FF03-1	3.0%	1.20%	1.296	1.654	1.654	13.2	12.9	1.60%	69.9	12.5	12.4	1.2%	2.1	10.4	130.2
FF03-2	2.1%	0.51%	1.148	1.548	1.556	11.9	11.6	1.00%	61.6	7.6	7.7	0.9%	1.7	10.0	108.0
FF09-1	6.7%	1.20%	1.200	2.448	2.479	48.9	49.0	3.70%	169.4	28.5	28.3	2.3%	5.3	13.4	328.7
FF09-2	2.9%	1.20%	0.825	1.523	1.517	11.1	11.1	1.60%	37.8	12.4	12.4	0.8%	1.9	10.1	118.6
FF16-1	3.9%	1.20%	1.117	1.744	1.742	18.1	18.0	2.20%	61.0	16.8	16.7	1.2%	2.1	10.3	127.6
FF16-2	4.2%	0.14%	0.966	1.848	1.893	22.8	23.0	2.30%	105.7	17.8	17.7	1.1%	2.9	11.2	181.2
FF18-1	2.6%	0.82%	1.096	1.511	1.515	9.8	9.9	1.20%	55.3	9.5	9.4	1.1%	1.9	10.1	119.5
FF18-2	1.3%	0.30%	1.478	1.389	1.395	5.9	5.8	0.69%	44.6	5.1	5.3	1.1%	1.4	9.7	86.4
FF19-1	6.2%	0.27%	0.864	2.307	2.338	43.3	43.2	3.50%	264.5	26.7	26.6	2.3%	4.2	12.5	263.5
FF19-2	6.5%	0.90%	0.828	2.184	2.183	41.0	41.2	3.70%	169.2	27.9	27.7	1.3%	4.1	12.3	252.4
NF02-1	3.5%	1.90%	0.768	1.737	1.744	16.7	16.7	2.00%	46.4	15.0	15.0	0.8%	2.2	10.4	135.2
NF02-2	8.7%	2.70%	0.957	2.328	2.310	36.7	36.3	4.90%	101.2	37.1	36.8	1.6%	4.1	12.3	253.3
NF04-1	3.6%	0.19%	0.728	1.809	1.849	19.4	19.2	2.00%	59.9	15.3	15.3	1.0%	2.8	11.0	175.0
NF04-2	3.5%	1.70%	0.799	1.650	1.645	13.0	13.0	1.90%	70.9	14.6	14.7	0.9%	2.4	10.6	145.8
NF06-1	3.5%	1.70%	1.209	1.848	1.858	21.0	20.8	2.00%	74.3	14.9	14.8	1.2%	2.6	10.8	160.6
NF06-2	4.9%	2.80%	0.592	1.797	1.787	19.8	19.7	2.70%	45.9	20.8	20.8	1.4%	2.8	11.0	171.5
NF07-1	4.0%	1.70%	1.401	1.709	1.690	17.0	16.5	2.20%	133.9	17.0	16.7	1.5%	2.0	10.2	123.8
NF07-2	6.2%	3.90%	1.159	1.954	1.937	22.2	22.2	3.50%	60.6	26.6	26.5	2.2%	3.2	11.4	197.6

Table A-59: FEMA P695 Perform 3D Results (ii) / LA6NSD, 90% of Calculated BRB Stiffness

Ground motion	Max Drift	Max Residual Drift	Max Acceleration	Max Normalized Brace Force Tension	Max Normalized Brace Force Compression	Max Tensile Ductility	Max Compressive Ductility	Max Brace Strain	Max Cumulative Ductility	Max Reference Tensile Ductility	Max Reference Compressive Ductility	Max Column Rotation	Max Column Stress (Tension)	Max Column Stress (Compression)	Max Column Uplift
NF09-1	1.8%	0.41%	0.566	1.351	1.362	6.2	6.2	0.99%	17.8	7.6	7.5	0.7%	1.3	9.5	80.4
NF09-2	1.9%	0.58%	0.589	1.528	1.545	10.6	10.7	1.10%	40.5	8.0	7.9	0.9%	2.1	10.4	128.3
NF10-1	3.0%	0.32%	0.792	1.621	1.627	14.0	14.2	1.70%	48.8	12.8	12.9	1.0%	2.0	10.3	125.4
NF10-2	2.3%	0.73%	0.828	1.477	1.494	9.6	9.4	1.30%	28.7	9.9	9.9	0.8%	1.9	10.2	118.8
NF12-1	4.2%	1.70%	0.645	1.960	1.977	24.6	24.4	2.30%	131.7	17.7	17.6	1.3%	3.1	11.4	195.0
NF12-2	2.6%	0.26%	0.690	1.657	1.674	12.2	12.0	1.30%	115.0	9.6	9.5	0.8%	2.6	10.8	160.9
NF15-1	3.0%	2.00%	0.834	1.585	1.576	10.8	10.6	1.70%	49.4	12.7	12.6	1.0%	2.3	10.5	141.7
NF15-2	5.3%	1.20%	1.312	1.961	1.969	24.6	24.6	3.00%	75.4	22.6	22.6	1.1%	2.9	11.0	181.3
NF22-1	3.6%	1.90%	1.518	1.609	1.605	13.8	13.9	2.00%	25.0	15.0	15.2	1.2%	1.8	10.1	113.4
NF22-2	2.2%	0.83%	0.645	1.618	1.635	14.3	14.4	1.20%	30.3	9.3	9.3	1.1%	2.2	10.3	137.5
NF23-1	2.3%	0.52%	0.992	1.621	1.650	10.6	10.9	1.20%	45.5	9.5	9.4	0.9%	1.9	10.1	117.2
NF23-2	2.5%	0.52%	1.614	1.522	1.524	9.8	10.0	1.40%	66.2	10.5	10.2	1.2%	1.8	10.2	114.2
NF24-1	3.1%	1.80%	1.094	1.662	1.663	10.4	10.4	1.70%	131.1	13.1	13.1	0.9%	2.3	10.6	141.8
NF24-2	2.8%	0.15%	0.974	1.627	1.659	13.5	13.4	1.60%	77.9	11.9	11.8	1.1%	2.4	10.7	148.6
NF26-1	6.0%	3.30%	0.788	2.035	2.036	25.3	25.2	3.30%	104.9	25.5	25.5	1.5%	3.2	11.5	200.5
NF26-2	3.4%	1.40%	0.769	1.793	1.797	10.8	10.9	1.90%	73.3	14.5	14.4	1.0%	2.8	11.0	174.5
NF27-1	2.0%	0.24%	0.709	1.505	1.523	10.6	10.8	1.00%	107.5	7.7	7.6	0.8%	1.8	10.1	113.5
NF27-2	3.8%	1.20%	0.991	1.673	1.670	11.0	11.0	2.10%	181.9	16.0	15.9	1.2%	2.1	10.3	127.8
NF28-1	3.4%	0.64%	0.506	1.770	1.805	17.7	17.5	1.90%	60.3	14.5	14.5	1.2%	2.3	10.6	141.9
NF28-2	3.6%	0.28%	0.680	1.819	1.860	19.8	19.8	2.00%	68.3	15.5	15.4	1.3%	2.7	10.9	164.3
μ	3.6%	1.15%	0.963	1.732	1.741	17.1	17.0	1.97%	81.7	15.0	15.0	1.2%	2.4	10.7	151.2
$\mu+\sigma$	5.2%	2.04%	1.262	1.983	1.994	26.8	26.8	2.89%	130.1	22.0	21.9	1.5%	3.3	11.5	201.8

Table A-60: SAC Perform 3D Results / LA6NSD, 110% of Calculated BRB Stiffness

Ground motion	Max Drift	Max Residual Drift	Max Acceleration	Max Normalized Brace Force Tension	Max Normalized Brace Force Compression	Max Tensile Ductility	Max Compressive Ductility	Max Brace Strain	Max Cumulative Ductility	Max Reference Tensile Ductility	Max Reference Compressive Ductility	Max Column Rotation	Max Column Stress (Tension)	Max Column Stress (Compression)	Max Column Uplift
LA21	2.1%	0.14%	1.083	1.582	1.609	13.6	13.8	1.20%	67.3	9.0	8.9	1.2%	2.3	10.5	141.1
LA22	4.4%	2.40%	1.470	1.808	1.805	17.9	17.9	2.40%	69.4	18.6	18.6	1.6%	2.7	10.9	164.6
LA23	3.7%	0.80%	1.206	1.950	1.994	24.7	24.8	2.00%	89.1	15.6	15.5	1.0%	2.9	11.1	179.5
LA24	6.4%	3.70%	0.856	2.140	2.140	31.6	31.3	3.60%	102.6	27.3	27.2	1.5%	3.3	11.5	205.3
LA25	4.7%	1.90%	0.909	1.718	1.698	18.5	18.4	2.60%	46.6	20.0	19.8	1.6%	1.9	10.2	120.0
LA26	2.7%	1.20%	0.802	1.697	1.725	15.4	15.6	1.50%	49.0	11.5	11.5	1.0%	2.4	10.6	145.8
LA27	6.7%	1.50%	1.167	2.195	2.189	32.9	32.5	3.80%	133.3	28.8	28.6	2.0%	2.6	10.9	159.7
LA28	4.2%	1.40%	1.211	1.652	1.631	16.1	16.1	2.30%	52.7	17.8	17.6	1.6%	2.3	10.6	142.5
LA29	2.4%	0.46%	1.174	1.613	1.617	10.8	10.6	1.30%	100.0	9.9	9.7	1.0%	1.8	10.0	109.9
LA30	5.4%	1.10%	1.135	2.083	2.100	26.2	26.1	3.00%	101.6	22.9	22.9	1.7%	3.5	11.7	220.0
LA31	3.4%	2.20%	1.065	1.746	1.767	14.4	14.6	1.80%	71.8	13.6	13.6	1.1%	2.5	10.7	155.1
LA32	2.6%	0.30%	1.081	1.540	1.576	11.8	12.0	1.40%	74.5	11.0	10.8	1.0%	1.8	10.1	110.9
LA33	4.7%	0.29%	1.214	1.903	1.947	24.8	24.6	2.60%	88.2	20.0	19.9	1.3%	3.3	11.4	201.7
LA34	4.4%	1.60%	1.037	1.812	1.855	23.2	23.2	2.40%	88.3	18.5	18.5	1.2%	2.6	10.9	163.9
LA35	9.6%	1.90%	1.165	2.541	2.533	44.4	44.0	5.40%	113.0	41.1	40.8	2.3%	4.6	12.8	285.8
LA36	7.8%	2.20%	0.950	2.232	2.222	34.7	34.7	4.40%	99.3	33.4	33.2	2.5%	3.0	11.2	185.0
LA37	5.2%	3.30%	0.921	2.179	2.205	31.8	31.6	2.90%	74.3	21.9	21.8	1.6%	3.8	11.9	233.9
LA38	6.4%	3.10%	0.796	2.157	2.201	31.6	31.6	3.10%	67.8	23.4	23.6	1.7%	3.6	11.9	220.8
LA39	5.9%	2.70%	1.214	1.911	1.895	23.9	23.8	3.30%	80.0	25.0	24.9	1.5%	2.6	10.8	159.0
LA40	8.1%	0.62%	0.828	2.170	2.148	36.5	36.6	4.60%	81.3	34.8	34.6	2.7%	3.3	11.5	203.4
μ	5.0%	1.64%	1.064	1.931	1.943	24.2	24.2	2.78%	82.5	21.2	21.1	1.6%	2.8	11.1	175.4
$\mu+\sigma$	7.0%	2.67%	1.236	2.195	2.202	33.4	33.2	3.91%	103.9	29.7	29.6	2.0%	3.5	11.7	219.0

Table A-61: FEMA P695 Perform 3D Results (i) / LA6NSD, 110% of Calculated BRB Stiffness

Ground motion	Max Drift	Max Residual Drift	Max Acceleration	Max Normalized Brace Force Tension	Max Normalized Brace Force Compression	Max Tensile Ductility	Max Compressive Ductility	Max Brace Strain	Max Cumulative Ductility	Max Reference Tensile Ductility	Max Reference Compressive Ductility	Max Column Rotation	Max Column Stress (Tension)	Max Column Stress (Compression)	Max Column Uplift
FF01-1	2.2%	0.75%	0.689	1.460	1.451	9.4	9.3	1.20%	79.6	9.4	9.4	0.9%	1.6	9.8	96.5
FF01-2	2.0%	0.63%	1.010	1.511	1.523	11.2	11.4	1.10%	94.0	8.5	8.7	0.9%	1.4	9.6	89.7
FF02-1	4.5%	2.20%	1.671	1.960	1.968	19.3	19.7	2.50%	103.5	19.1	18.9	1.4%	2.7	10.8	166.0
FF02-2	1.6%	0.48%	1.221	1.467	1.463	8.1	7.9	0.86%	54.8	6.4	6.5	1.0%	1.4	9.5	89.7
FF03-1	3.2%	1.10%	1.390	1.666	1.664	13.8	13.6	1.80%	69.3	13.6	13.5	1.0%	2.0	10.2	121.6
FF03-2	2.1%	0.55%	1.340	1.574	1.580	13.4	13.1	1.20%	62.2	8.8	9.0	0.8%	1.7	9.9	105.4
FF09-1	6.3%	1.30%	1.382	2.401	2.434	47.4	47.5	3.50%	169.8	27.0	26.8	2.1%	5.2	13.4	323.5
FF09-2	2.9%	1.10%	0.853	1.516	1.541	11.3	11.3	1.60%	37.7	12.4	12.4	0.8%	1.8	10.1	113.7
FF16-1	4.0%	1.40%	1.183	1.755	1.750	19.0	18.9	2.30%	64.9	17.3	17.2	1.3%	2.0	10.3	125.4
FF16-2	4.1%	0.24%	1.044	1.850	1.896	23.2	23.4	2.30%	105.2	17.5	17.3	1.1%	2.8	11.0	174.2
FF18-1	2.3%	0.60%	0.987	1.492	1.512	10.1	10.1	1.10%	53.9	8.6	8.5	1.0%	2.0	10.3	123.6
FF18-2	1.3%	0.25%	1.520	1.374	1.376	6.2	6.1	0.61%	51.4	4.6	4.6	1.0%	1.3	9.6	83.4
FF19-1	6.0%	0.37%	0.898	2.250	2.276	42.5	42.4	3.40%	250.7	25.8	25.6	2.2%	4.1	12.4	254.7
FF19-2	6.3%	0.83%	0.840	2.159	2.161	39.7	39.9	3.50%	160.4	27.0	26.8	1.2%	3.9	12.1	242.7
NF02-1	3.4%	1.90%	0.844	1.704	1.709	16.4	16.4	1.90%	47.8	14.5	14.5	0.8%	2.0	10.2	126.6
NF02-2	8.5%	2.70%	0.991	2.312	2.294	36.8	36.5	4.80%	99.9	36.4	36.1	1.5%	4.0	12.2	246.6
NF04-1	3.3%	1.20%	0.723	1.804	1.838	19.5	19.3	1.80%	58.2	14.0	14.0	1.0%	2.7	10.9	169.1
NF04-2	3.6%	1.70%	0.961	1.632	1.627	14.0	14.0	2.00%	72.5	15.1	15.2	1.0%	2.3	10.6	145.4
NF06-1	3.2%	1.40%	1.271	1.832	1.841	21.0	20.7	1.80%	73.6	13.5	13.4	1.3%	2.2	10.4	138.1
NF06-2	4.9%	2.70%	0.551	1.786	1.775	19.9	19.9	2.70%	47.0	20.8	20.8	1.4%	2.7	11.0	168.8
NF07-1	3.8%	1.40%	1.361	1.698	1.679	17.2	16.7	2.10%	131.4	16.4	16.0	1.4%	1.9	10.2	116.4
NF07-2	6.3%	3.90%	1.128	1.960	1.942	22.9	22.9	3.50%	72.6	26.8	26.6	2.2%	3.2	11.4	195.3

Table A-62: FEMA P695 Perform 3D Results (ii) / LA6NSD, 110% of Calculated BRB Stiffness

Ground motion	Max Drift	Max Residual Drift	Max Acceleration	Max Normalized Brace Force Tension	Max Normalized Brace Force Compression	Max Tensile Ductility	Max Compressive Ductility	Max Brace Strain	Max Cumulative Ductility	Max Reference Tensile Ductility	Max Reference Compressive Ductility	Max Column Rotation	Max Column Stress (Tension)	Max Column Stress (Compression)	Max Column Uplift
NF09-1	1.7%	0.06%	0.523	1.348	1.361	6.2	6.2	0.95%	18.5	7.2	7.2	0.6%	1.2	9.4	72.4
NF09-2	1.8%	0.54%	0.650	1.509	1.524	10.4	10.3	1.00%	40.8	7.7	7.6	0.9%	2.0	10.2	125.3
NF10-1	3.1%	0.35%	0.788	1.610	1.613	14.2	14.3	1.70%	54.4	13.0	13.1	1.1%	2.0	10.3	124.3
NF10-2	2.4%	0.70%	0.880	1.475	1.497	9.9	9.8	1.40%	30.5	10.3	10.3	0.9%	1.9	10.1	116.8
NF12-1	3.7%	1.40%	0.761	1.907	1.924	23.5	23.3	2.10%	130.1	15.9	15.8	1.1%	2.9	11.2	181.1
NF12-2	2.5%	0.19%	0.799	1.664	1.679	11.9	11.7	1.30%	121.0	9.9	9.8	0.8%	2.5	10.8	157.4
NF15-1	2.9%	1.90%	0.882	1.588	1.586	10.7	10.4	1.60%	46.0	12.3	12.2	0.9%	2.1	10.4	132.5
NF15-2	5.2%	1.00%	1.099	1.967	1.973	25.8	25.6	2.90%	82.3	22.3	22.2	1.1%	2.9	11.0	178.2
NF22-1	3.8%	2.20%	1.654	1.623	1.617	14.7	14.9	2.10%	25.8	16.0	16.1	1.3%	1.7	10.0	108.3
NF22-2	2.2%	0.75%	0.686	1.605	1.620	14.4	14.5	1.20%	34.0	9.4	9.5	1.0%	2.1	10.4	131.5
NF23-1	2.4%	0.24%	1.017	1.601	1.624	10.3	10.7	1.30%	46.5	10.1	10.0	0.9%	1.8	10.0	109.0
NF23-2	2.4%	0.43%	1.520	1.510	1.520	10.4	10.6	1.30%	66.7	10.1	9.7	1.0%	1.7	10.0	107.3
NF24-1	2.9%	1.60%	1.161	1.634	1.636	11.1	11.2	1.60%	144.4	12.3	12.3	0.9%	2.1	10.3	130.4
NF24-2	2.6%	0.36%	1.027	1.609	1.637	13.9	13.9	1.50%	73.3	11.2	11.1	1.0%	2.3	10.5	141.9
NF26-1	5.9%	3.30%	0.734	2.023	2.024	25.3	25.3	3.30%	108.9	25.3	25.3	1.5%	3.2	11.5	197.2
NF26-2	3.3%	1.20%	0.897	1.824	1.834	11.6	11.4	1.80%	77.2	13.9	13.7	1.0%	2.8	11.1	172.1
NF27-1	1.8%	0.25%	0.732	1.503	1.518	11.1	11.2	0.97%	90.6	7.4	7.4	0.7%	1.8	10.0	109.7
NF27-2	3.9%	0.99%	1.072	1.718	1.708	12.6	12.4	2.20%	172.7	16.7	16.5	1.1%	2.0	10.2	121.4
NF28-1	3.1%	0.17%	0.575	1.758	1.785	18.2	18.0	1.70%	57.5	13.2	13.3	1.3%	2.3	10.6	141.4
NF28-2	3.1%	1.20%	0.642	1.830	1.867	20.6	20.6	1.70%	66.2	13.2	13.1	1.2%	2.7	10.9	166.9
μ	3.5%	1.13%	0.999	1.726	1.734	17.4	17.3	1.93%	82.1	14.8	14.7	1.1%	2.4	10.6	146.2
$\mu+\sigma$	5.0%	2.01%	1.297	1.970	1.979	26.8	26.7	2.82%	128.3	21.5	21.4	1.5%	3.2	11.4	196.4

Appendix B

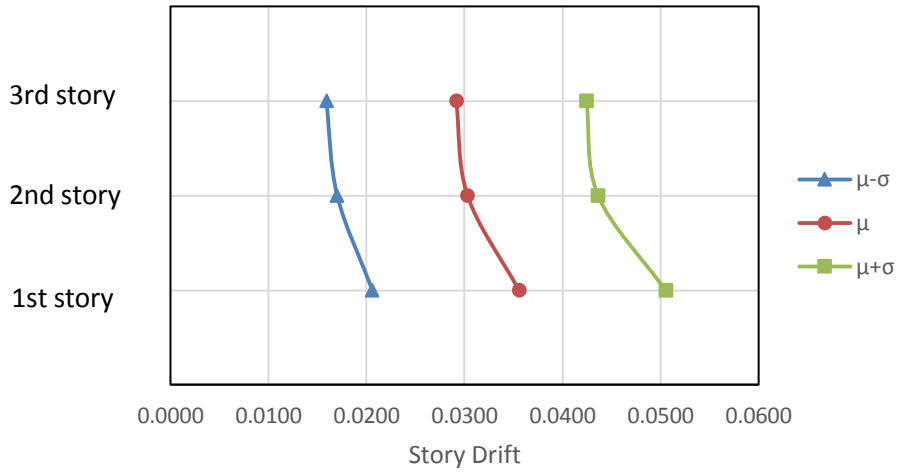

Figure B-1: Plot of the Story Drift for LA3NCh

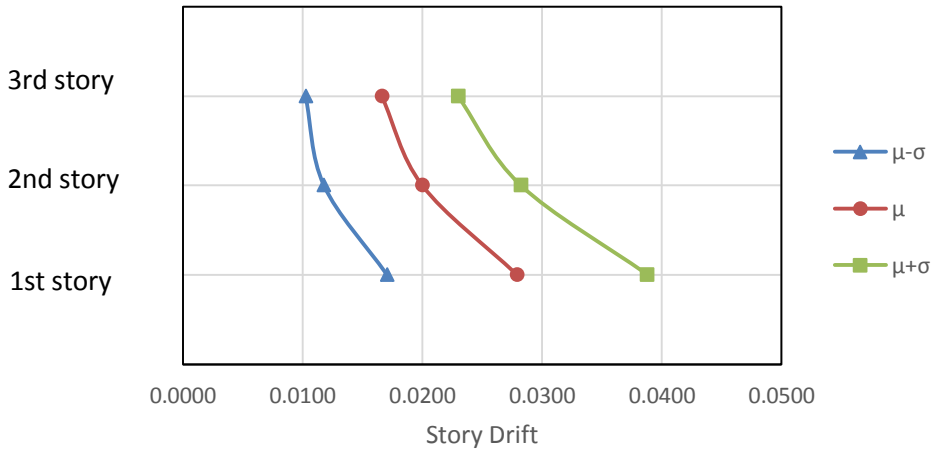

Figure B-2: Plot of the Story Drift for LA3NCh1.5

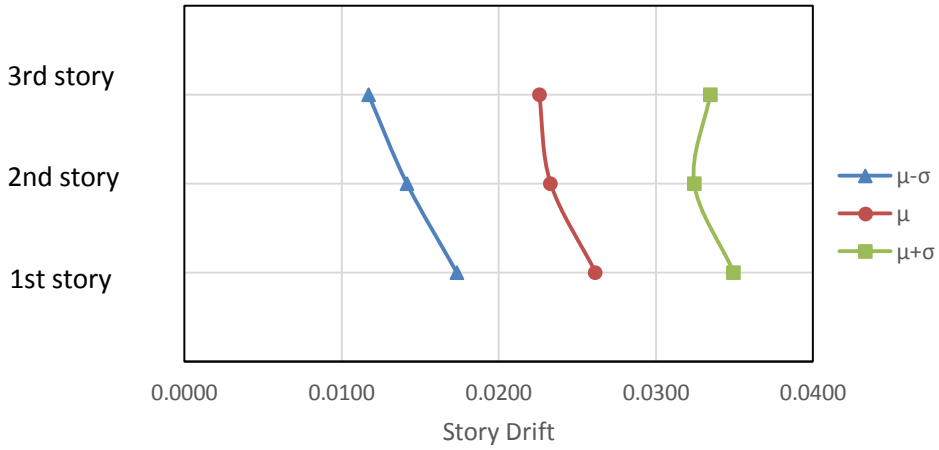

Figure B-3: Plot of the Story Drift for LA3SCh

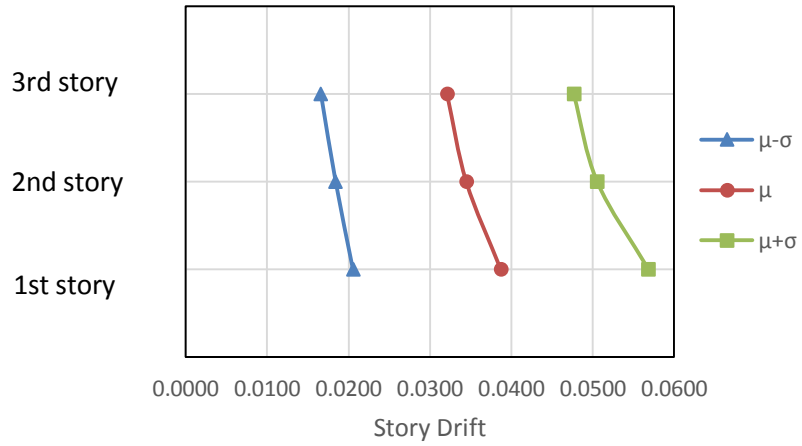

Figure B-4: Plot of the Story Drift for LA3NSD

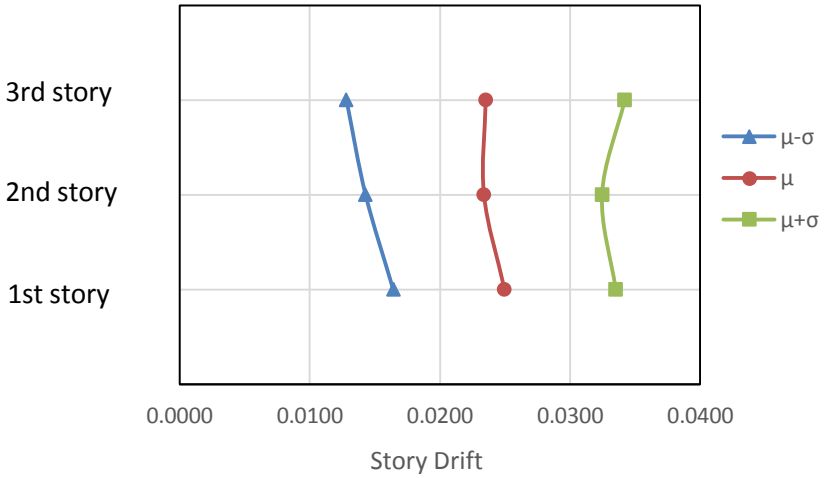

Figure B-5: Plot of the Story Drift for LA3SSD

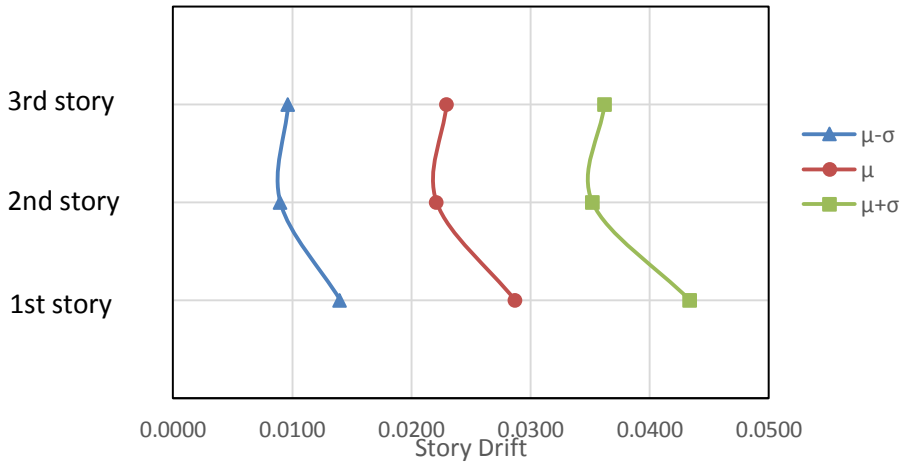

Figure B-6: Plot of the Story Drift for Riv3NCh

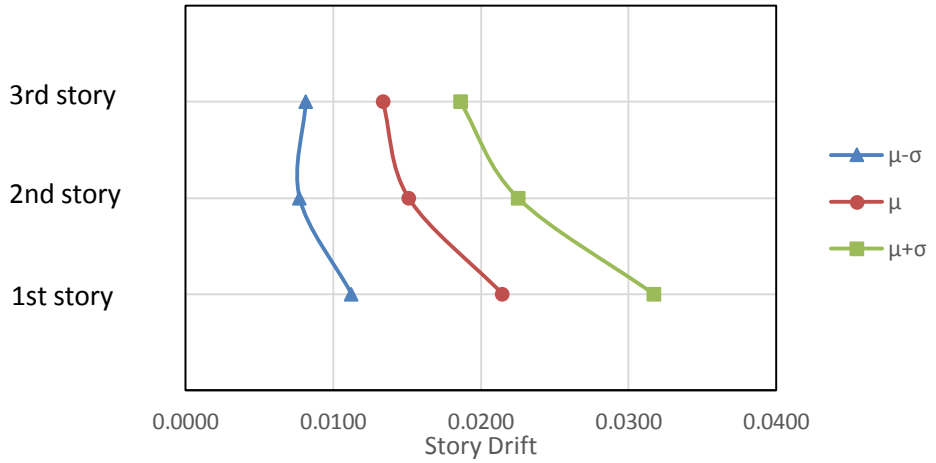

Figure B-7: Plot of the Story Drift for Riv3NCh1.5

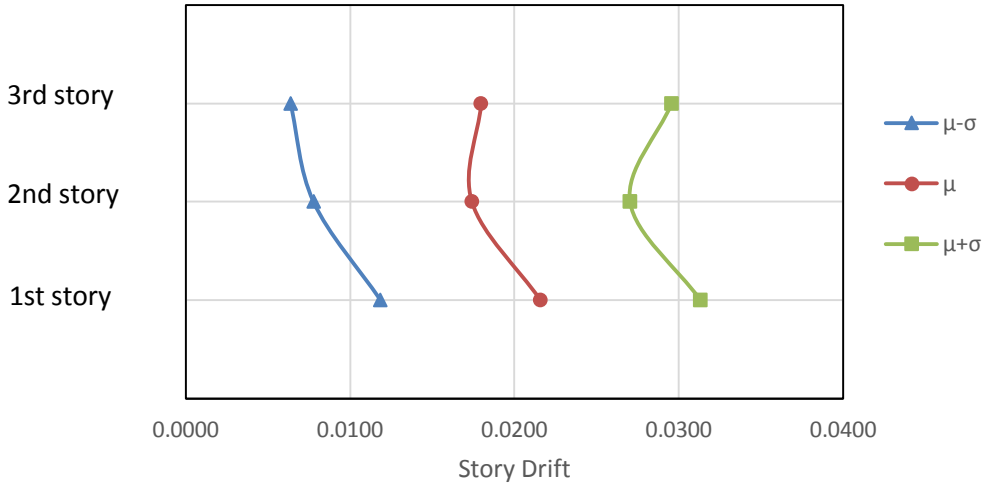

Figure B-8: Plot of the Story Drift for Riv3SCh

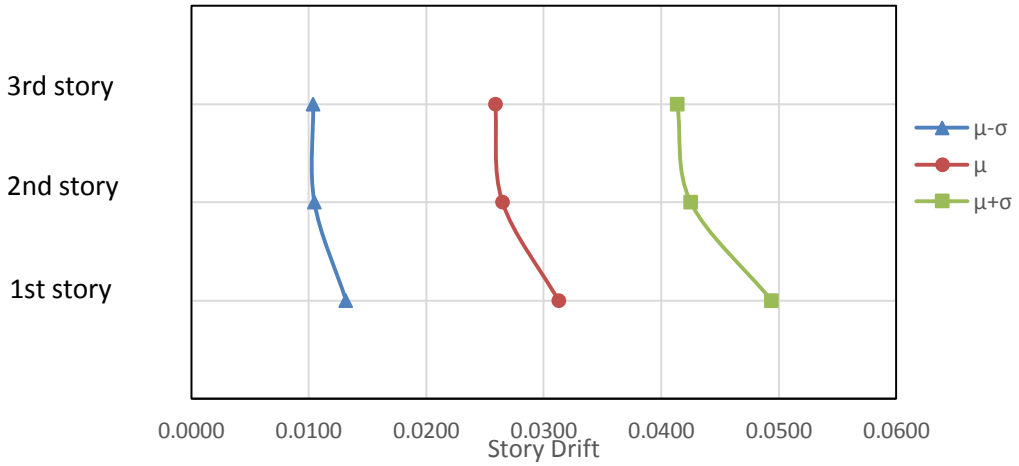

Figure B-9: Plot of the Story Drift for Riv3NSD

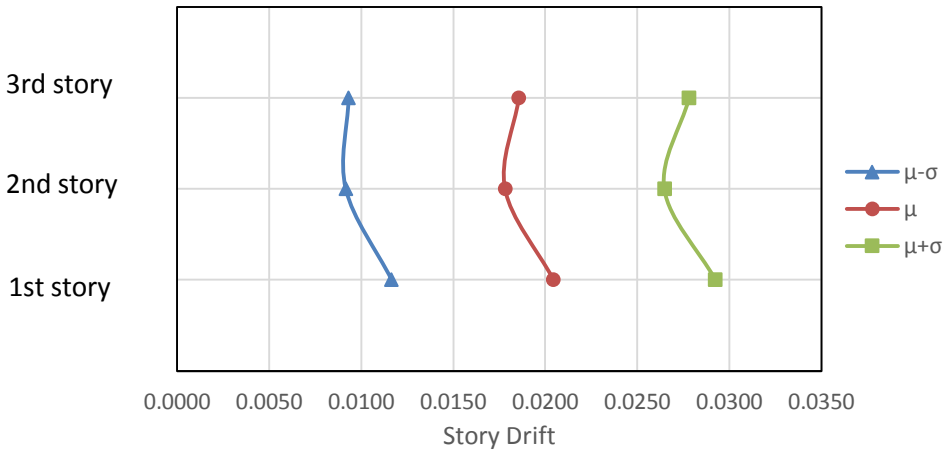

Figure B-10: Plot of the Story Drift for Riv3SSD

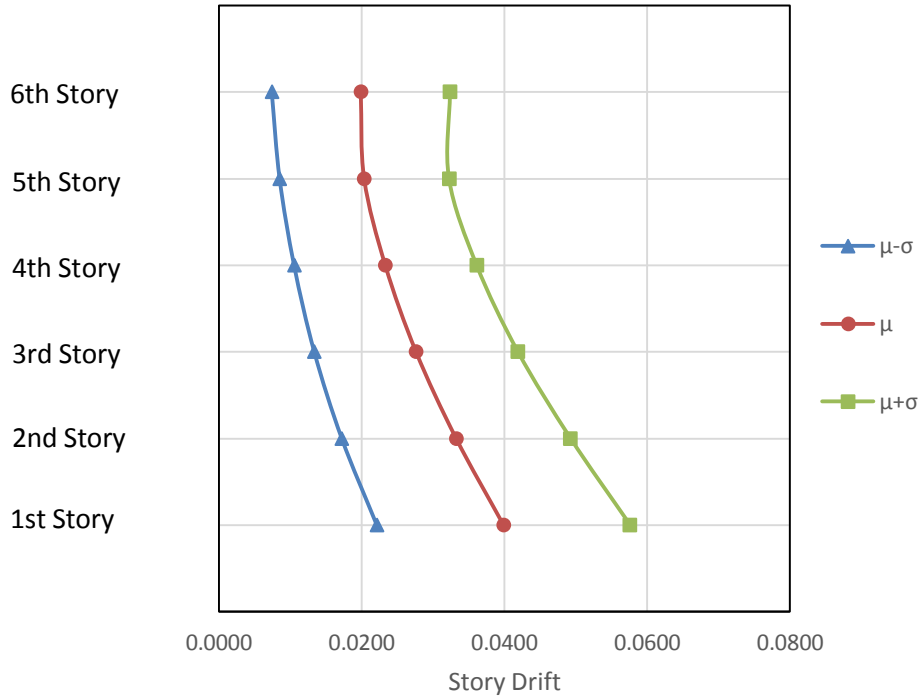

Figure B-11: Plot of the Story Drift for LA6NCh

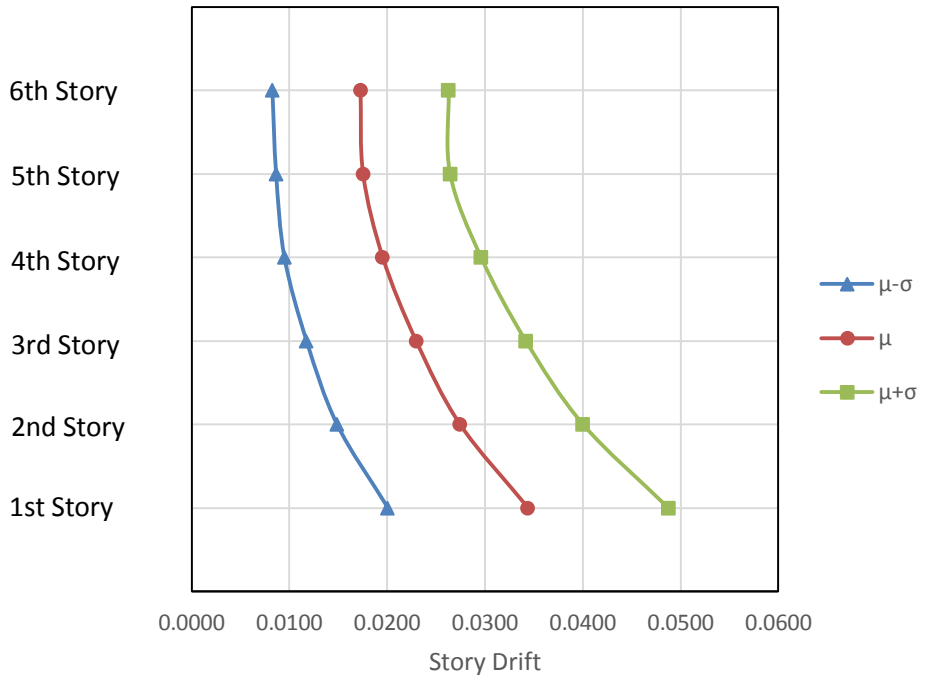

Figure B-12: Plot of the Story Drift for LA6NCh1.5

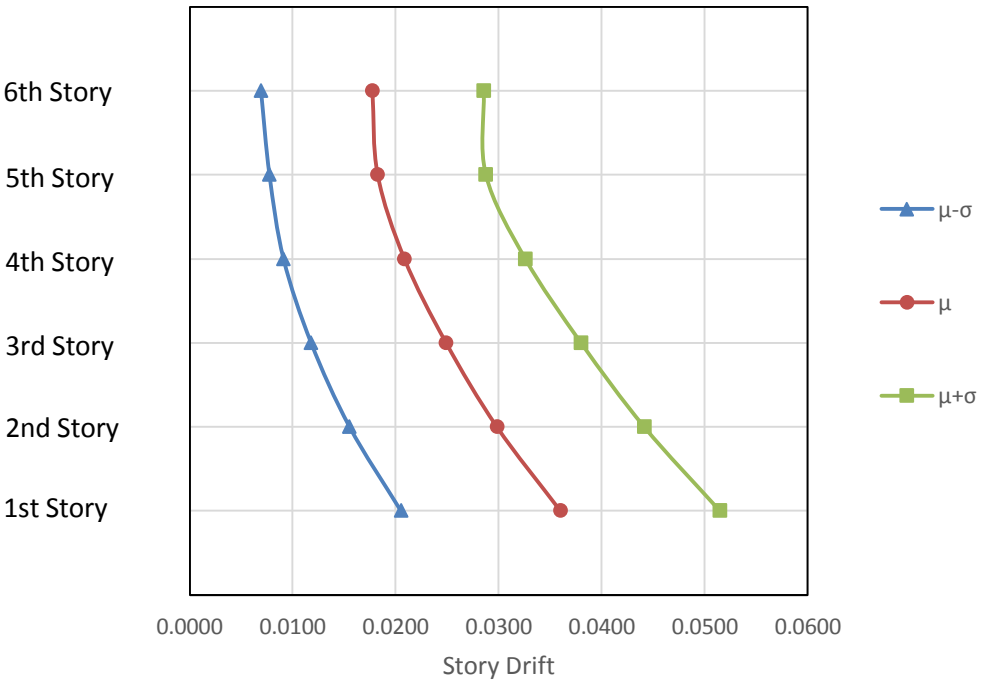

Figure B-13: Plot of the Story Drift for LA6SCh

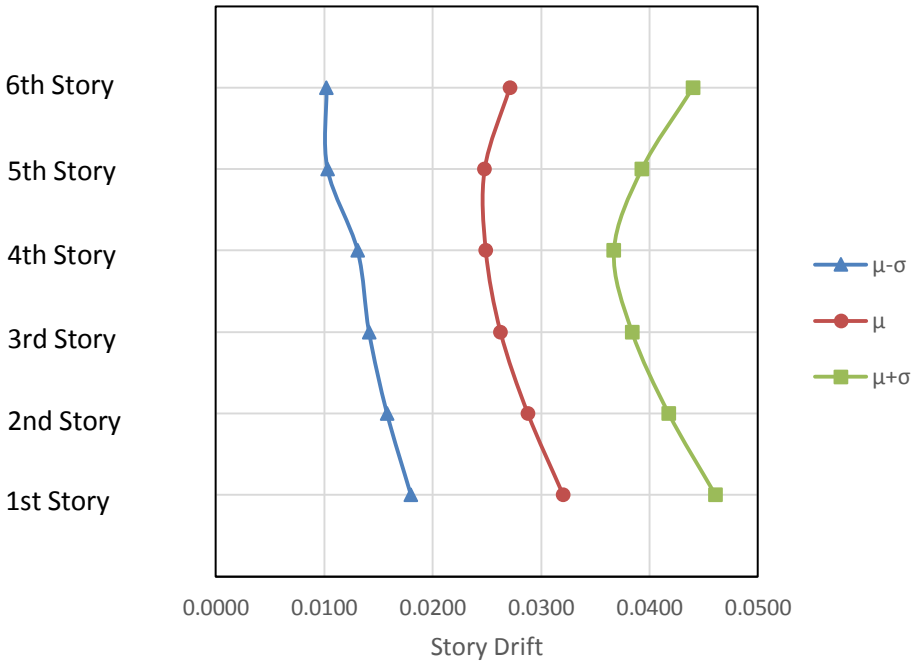

Figure B-14: Plot of the Story Drift for LA6NSD

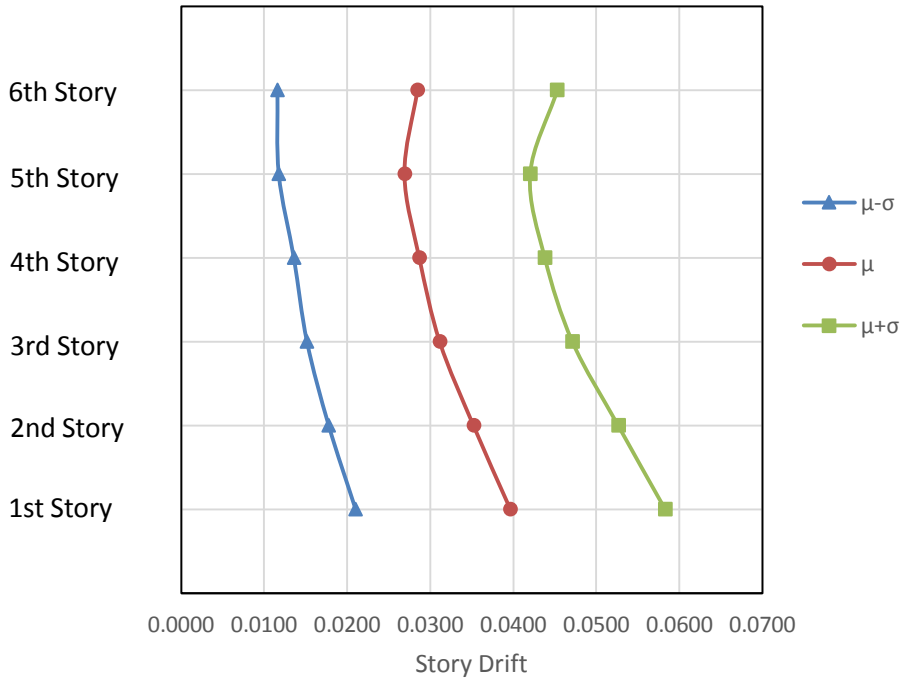

Figure B-15: Plot of the Story Drift for LA6SSD

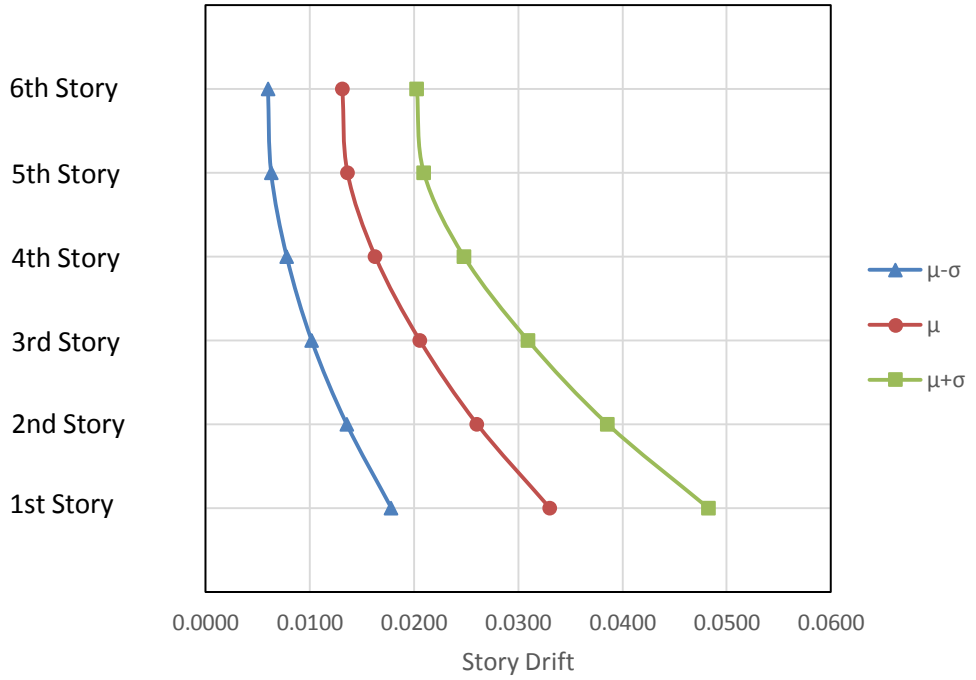

Figure B-16: Plot of the Story Drift for Riv6NCh

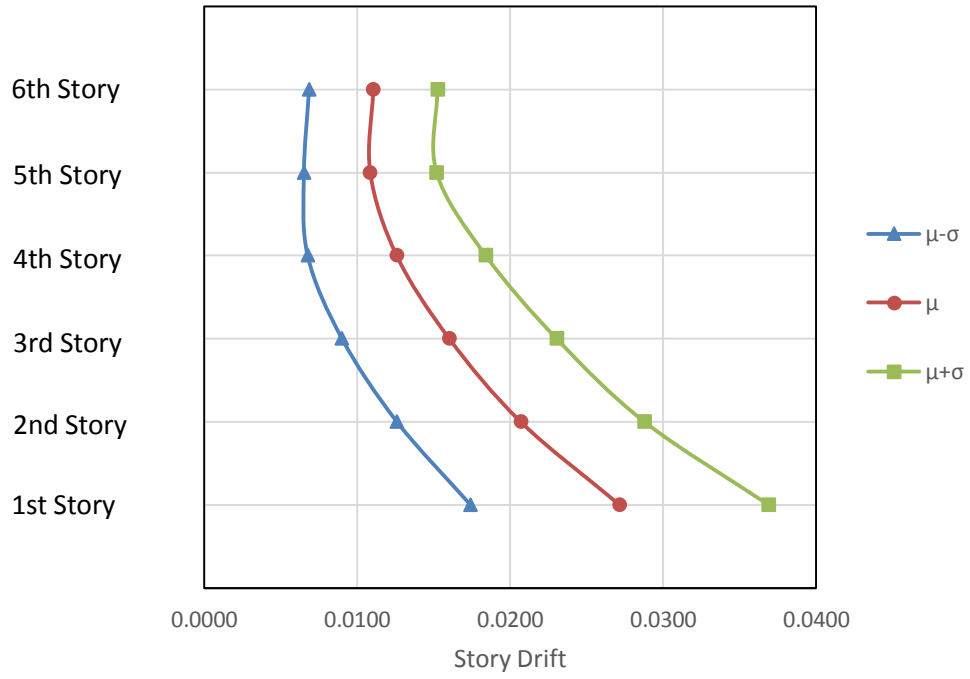

Figure B-17: Plot of the Story Drift for Riv6NCh1.5

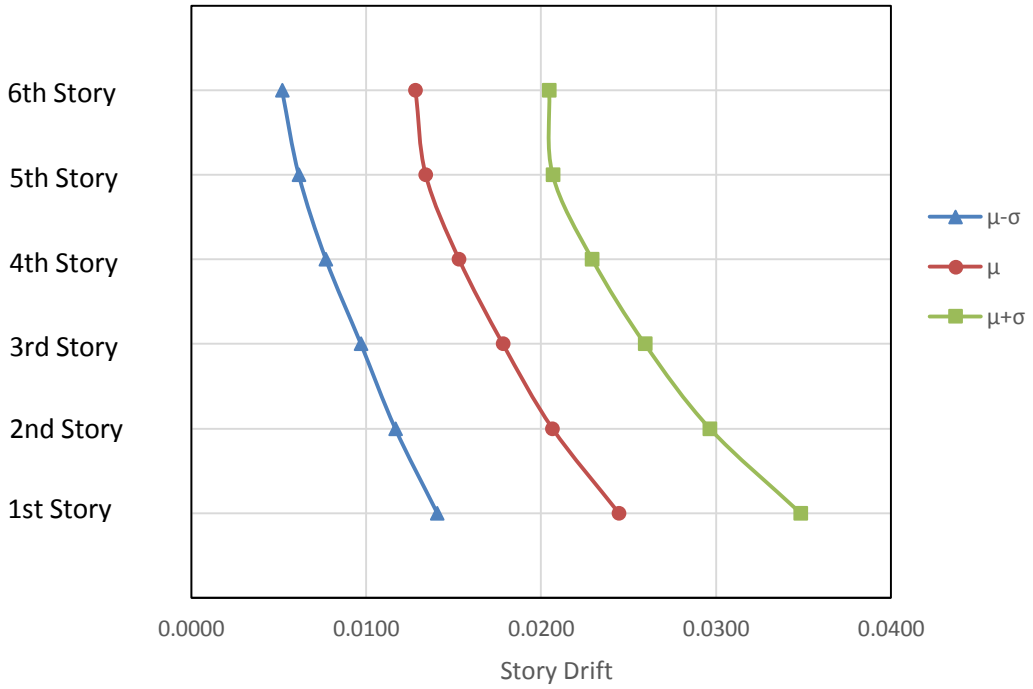

Figure B-18: Plot of the Story Drift for Riv6SCh

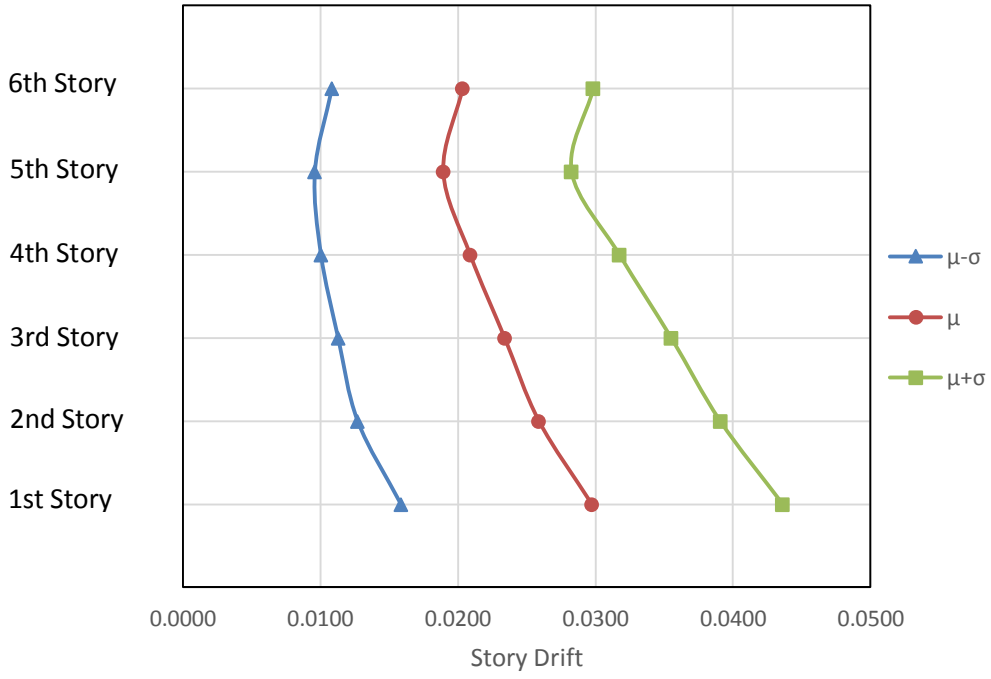

Figure B-19: Plot of the Story Drift for Riv6NSD

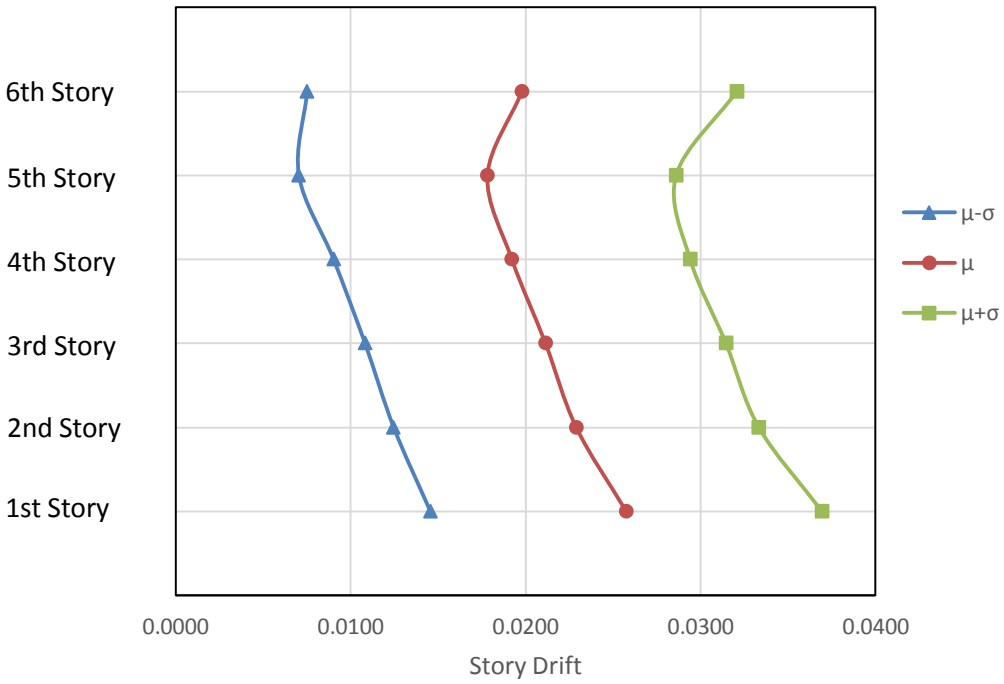

Figure B-20: Plot of the Story Drift for Riv6SSD