Concrete Coalition Phase II: Concrete Building Performance Record

Instructions: This form is for use in collecting data for phase two of the Concrete Coalition project: Developing a Global Database of Concrete Buildings Damaged in Earthquakes. For more information about how to use this form, see the sample form or view the demo at: http://concretecoalition.org.

Record ID: 22 **Building Name:** Holiday Inn **Prepared By:** Quinn Peck

Section 1: Basic Building Information

North elevation of the Van Nuys Holiday Inn prior to damage from the Northridge Earthquake (Clark, 1994).

Country:	United States	
State/Province:	California	
City:	Van Nuys	
Latitude:	34.2201	
Longitude:	-118.471	
Street Address:	8244 Orion Avenue	
Occupancy:	Hotel	
Height:	65	ft
Number of Stories:	7	
Number of Stories below ground:	0	
Size:	93000	gsf
Year Built:	1966	
Original Code:	1964 Los Angeles City Code	
Modification:	Retrofit	
Year Modified:	1971	
Code of Modification:		

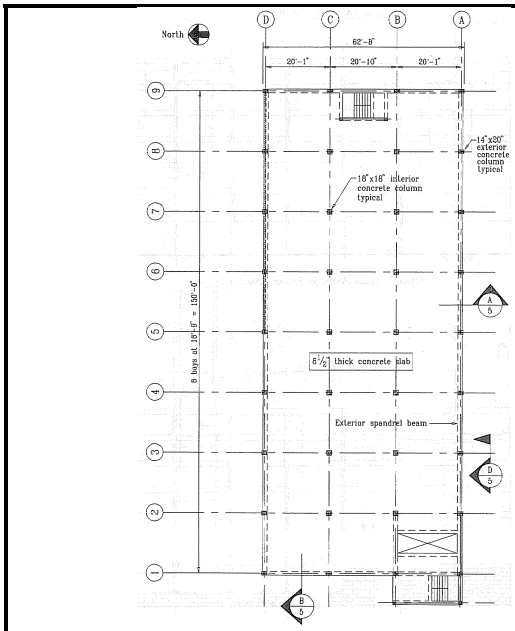
Record ID: 22 **Building Name:** Holiday Inn **Prepared By:** Quinn Peck

Section 1: Basic Building Information-(Continued)

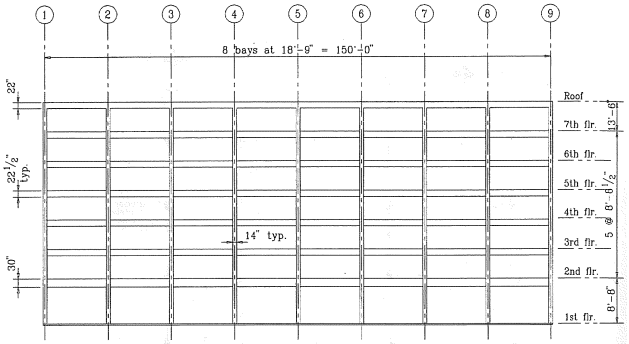
Lateral Load System:	Moment Frame
Other Lateral Load System:	
Vertical Load System:	Slab, beams, and columns
Other Vertical Load System:	
Foundation:	Piles or Piers
Building Description:	The Van Nuys Holiday Inn is a 7-story concrete frame building built in 1966 with consistent plan dimensions of approximately 63 feet by 151 feet. The building is mostly symmetrical in plan and has three bays in the transverse direction and eight bays in the longitudinal direction. The building has reinforced concrete flat slabs varying between 8 inches and 10 inches in thickness, generally increasing in thickness down the height of the building. Columns are typically spaced at 20 feet on center in the transverse direction and 18.75 feet on center in the longitudinal direction. The columns are18 inches square and 14 inches by 20 inches in the interior and perimeter respectively. Spandrel beams have a typical depth of 22.5 inches with the exception of the second floor spandrel beams, which had depths of 30 inches. Both slab-column interior frames and spandrel beam-column perimeter frames work to resist lateral loads in each orthogonal direction. The four easternmost bays of the north face of the structure had brick infill with 1/2" - 1" separation joints. These infilled walls were not designed as part of the lateral force resisting system, but post-earthquake inspection suggests that they played a significant role in the overall response of the structure.

Supplemental Basic Information:

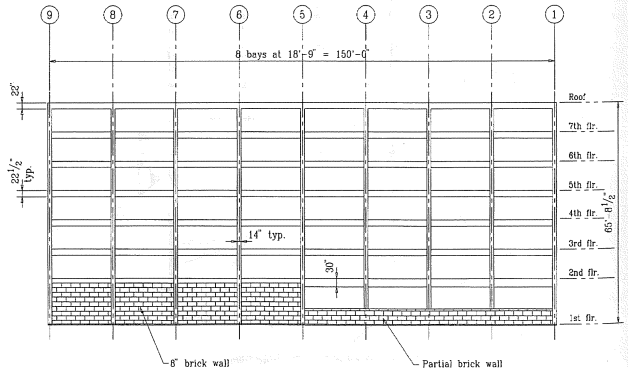
Paste in building plans, engineering drawings or sketches



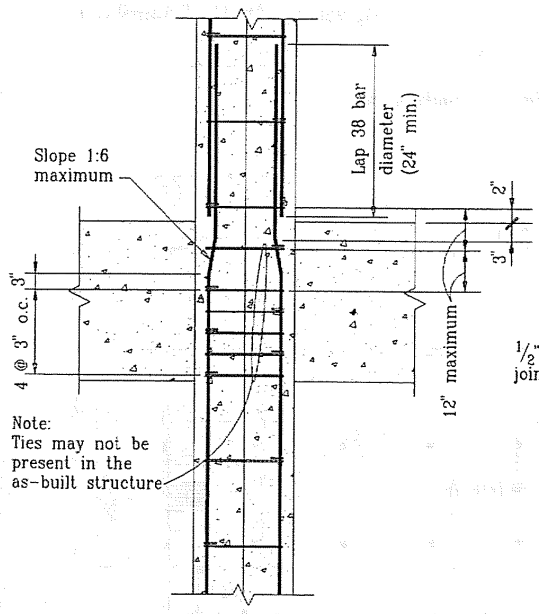
Typical floor framing plan. (SSC, 1994)



South perimeter frame elevation. (SSC, 1994)



North perimeter frame elevation. (SSC, 1994)



Typical beam-column section at elevation D. (SSC, 1994)

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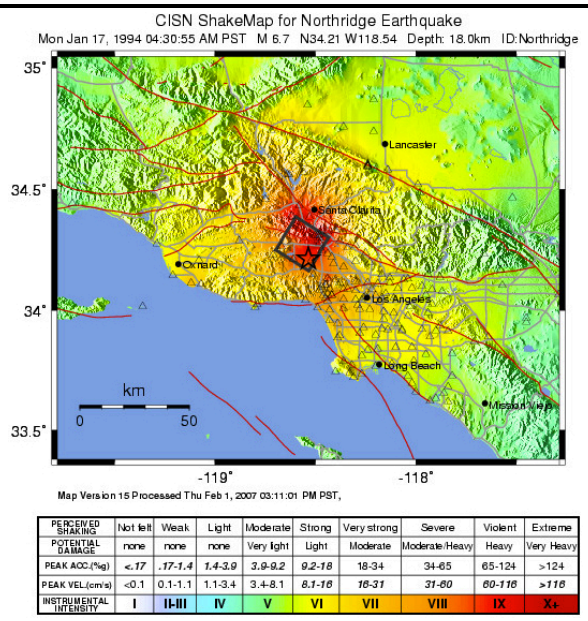
Section 2: Earthquake Information

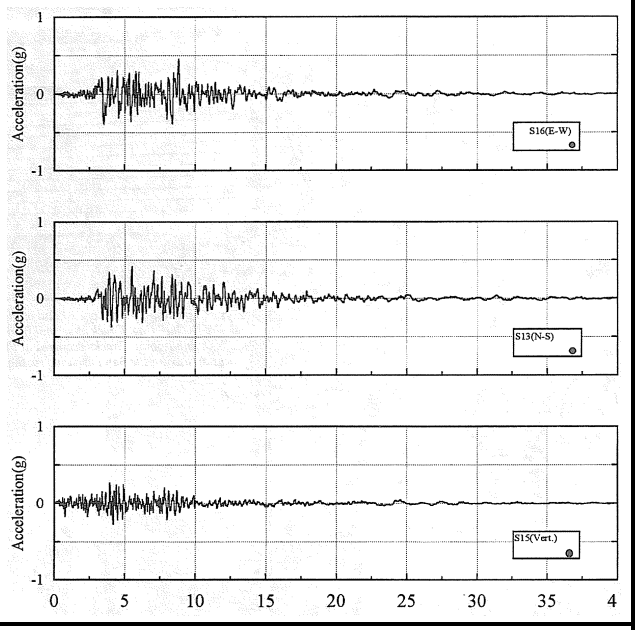
Earthquake Date:	01/17/1994		
Moment Magnitude:	6.7		
Epicentral Distance (km):	7		
Local Intensity:	VIII	Intensity Scale:	MMI
Site Description:	"Geologic source data indicate that the site lies on recent alluvium. The underlaying soil was identified to be primarily fine sandy silts and silty fine sands. This suggests a site factor coefficient of S2 or greater." (SSC, 1994)		
PGA (max horizontal):	0.45g		
PGA (vertical):	0.27g		
SaT:			
Ground Motion Recording Stations:	CSMIP Station No. 24386		
Distance to Station (km):	0		
Station Latitude:	34.2201		
Station Longitude:	-118.471		
Ground Motion Summary:	The earthquake occurred along the Pico thrust fault, a previously undiscovered Northridge blind thrust fault, and produced some of the strongest ground motions ever recorded in North America. The earthquake started at the down-dip, southeastern corner of the Pico fault plane and ruptured up northwest approximately 15 km, with no evidence of slip above 7 km below the earth's surface. The hypocenter is believed to lie at a depth of about 19 km km at a location of 34.213, -118.537. An overall maximum horizontal ground acceleration of 1.93g was recorded at Tarzana, about 11.2 km from the epicenter. The Van Nuys Holiday Inn had a total of sixteen ground motion sensors located throughout the building, including 10 measuring north-south motion, 5 measuring east-west motion, and one measuring vertical motion.		

Additional Ground Motion Information:

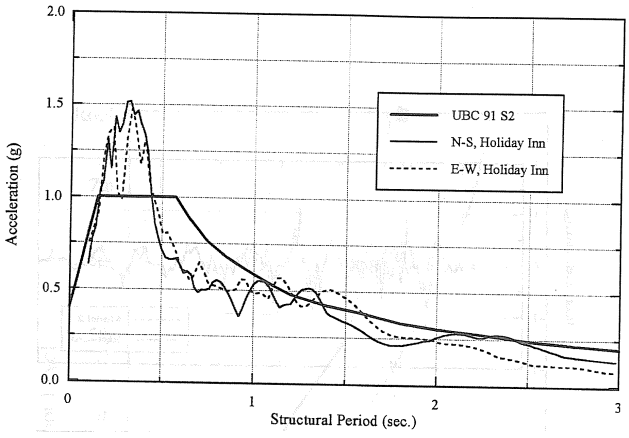
Paste in earthquake maps, spectra, or figures involving the ground motion at the building site



Shaking intensity for Northridge earthquake. (USGS, 2009)



Acceleration traces recorded at ground floor. (SSC, 1994)



Comparison of response spectrum for 5% critical damping. (SSC, 1994)

Insert image here

Type image caption here:

Record ID: 22 **Building Name:** Holiday Inn **Prepared By:** Quinn Peck

Section 3: Damage Information

Performance Summary:	The Holiday Inn experienced extensive structural damage during the Northridge earthquake and was "red tagged" and remained unoccupied until renovation and retrofit measures were completed.
Damage State Description:	Structural damage from the Northridge Earthquake was predominantly restricted to the longitudinal perimeter frames. Damage was most extreme on the south face of the building between the fourth and fifth floors, including severe X-pattern shear failures in the columns and subsequent buckling of the vertical reinforcing. Minor to moderate cracking occured in the beam-columns joints below the fifth floor, with damage most extensive along the south face. Some minor flexural cracking occured in the bottoms of several spandrel beams suggesting possible yielding of the borrom reinforcing steel. The transverse perimeter frames only exhibited minor flexural cracks in the end bays. The nonstructural brick infill in the northeastern corner of the first floor exhibited cracking at the corners of each panel, suggesting they participated in the seismic response of the structure.
Summary of Causes of Damage:	1. The presence of brick infill solely on the north face of the building in the eastermost bays introduced assymetry in the longitudinal direction of the building, likely resulting in a torsional eccentricity. The concentration of damage in the spandrel beam-column framing on the south face of the structure would appear to corroborate this hypothesis. 2. The concentration of damage between the fourth and fifth floors suggest that building's second mode of vibration played a signficant role during the earthquake. The recorded story shears appear to confirm this, as the shear demand between the fourth and fifth floor is nearly the maximum experienced by the structure. This fact, along with the lower shear capacity at this story largely explains the damage at this location. 3. The larger displacement demand caused by a combination of the unexpectedly large shear forces and the plan asymmetry resulted in significant forces along south face between the fourth and fifth floors, resulting in significant shear failures in five of the nine columns. Widely spaced or entirely absent transverse reinforcing in the beam-column joints contributed to the extensive failure along this face of the building.

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Record ID: 22 **Building Name:** Holiday Inn **Prepared By:** Quinn Peck

Section 4: Observed Design and Construction Characteristics-Construction Quality

	Notes	Contribution to Observed Damage				
		Unlikely	Possible	Likely	Unknown	N/A
Materials						
Concrete		◉	○	○	○	○
Reinforcing steel		◉	○	○	○	○
Execution						
Conveyance/ placement of concrete		○	○	○	◉	○
Rebar		○	◉	○	○	○
Field variance with design documents		○	◉	○	○	○
Other Factors						
Please Specify:		○	○	○	◉	○

Record ID: 22 **Building Name:** Holiday Inn **Prepared By:** Quinn Peck

Section 4: Observed Design and Construction Characteristics-Configuration

	Notes	Contribution to Observed Damage				
		Unlikely	Possible	Likely	Unknown	N/A
Plan Irregularities						
Torsion		○	○	◉	○	○
Perimeter boundary		◉	○	○	○	○
Diaphragm		◉	○	○	○	○
Out-of-plane offsets in lateral resisting system		◉	○	○	○	○
Non-orthogonal systems		◉	○	○	○	○

Record ID: 22 **Building Name:** Holiday Inn **Prepared By:** Quinn Peck

Section 4: Observed Design and Construction Characteristics-Configuration-(Continued)

	Notes	Contribution to Observed Damage Unlikely	Possible	Likely	Unknown	N/A
Vertical Irregularities						
Soft Story		◉	○	○	○	○
Weak story		◉	○	○	○	○
Mass distribution		◉	○	○	○	○
Geometric variability of lateral resisting system		◉	○	○	○	○
In-plane discontinuity of lateral resisting system		◉	○	○	○	○
Setbacks		◉	○	○	○	○
Change in stiffness		◉	○	○	○	○
Other Factors						
Please Specify:		○	○	○	◉	○

Concrete Coalition Phase II: Concrete Building Performance Record

Record ID: 22 **Building Name:** Holiday Inn **Prepared By:** Quinn Peck

Section 4: Observed Design and Construction Characteristics-Lateral Load Resisting System-General

	Notes	Contribution to Observed Damage				
		Unlikely	Possible	Likely	Unknown	N/A
Strength						
Overall lack of strength	Strength in the upper stories was insufficient for the applied forces, but only because the second mode of vibration was significant.	○	◉	○	○	○
Stiffness						
Extreme Flexibility		◉	○	○	○	○
Load Path						
Collectors/Struts		◉	○	○	○	○
Anchorage of nonstructural elements		◉	○	○	○	○
Out-of-plane capacity of walls		◉	○	○	○	○
Diaphragm chords		◉	○	○	○	○
Diaphragm openings		◉	○	○	○	○
Other Factors						
Please Specify:		○	○	○	◉	○

Concrete Coalition Phase II: Concrete Building Performance Record

Record ID: 22 **Building Name:** Holiday Inn **Prepared By:** Quinn Peck

Section 4: Observed Design and Construction Characteristics-Lateral Load Resisting System-Frames

	Notes	Contribution to Observed Damage: Unlikely	Possible	Likely	Unknown	N/A
Columns						
Shear strength		○	○	◉	○	○
Flexural strength		○	◉	○	○	○
Axial load ratio (P/Ac/fc')		◉	○	○	○	○
"Vertical" load columns drift capacity		○	◉	○	○	○
Interference of frame action by infill		◉	○	○	○	○
Beams						
Strength relative to columns		○	◉	○	○	○
Shear controlled behavior		◉	○	○	○	○
Continuity of longitudinal reinforcing		◉	○	○	○	○
Loss of vertical capacity		◉	○	○	○	○

Record ID: 22 **Building Name:** Holiday Inn **Prepared By:** Quinn Peck

Section 4: Observed Design and Construction Characteristics-Lateral Load Resisting System-Frames-Continued

	Notes	Contribution to Observed Damage: Unlikely	Possible	Likely	Unknown	N/A
Beams –(continued)						
Interference of frame action by infill		◉	○	○	○	○
Joints						
Interior		◉	○	○	○	○
Exterior		○	◉	○	○	○
Corner		○	◉	○	○	○
Other Factors						
Please Specify:		○	○	○	◉	○

Record ID: 22 **Building Name:** Holiday Inn **Prepared By:** Quinn Peck

Section 4: Observed Design and Construction Characteristics-Lateral Load Resisting System-Shear Walls

	Notes	Contribution to Observed Damage: Unlikely	Possible	Likely	Unknown	N/A
Shear						
Diagonal tension/compression		○	○	○	○	◉
Sliding shear		○	○	○	○	◉
Flexure/shear		○	○	○	○	◉
Flexure						
Compression zone buckling capacity		○	○	○	○	◉
Boundary reinforcing fracture/buckling		○	○	○	○	◉
Discontinuity of wall		○	○	○	○	◉
Boundary Reinforcing at openings		○	○	○	○	◉
Other Factors						
Please Specify:		○	○	○	○	◉

Concrete Coalition Phase II: Concrete Building Performance Record

Record ID: 22 **Building Name:** Holiday Inn **Prepared By:** Quinn Peck

Section 4: Observed Design and Construction Characteristics-Lateral Load Resisting System-Infills

	Notes	Contribution to Observed Damage				
		Unlikely	Possible	Likely	Unknown	N/A
Unreinforced		○	○	○	◉	○
Interference with frame action		○	◉	○	○	○
Out-of-plane		○	○	○	◉	○
Attachment to framing		○	○	○	◉	○

Other Factors

Please Specify:		○	○	○	◉	○

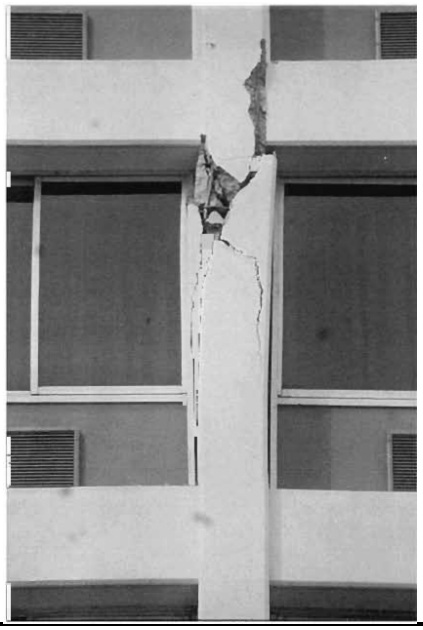
Record ID: 22 **Building Name:** Holiday Inn **Prepared By:** Quinn Peck

Section 4: Observed Design and Construction Characteristics-Lateral Load Resisting System-Other

	Notes	Contribution to Observed Damage: Unlikely	Possible	Likely	Unknown	N/A
Foundations						
Liquefaction		◉	○	○	○	○
Pile/pier tension capacity		○	○	○	◉	○
Spread footing capacity		○	○	○	◉	○
Other:						
Please Specify:		○	○	○	◉	○
Miscellaneous						
Pounding		○	○	○	◉	○
Surface Rupture		○	○	○	◉	○
Other:						
Please Specify:		○	○	○	◉	○

Illustrations of damage:

Paste in drawings, sketches or photos of building damage

	
Close-up of x-cracking in column where tie failed. (Comartin et al., 2004)	Close-up of x-cracking in column. (EEFIT, 1994)
	
North elevation of the damaged building with temporary shoring in place. (Comartin et al., 2004)	Close-up view of damaged exterior spandrel beam-column connection at fifth floor level. (SSC, 1994)

Record ID: 22 **Building Name:** Holiday Inn **Prepared By:** Quinn Peck

Section 4: Repair and Retrofit Information

Type of retrofit or repair:	Improved Performance
Other:	
Performance Level:	Unknown
Hazard Level:	Unknown
Code:	Unknown
Other:	
Lateral Analysis:	Unknown
Other:	
Design Strategy:	New reinforced concrete shear walls were introduced to strength the lateral force-resisting system.
Retrofit Summary:	

Illustrations of Repair or Retrofit:

Paste in drawings, sketches or photos of building repair or retrofit

Insert image here	Insert image here
Type image caption here:	Type image caption here:
Insert image here	Insert image here
Type image caption here:	Type image caption here:

Concrete Coalition Phase II: Concrete Building Performance Record

Record ID: 22 **Building Name:** Holiday Inn **Prepared By:** Quinn Peck

Additional Notes:	
Section 1	
Section 2	
Section 3	
Section 4	

Appendix 1: Supplemental Basic Information

File Location	/static/data/2-supplemental-basic-information/USA001_Cover_Image
File Caption	North elevation of the Van Nuys Holiday Inn prior to damage from the Northridge Earthquake. (Clark, 1994)
File Location	/static/data/2-supplemental-basic-information/USA001_Plan_1.jpg
File Caption	Typical floor framing plan. (SSC, 1994)
File Location	/static/data/2-supplemental-basic-information/USA001_Plan_2.jpg
File Caption	South perimeter frame elevation. (SSC, 1994)
File Location	/static/data/2-supplemental-basic-information/USA001_Plan_3.jpg
File Caption	North perimeter frame elevation. (SSC, 1994)
File Location	/static/data/2-supplemental-basic-information/USA001_Plan_4.jpg
File Caption	Typical beam-column section at elevation D. (SSC, 1994)
File Location	
File Caption	
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File Caption	

Record ID: 22 **Building Name:** Holiday Inn **Prepared By:** Quinn Peck

Appendix 2: Additional Ground Motion Location

File Location	/static/data/3-additional-ground-motion/USA001_Ground_Mc
File Caption	Shaking intensity for Northridge earthquake. (USGS, 2009)
File Location	/static/data/3-additional-ground-motion/USA001_Ground_Mc
File Caption	Acceleration traces recorded at ground floor. (SSC. 1994)
File Location	/static/data/3-additional-ground-motion/USA001_Ground_Mc
File Caption	Comparison of response spectrum for 5% critical damping. (SSC, 1994)
File Location	
File Caption	
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Record ID: 22 **Building Name:** Holiday Inn **Prepared By:** Quinn Peck

Appendix 3: Illustrations of Damage

File Location	/static/data/4-illustration-of-damage/USA001_Damage_1.jpe
File Caption	Close-up of x-cracking in column where tie failed. (Comartin et al., 2004)
File Location	/static/data/4-illustration-of-damage/USA001_Damage_2.jpg
File Caption	Close-up of x-cracking in column. (EEFIT, 1994)
File Location	/static/data/4-illustration-of-damage/USA001_Damage_3.jpe
File Caption	North elevation of the damaged building with temporary shoring in place. (Comartin et al., 2004)
File Location	/static/data/4-illustration-of-damage/USA001_Damage_4.jpg
File Caption	Close-up view of damaged exterior spandrel beam-column connection at fifth floor level. (EEFIT, 1994)
File Location	
File Caption	
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Appendix 4: Illustrations of Repair/Retrofit

File Location	
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Appendix 5: References

Citation	Seismic Safety Commission (SSC), 1994. Holiday Inn. Northridge Building Case Studies Project. M. Saiful Islam, Englekirk & Sabol Consulting Engineers for the California Seismic Safety Commission. Second Draft, September 26.
Link to Purchase	http://www.seismic.ca.gov/pub.html
File Location	
Citation	Earthquake Engineering Field Investigation Team (EEFIT), 1994. The Northridge, California Earthquake of 17 January 1994: A Field Report by EEFIT. EEFIT, Institute of Structural Engineers.
Link to Purchase	
File Location	/static/data/6-references/USA001_Reference_2.pdf
Citation	Clark, Peter W., 1994. "Van Nuys Holiday Inn." Photo. Courtesy of the National Information Service for Earthquake Engineering, EERC, University of California, Berkeley. http://nisee.berkeley.edu/elibrary/Image/NR212 (9 July 2012).
Link to Purchase	http://nisee.berkeley.edu/elibrary/Image/NR212
File Location	
Citation	Comartin, Craig, Kenneth Elwood, and Heidi Faison, 2004. "Reinforced Concrete Moment Frame Building without Seismic Details." World Housing Encyclopedia. http://www.world-housing.net/WHEReports/wh100108.pdf (9 July 2012).
Link to Purchase	
File Location	/static/data/6-references/USA001_Reference_4.pdf
Citation	United States Geological Survey (USGS), 2009. *CISN ShakeMap for Northridge Earthquake*, http://earthquake.usgs.gov/earthquakes/shakemap/sc/shake/Northridge/ (9 July 2012).
Link to Purchase	
File Location	/static/data/3-additional-ground-motion/USA001_Ground_Mc

Appendix 5: References-(Continued)

Citation	Osteraas, John, and Peter Somers, 1996. Reinforced Concrete Structures. *Earthquake Spectra*, **11**, Supplement C, Vol. 2, 59–61.
Link to Purchase	http://eqs.eeri.org/resource/1/easpef/v12/iS1/p49_s1
File Location	
Citation	Huang, M.J., and A. F. Shakal, 1995. Recorded ground and structure motions. *Earthquake Spectra*, **11**, Supplement C, Vol. 1,13–96.
Link to Purchase	http://eqs.eeri.org/resource/1/easpef/v11/iS2/p13_s1
File Location	
Citation	Jirsa, James O., and Y. Roger Li, 1998. Nonlinear analyses of an instrumented structure damaged in the 1994 Northridge earthquake, *Earthquake Spectra*, **14**, 265–283.
Link to Purchase	http://eqs.eeri.org/resource/1/easpef/v14/i2/p265_s1?isAutho
File Location	
Citation	Applied Technology Council (ATC), 1996. *Seismic Evaluation and Retrofit of Concrete Buildings*, Vol. 2, *Report No.* ATC-40, Redwood City, CA.
Link to Purchase	https://www.atcouncil.org/Rehabilitation-of-Engineered-Buildi
File Location	
Citation	
Link to Purchase	
File Location	