



20th Anniversary of Northridge Earthquake: “Memories of Northridge” Newsletter Supplement

SEAOSC and Southern California remembers 20th anniversary of the 6.7 earthquake that jolted residents awake in the morning darkness of January 17, 1994. The shaking lasted 10-20 seconds, but the effects have left an indelible impression on everyone.

SEAOSC’s members have compiled their memories and “lessons learned” from their experiences during and in the days, months and years following the historic events. Some of our younger engineers were children during the earthquake and were inspired to pursue engineering as a life mission. Our senior engineers have been able to analyze plans and influence code

changes making our buildings safer. Our community of engineers went above and beyond the call of duty inspecting buildings, performing search and rescue, making evacuation calls and lent hands wherever needed. Their selfless humility is evident in these recollections.

The SEAOSC members and engineering community strive to increase the public’s awareness of the purpose and responsibility of civil and structural engineers. Let us not forget the efforts made by the engineers saved many lives on the morning of January 17, 1994 and whose contributions continue to improve building safety across Southern California today.

THE QUAKE

On January 17, 1994, an earthquake rocked Los Angeles, California, killing at least 57 people and damaging or destroying thousands of buildings. The Northridge quake, named after the San Fernando Valley community near its epicenter, was the costliest in U.S. history, with damages estimated at more than \$20 billion.

Damage was widespread, as buildings, shopping centers, parking lots and portions of major freeways all collapsed. At least 57 people perished, while over 5000 were injured. At the Northridge Meadows apartment complex, 16 people were killed, all of whom lived on the first floor, when the three-story, stucco-and-wood structure fell down on them. A motorcycle police officer died when his vehicle plunged off of a just-collapsed section of freeway.

The fact that the quake occurred on a federal holiday (Martin Luther King Jr. Day) and in the early morning hours when most people were home in bed was critical in reducing the number of casualties. Another important factor was that the building and safety codes in Los Angeles had been strengthened following a powerful quake in the San Fernando Valley in 1971 (also called the Sylmar Earthquake).

Following the Northridge disaster, which was responsible for estimated damages in excess of \$20 billion, the majority of insurance companies representing homeowners in California severely restricted—or completely stopped offering—new policies because the law required them to also offer earthquake coverage. In response, the state created the California Earthquake Authority as a publicly managed, primarily privately funded organization providing basic residential earthquake coverage.

Courtesy of History.com



Many roads, including bridges and elevated highways were damaged by the earthquake, affecting commuters for months. FEMA News Photo

Doug Thompson, S.E.
STB Structural Engineers, Inc.
SEAOSC President 2013-2014
Member since 1987

Don Gilbert
SEAOSC Executive Director, 1994-2012
Lynn Hanger
SEAOSC Executive Director, 2012-present

Early Monday morning January 17, 1994, Southern California was rocked by a magnitude 6.7 earthquake. At that time John Shipp was our SEAOSC president and SEAOSC had recently entered into contract with a new Executive Director, Donald Gilbert. The phones were ringing off the hooks everywhere.

Many of us were assessing the damage to buildings. This was at several different levels; buildings your own firm had designed, buildings your clients owned, buildings assigned to your team through the Safety Assessment Program (SAP) with the California Office of Emergency Management (CalEMA), or even “cold calls” to look at buildings.

Shortly after the event SEAOSC and the Los Angeles Department of Building and Safety (LADBS) collaborated together in forming several Joint Task Force Committees with members from many organizations such as L.A. County Building and Safety, the Division of the State Architect (then Office of), industry representatives and FEMA to investigate structural damage to buildings. The committees were tasked with investigating the damage and formulating opinions on the probable causes for the damage including:

- Inadequate code design provisions
- Inadequate structural design
- Inadequate building maintenance
- Inadequate construction (workmanship or not built per plans)
- Inadequate testing and inspections
- Inadequate structural observations
- Inadequate materials and/or testing of materials

The various Joint Task Force committees then wrote reports detailing their findings and recommendations for changes in the code requirements. In almost every construction type, the building damage started research and testing programs from wood sheathed shear walls to steel moment frame connections. The City of Los Angeles decided to mandate many of the recommendations as emergency changes to the code so as to not have to wait for the next code cycle(s). Code changes included:

- Ductile column detailing for all concrete columns
- Welded steel moment frame connections
- Removal of stucco and drywall from the lateral force resisting systems
- Limit of the aspect ratio for wood sheathed walls
- Tie-down displacement and sill plate anchorage
- Higher anchorage forces and better detailing

In 1994, when the Northridge Earthquake hit, my family and I had arrived in California only 3 months prior from the Midwest. We were thrilled to be in this wonderful climate but, at the same time, still trying to establish our new lives and get our bearings. We found an apartment, enrolled me in school (I was 11 years old and in 6th grade), and began to set up the SEAOSC office, which was in a state of complete disarray having just been moved from offices with the Masonry Institute on 6th Avenue in Los Angeles to the ICBO building in Whittier. Ed McDermott, SEAOSC’s previous executive director, gave us a few sentences of instruction and we were off and running.

We had telephones – but they weren’t in the right places, so cords were strung across doorways and sometimes we ran from one room to another to answer the phone when it rang. We had hard-copy files but barely had a computer with Windows (3.0?) on it. There was one dot-matrix printer for labels for the newsletter. We used a three-ring binder with 200+ pages for the membership list as this was before the data was computerized!

Imagine my surprise when my parents woke me at about 4:30 a.m. on Jan. 17th so I could experience an earthquake. We were all surprised at how loud it was and how long it lasted. We pinched our fingers in the doorways and sat on the couch in our 2nd floor apartment and watched TV for news of what was happening. The announcer would mention an aftershock, and we would count how long it took to reach us in La Habra. We were a little nervous as our apartment building swayed and the silverware rattled in the drawer but mostly it was exciting. Finally we went back to bed (all together in one bed for protection) for a quick nap before it was time to get to the office. Just as we dozed off, friends from around the country began calling to see if we were all right and were re-counted our experience over and over.

The next day, my dad left for the office first so he could verify that the route was open. He made it and called to tell us to come ahead. That was the beginning of 12-14 hour workdays that lasted for the next year or more. The phones started ringing with engineers wanting to volunteer (there was no formal SEAOSC program set up to handle that then), engineers looking for books or FEMA cards, and the general public looking for engineers. We had little knowledge of the membership but we gave out names and phone numbers as best we could on our one and only phone line. There was no clearing house and callers were completely confused about whom to call for assistance.

It wasn’t long before we established a free referral service and notified the building departments and other government agencies. The phone company quickly accommodated us with extra lines and then the phones really started ringing. We estimate that at the

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for Concrete and masonry to wood diaphragms
• Increased structural observation

In the 1980's the Existing Buildings Committee which included several individuals from LADBS and the County of Los Angeles, developed procedures for retrofitting un-reinforced masonry (URM) buildings. These procedures were adopted by the City of Los Angeles and when the Northridge Earthquake came, there were no deaths associated with URM buildings that had been retrofitted. This is truly a retrofit success story.

In the early 1990's the Existing Buildings Committee spent a considerable amount of effort analyzing and developing retrofit procedures for concrete tilt-up wall anchorage. The City of Los Angeles and the County of Los Angeles adopted the procedures as voluntary. These retrofit procedures then become mandatory a day or two after the Northridge Earthquake. That was twenty years ago. Likewise, there are voluntary retrofit procedures for wood framed-soft story buildings, non-ductile concrete buildings and pre-Northridge steel framed buildings as well as several other building types. Is it going to take another disaster to get these procedures adopted?

At the expense of the "big tobacco" industry, we watch public service commercials about professionals learning about the un-healthy effects of second hand smoke that can exist in places that we live and work in. Yet we have life-threatening buildings that do exist in places we live and work in. Professionals have determined these types of buildings need retrofitting and all we have are voluntary procedures because we don't have a "big industry" to help pay for it? Hello, is anybody listening?

Northridge Personal Experiences:

We sent out a request for those that would like to share their personal experience from the Northridge event. The results were overwhelming. Obviously, this event still has long lasting memories with us all. We have included them in this Newsletter. Please take the time to read these personal experiences as they truly tell the stories as they occurred.

As for myself, yes I visited many damaged buildings. Being the SEAOSC Wood Committee chair at the time, I was asked, and accepted, to be part of the SEAOSC/COLA Wood Frame Construction Joint Task Force and worked on ways to improve the building code for wood construction.

Doug Thompson, S.E.

peak, we were handling 500 calls per eight-hour day. Our phones were so tied up that we had to designate one phone line and the fax for members only. SEAOSC Auxiliary members, including Nancy Cochran, Millie Stockinger and Alice Loevenguth, volunteered to assist with referrals, which was a big help.

Memorable calls included a little old widow lady who was quite deaf, and Ben Schmid volunteering to drive right over and help her; St. John's hospital in Santa Monica asking Executive Director Don Gilbert, my father, if they should evacuate and SEAOSC member Sandy Pringle rushing over there, where the building was immediately red-tagged; numerous schools in the LA District asking what to do (didn't they have an emergency plan?).

People wanted engineers from their area but we had no idea where these places were so we went by members' telephone area codes. Being new to the area, we didn't know Santa Clarita from Santa Catalina! One person said, "How can you not know where Santa Clarita is?" We had to read off city names and he picked one he felt was closest. Many callers thought we were engineers and asked us technical questions or requested an engineer with a certain specialty like hillside or foundations. Also, we had to explain to callers that we were giving them referrals, not recommendations or references.

It wasn't easy for SEAOSC members receiving these referrals either. The offices of many members were damaged and in disarray, plus they had their own clients to service. But all in all, it was a group effort of people helping people and the referral service brought business and good public relations to SEAOSC and its members. The bad news for us was that we "didn't see daylight" for a YEAR. We went to work in the dark of early morning and went home in the dark at night, no vacation, no time off. I was often picked up at school and driven to the office to do my homework and wait for my parents to go home. I sometimes fell asleep on that old orange 1970's couch.

As the days wore on, we avidly watched the news and learned more about which buildings were damaged and where. Floyd Apodaca, ICC structural engineer and code interpreter, whose office was next to ours, taught us about the safety of our building, earthquakes in general, and what it was like riding out the Whittier quake in 1987.

After a couple of months, SEAOSC members were clamoring for programs on the seismology and damage of the Northridge earthquake. Many extra and well-attended programs were added to the schedule, along with large sets of notes to be prepared. There was a large increase in the workload from seminar registrations and publications, which were ordered by the carload. I often helped collate and assemble handouts and packets in the evenings.

To me, the Northridge Earthquake was at first scary, and then exciting, and finally lots of work. But beyond all that, we were so proud to work for the professional, competent and caring structural engineers of Southern California.

Lynn Hanger & Don Gilbert



Chimneys collapsed due to inadequate reinforcement or attachment to the building structure. In this subdivision, every house's chimney fell down. Photo: <http://www.nbmj.unr.edu/nesc/BobCox/ndx2.php>

Doug Silver, S.E. **Senior Engineer, Coffman Engineers Inc.** **Member since 1981**

I have been involved in earthquake risk consulting since the early 1980s. Prevailing knowledge was that wood frame houses did just fine in earthquake, consequently, I did not have earthquake insurance on my house. Little did I expect an earthquake to occur within about 2 miles of the house. Luckily I was able to take care of repairs for about \$10,000. But the office building where I had my small consulting business was in Sherman Oaks—an unusually hard-hit area. The building I was in was red-tagged but this was overly conservative given the rather limited damage. Still the post-earthquake experience was like being in a text-book example of what happens in earthquake since our office was within walking access of damaged office buildings, tuck-under parking buildings, a nonductile hotel that would have collapsed had the earthquake lasted a few seconds longer, etc.

Positive outcomes included a sharp uptick in our earthquake risk assessment work, the chance to work on the City of Los Angeles Committee that wrote Division 91, and learning that much more about how buildings perform in earthquake.

The amount of damage for homeowners was often proportional to whether or not they had earthquake insurance. On my street there are 6 essentially identical 2-story 1978 vintage homes. ALL of the homes sustained varying amounts of minor-to-moderate damage. Important parameters were site conditions (the homes at the north end of the block closest to the wash did worse) and chimney location. The chimney location thing is interesting. Five of the houses had the chimney on the south side and my house had the chimney on the north (my house is reverse plan from the other 5). The pulse from Northridge went towards the south so the chimneys pulled away in the other 5 houses causing more damage to address. In my house the chimney basically tried to push into the house and resulting damage was to the ceiling of the adjacent bedroom.

FEMA came in and I was able to get about \$4,000 right off the top for repairs. I took an SBA loan for maybe \$6,000 more

which basically took care of everything. Plus I did some seismic upgrading (added bracing in attic space and converted some of the wood stud/stucco walls to real plywood shear walls). The one homeowner on my street who had earthquake insurance had everything taken down to the studs and essentially rebuilt—ridiculous.

I have some mix of photos stashed away for buildings I looked at. Actually, the most interesting almost-catastrophe was the near-collapse of a hotel down the street from my office in Sherman Oaks. Coincidentally, I had done an earthquake risk assessment of the building in 1986 and had concluded that this non-ductile concrete building could collapse if there was a severe earthquake. Well, the Northridge earthquake happened and I saw a bunch of damage to other buildings in the Sherman Oaks area but the hotel basically looked not too bad which I thought was curious. Since it was down the street my business partner and I took a walk down there and walked around to the back of the building which was basically the entrance to the parking. That's when we saw that almost every concrete column was badly damaged and there was a bunch of wood shoring at that parking level that was holding everything up. We were actually able to get inside the building (which had been vacated) since we told the owners that we were engineers and we were professionally interested.

We found the floors inside to be way out of whack due to the damage of the columns, below and the owner showed us drawings for the proposed repair/upgrade. The real interesting thing is that repairs/upgrading was done over the period of a year or so and the hotel was reopened but there was never ANY mention of this building in any of the newspapers. Years later I discovered that the owners went to great lengths to keep the near-collapse of a significant hotel under wraps. The photos I have of the damage to the columns are quite sobering.

Doug Silver, S.E.

Bill Seckler
William S. Seckler, Civil Engineer
Member since 1988

Michael Krakower, S.E.
Krakower & Associates Structural Engineers
Member since 1983

I did a very limited amount of post-event inspection, but I do have a very vivid memory of an apartment complex near CSUN. Basically, I saw an apparently complete lack of any construction measures to protect against earthquakes, and this complex was built after Sylmar-San Fernando. The plans had been submitted before the new code following the 1971 event would be adopted. I also remember hearing about the location being “at the peak of the sine curve”, and hearing the expression used more than once, and reacting to it when I heard it a second time, from an architect.

Also, I recall driving out to Santa Monica about a day-and-a-half after Northridge to allay my concern about a three-story condo building where I had done all, or nearly all, of the structural work through another engineer’s office. As it happened, the building and the respective careers of my temporary employer and myself were still in one piece.

Bill Seckler

After evaluating a large damaged tilt-up building on the roof in the West San Fernando Valley after the initial earthquake, I climbed back down and started a meeting in the building with the owners to review my field notes and findings. Just after I started the discussion a large aftershock hit. I was so intent on reading from my field notes, that when I looked up to get their input, there was no one there. Everyone had fled the building and I didn’t even notice they had left. After awhile they all came back in and we continued the meeting.

I thought it was hilarious. I had convened the meeting in a safer part of the building away from the damage, but the client may not have realized that. There is also an unwritten rule that no damage is allowed in the building while the SE is there!

Michael Mrakower, S.E.

Among the buildings most susceptible to earthquake damage are the low-cost tilt-up buildings that dominate the industrial landscape of much of the Southwest. This tilt-up building in Chatsworth, CA was typical of many in the area that sustained extensive damage.

“Tilt-ups” built prior to the building code changes that followed the 1971 San Fernando earthquake incurred the most damage. If these older buildings had been retrofitted, their performance would have improved considerably. “Tilt-ups” built after the building code changed performed well, but there were a few notable exceptions.

Photo: <http://www.smate.wvu.edu/teched/geology/eq-CA-Northridge2.html>



Keith Martin, S.E.
Keith Martin, Structural Engineer
Member Since 1979

The earthquake woke me up from a sound sleep in my apartment in Redondo Beach. After putting on shoes and investigating the apartment, I then called my family to make sure everything was ok.

Once I was sure my family was ok, I checked in with the Los Angeles County Fire Department Urban Search and Rescue Team, which I had joined as a Structural Specialist when it formed in 1991. They said they were forming a response team and asked that I join them at the Fire Department Headquarters off Eastern Avenue. Fortunately there were no damaged freeways between my apartment in Redondo Beach and the headquarters.

As I drove into the headquarters, I was impressed with the large number of fire engines which were being assembled in a large vacant lot next to the headquarters. They came from fire departments all over the southland, and were being assembled to dispatch as needed.

The USAR team assembled at the headquarters and awaited further instructions. About mid afternoon we were asked to stage at the Los Angeles City Fire Station next to Sepulveda Dam. We waited there for a couple of hours and then were asked to go to the North Ridge Meadows apartment building which had collapsed. When we arrived the Los Angeles City First responders were finishing up after spending most of the day at the site since the earthquake. All of the live rescues had been accomplished as well as most of the victim removals. We were asked to do a secondary search of the collapse. The bottom level of the building had collapsed and shifted about 8 feet to the north. The upper two stories were pretty much still intact. We needed to search the bottom floor for any additional trapped victims. We systematically began cutting holes in the floors so we could lower a search camera into the void spaces below formed by parked vehicles and large pieces of furniture holding up the floor above. Unit by unit we cleared the building.

During the night we were informed by the Los Angeles City Fire Department Chief, who was the incident commander, that a woman reported her husband as missing. She last saw him shortly before the earthquake as he got up to use the bathroom. We determined where the bath room should be located based on the floor plan of the unit above. We then began cutting holes to search for the victim. The collapse had pushed the closet and its contents over the bathroom and crushed him. We found ourselves cutting through layers of clothing in order to access the space below, where we eventually found the crushed body of the husband.

While we were searching the front, eastern portion, of the complex, Riverside Urban Search and Rescue arrived and were stationed at the rear portion of the building from which they began clearing the



Northridge Meadows apartment building over 6 months after the Northridge earthquake, August, 1994.

back portion of the complex.

About the middle of the night the Incident Commander learned from a young woman that her boy friend was missing. She last saw him about 1am when she left. He was on a ground floor apartment. We found him still in his bed. As the building collapsed the wall next to his bed hinged and fell on top of him, trapping him in his bed and crushing him to death.

During the night the electrical power was finally restored to the neighborhood. Some of our team inside the collapse immediately began to report that they smelled smoke. Visualize a huge pile of shattered 2x framing lumber with sparks going off inside. Very scary! DWP had a representative available and we immediately began looking for a way to shut off the electricity to the building. We found the electrical vault in the alley way along the north side of the building. Unfortunately the building had collapsed over the man hole cover. A heroic effort was made by the firemen at hand with a large number of chain saws to cut away the collapse from the man hole before everything went up in flames. Fortunately it was done in quick order and soon the man hole cover had been removed and the DWP employee was standing at the lip looking down to the shut off switch below. He said something about OSHA regulations requiring that the hole be tested and vented before entering, but he then said that there was obviously no time and with all these firemen waiting above he felt he could go down. He went down without problem and soon the power was off and additional catastrophe avoided.

As the sun began to rise the next morning, we completed the last of our victim removals and search of the building as well as an adjacent apartment building immediately to the north which had collapsed in a similar manner. There were no victims in this building and the apartment manager had accounted for everyone who lived there. Very good manager!

To help us in our search for victims we asked for first hand reports from survivors. We learned that the quake was so violent and sudden, the survivors thought it was an explosion, not an

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earthquake. No one had a chance to go to a safer place before the building collapsed on top of them. To see the victims and their condition was very disturbing. Many died in bed, their beds and bed covers stained deep red by their blood as they bled and suffocated to death.

As we searched the collapse, we found that there were many void spaces where someone could survive formed by large pieces of furniture holding up the collapsed floor above. If people reacted fast enough, rolling out of bed onto the floor next to them in the few seconds available to them before the floor above crushed them in their beds, then they might survive.

The Northridge Meadows has left a lasting memory. There are still many soft story apartment buildings in Los Angeles which can collapse and crush their occupants just as the Northridge Meadows did to its occupants. When I live in apartments, I always pick the top story apartment, not the bottom. I would never live in the bottom floor of an apartment built before the code changes made after the Northridge Earthquake. I could never sleep at night. I would encourage members of SEAOSC to encourage their friends and family members not to live on the bottom floor of apartment buildings, especially those built before the Northridge Earthquake.

Joel Castro Castro Associates Affiliate Member Since 2013

I was the attorney for Northridge Meadows and have hundreds if not thousands of relevant photos. Many of them were used in court with Judge McLaughlin. Here's a link to the LA Times settlement article: http://articles.latimes.com/1995-09-12/news/mn-45070_1_northridge-meadows-apartments

Joel Castro

Article excerpt: **Lawsuit Over Collapsed Apartments Is Settled : Quake: Undisclosed accord over Northridge complex where 16 died is estimated at more than \$1 million.**

The early settlement of the case means a jury will never decide whether the collapse of the three-story, 163-unit apartment building was due to shoddy construction, as the lawsuits contended, or was an act of God, as the owner and builder claimed.

Santa Monica attorney Joel B. Castro, the lead plaintiffs' lawyer, said proceeds from the settlement will be placed in trust, and that individual plaintiffs will later present evidence of their damages. An independent judge--not MacLaughlin--then will distribute the money.

Castro had arranged for a controlled demolition of the building last year during which experts pored over the surviving details of its construction. In the lawsuit, numerous building defects were alleged, including the failure to use plywood to brace walls, too few anchor bolts attaching the structure to its foundations, and inadequate connections between floors and walls, and walls and roofs.

Even more important is to encourage the City and County of Los Angeles to adopt mandatory ordinances to retro fit soft story buildings. Recommended ordinances have been around for years and other cities have adopted them. It will be very sad when once again the bodies of crushed and bloodied apartment dwellers will need to be removed by search and rescue teams because the city, county and the owners of these buildings did not do the right thing.

Incidentally, I personally know the Structural Engineer who designed North Ridge Meadows as well as another Structural Engineer who had close family friends crushed to death in the building. The former is a responsible engineer who designed according to the code at the time, using much higher shear values for sheetrock than that which experience has since shown to be safe. The latter was very disturbed, as a structural engineer we both realized that earthquakes do not kill people, buildings kill people. All of us who designed multi story multi family buildings before North Ridge may well have pending disasters with the structures we have designed. I pray that before that time occurs that retrofit ordinances are passed to save many future apartment dwellers from the same horrid deaths I saw that day nearly twenty years ago.

Keith Martin



Northridge Meadows apartment complex May 5, 1994. The building collapsed onto the ground floor killing 16 people. Here you can see a kitchen table among the debris.

Photo: © Roger Ressimeyer/CORBIS

Aileen M. Santos-Redman, P.E. Hatch Mott MacDonald Member Since 2004

Ah, the Northridge Earthquake. At the time, I was an engineering student at Cal State Northridge, so I lived at home with my family in Granada Hills, conveniently close to campus. I was a Civil Engineering major, and that year, I was scheduled to take my hydraulics class that I really didn't care for (I really wanted to focus on structural engineering...why did I need to know about water?!?!?), so my boyfriend whose engineering curriculum was focused on water resources was over at my parents' home to help me with the basics of open channel flow.

Spring semester classes hadn't started yet, but was only a days away, and not wanting to repeat my abysmal experience with fluid dynamics class from the previous semester, I wanted to get a head start on all things water. My boyfriend had just left around 4 a.m. to head back to his parents' home a couple of miles away, and I had just gotten to bed for the night when the shaking started shortly thereafter.

What I still remember very clearly is feeling my bed get slammed up and down, and hearing my glasses fall off my nightstand. I knew we were having an earthquake, and I was panicking that I wouldn't be able to make my way out because I won't be able to see - my eyesight is pretty bad. Still, despite the bad vision, I could see that the tall bookcase by my bedroom door had now fallen over at the end of my bed, and the only thing that kept it from crushing my legs was the bed's metal foot board. I was relieved to be unhurt, but bewildered because my doorway was completely blocked by the bookcase, so I started yelling for my mom to come get me.

I don't know how I got out of my room. My mom or my dad must've gotten me out, and we sat out on the steps in front of the house while my dad went got to work on shutting off the gas main. Later, we found out (maybe we were listening on the radio?) that only a couple of blocks over, a huge hole blew open in the middle

of Balboa Boulevard, because a gas line exploded in the middle of the street. I was so grateful that our house was spared from the fires that spread. We were lucky - we lost power, but we had water and gas, so we could cook and shower, thanks in part to the Maglites that became attached to each of us. A majority of the cinderblock wall that fenced in our backyard had collapsed, as did the brick chimney. We lost a couple of dishes when they flew out of the kitchen shelves. But none of us were hurt.

The worst part of the aftermath were the aftershocks. They were strong; I remember one was a 5.0, which would've been a somewhat significant earthquake in itself. And I couldn't understand all the reports afterwards that talked about the "soft, rolling motion" that characterized the type of earthquake that it was, because from where I was, it felt like the hand of God had reached down, picked up the end of my bed, and tried to bounce me out of it. Nothing soft about it.

The earthquake definitely affected my engineering education. Cal State Northridge was heavily damaged and the start of the spring semester was delayed until the end of February, reopening with the motto, "Not just back. Better." I'm not sure what was better about the portable, pop-up tents that replaced many of the red-tagged buildings on campus. A lot of my engineering classes were relocated to trailers, as the steel-framed engineering building that had only started to take shape during the previous semester ended up with heavily damaged welded connections, which no doubt contributed to the "pre-Northridge welded connection" studies that changed the way we engineer steel buildings today.

I wanted to help out, so I joined Habitat for Humanity. I was hoping I would get to rebuild some homes, and gain some practical knowledge in construction practices in the process. But when they found out I was an engineering student, I was teamed with a

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"My fellow graduating seniors and I were tasked with choosing a structure for group study, and I was elated when my group got to pick first - we all wanted first dibs on the pancaked parking garage." Photos: Southern CA Earthquake Data Center

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contractor and tasked with visiting homes to talk to homeowners about earthquake retrofit solutions instead.

In the later half of 1994, I started my last undergrad year and our heavily damaged campus became our senior project, an NSA-funded study on what happened with the various Cal State Northridge structures. My fellow graduating seniors and I were tasked with choosing a structure for group study, and I was elated when my group got to pick first - we all wanted first dibs on the pancaked parking garage.

Our senior project gave us a first-hand look at the effects of the Northridge quake on our parking garage (not enough redundancies, the lateral loads couldn't get to the shear walls at the core of the garage...and stay away from post-tensioned anchors that turn into projectiles when the cables snap), our campus library with the newly built wings (impressive to see large dwyidag anchors and thick base plates all bent like paperclips and paper), and other campus buildings. More importantly, it made my senior year an unforgettable one that solidified the friendships I formed with my senior project teammates into lifelong bonds.

Aileen M. Santos-Redman, P.E.



Both gas and water pipes burst beneath Balboa Boulevard north of the Simi Valley Freeway from the force of the main shock, creating this bizarre and destructive combination of fire and water. (photo: Southern CA Earthquake Data Center, Kerry Sieh)

Kevin O'Connell, S.E. Structural Focus Member since 1996

I was in college at USC at the time (and already studying structural engineering), but was up in Big Bear skiing during the holiday weekend with my family. My younger brother had broken his arm the day before, so when the earthquake woke us up, I remember telling him to stay where he was and not climb down off the top bunk since the shaking was not too intense and I did not want him to fall in the dark.

As we drove down the mountain that morning, the radio reception kept coming in and out due to the hills and valleys, and so we had very limited information about the epicenter, magnitude, and damage. But we did hear bits about some of the significant damage, freeways collapsing, etc. The news reports were very surrealistic, very "War of the Worlds" sounding, since we hadn't seen it with our eyes (in person or on television).

Once we got home to Orange County, we were shocked at what we saw on television. Back at USC, things were very exciting. Lots of real world experiences to learn from, lots of "field trips" to see earthquake damage, and eventually lots of testing in the Kaprielian Hall basement laboratory.

It added another chapter to my four year experience at USC which included riots, wild fires, mud slides, and earthquakes.

Kevin O'Connell, S.E.

Jim Farasatpour, S.E. Jim Farasatpour Associates Member since 1984

- Lots of badly damaged (Red Tagged) apartments buildings in the valley
- Lots of damaged SFD in Northridge, particularly the two-story ones and the ones with the heavy Spanish roof tiles
- Some high-end condos and apartments in Santa Monica got all kind of damage
- Most Importantly: The Steel Moment Frame Connections Failure Discovery, which almost was accidental
- I did not have a day off for nearly five months from the day of the earthquake on
- Engineers, construction crews and suppliers simply could not keep up with the calls and demands!

Jim Farasatpour, S.E.

Terry Dooley Honorary Member Member Since 1960

I was awakened by the quake, checked to see that my wife was OK, and we rode out the quake in bed. No calm and collected “take cover – protect your head” thoughts. My over-riding thought: “I don’t see how the wood frame of this house can survive such punishment”. Large lateral accelerations, no memory of vertical motion, sounds of breaking glass, falling dishes and bottles and pictures. Heavy shaking was soon over. No light, no power.

We turned on a battery-powered radio and heard early reports of approximate epicenter and magnitude. Our first thoughts were for our children, one of whom lived with us in Sherman Oaks, and two others in Northridge. Phones were out so we drove to their homes on side streets, avoiding downed poles and wires. Everyone had damage, but no injuries. Visited site of the collapsed parking structure along Zelzah Avenue at Cal State Northridge and speculated about mechanism of collapse – did not arrive at the right answer until later.

Both of our home fireplace chimneys collapsed. Old lightly reinforced brick. The concrete cap of one chimney was embedded in front lawn about 15 feet north of its original position – I reckoned its trajectory as approx. a 1 : 1 slope. A tremendous “shot put” by the quake.

My attention turned to projects built or under construction by my employer, Morley Construction. I visited some sites. Could not phone until later. Morley started emergency shoring of the two badly damaged Royce Hall towers at UCLA on verbal orders from the UCLA Chancellor at the site on the day of the quake. That building and Powell Library were extensively retrofitted, including some new foundation elements.

Reflections 20 years later:

- There was a three year spurt in seismic repair and upgrade activity, which tapered to little or nothing, except for hospitals, some universities and a few corporate sites.
- Structural steel story office buildings in areas of heavy shaking were required to have connections exposed and examined. Damage was found and repairs required.
- Structural steel residential towers did not have to be checked, and I believe that cracked connections remain undetected to this day.
- Several cities tabulated the non-ductile reinforced concrete buildings (4-14 story) in their inventory. Few were in the area of heaviest shaking. Building owners and managers lobbying killed any positive action by governments to require investigation and/or repair. These hazards remain.

- One valuable commercial site in Sherman Oaks remains empty to this day. The four story office building there was condemned and demonished. There are other such examples.
- Three blocks away, the 14-story Union Bank Building at Ventura Blvd and Sepulveda Blvd is a shining example of enlightened ownership. Emergency repairs to stairs and exiting routes allowed re-occupancy in about a month, and chevron bracing with friction sliders at the apex of each frame upgraded the non-ductile reinforced concrete frame effectively. There are a few other such examples, but not many among private owners.
- The true extent of economic loss from Northridge was enormous. It would have been much smaller if positive measures had been taken in advance. Few private individuals or corporations are prepared to deal in probabilities, and to evaluate potential loss scenarios.

Terry Dooley



“Emergency repairs to stairs and exiting routes allowed re-occupancy of the 14-story Union Bank Building in about a month.”

John Whiteman, S.E.
Vice President, Kramer Engineering, Inc.
Member Since 1996

The Northridge Earthquake was a major influence for me. I grew up and was living in Granada Hills, about 3 miles from the epicenter, the morning of the Northridge earthquake. I was an engineering student in college at the time. Like most people in the area, it was startling to be awakened by such violent shaking that morning. It was probably the longest 31 seconds of my life. My family was fortunate that we only lost the chimney from our house and no one was seriously hurt.

I got to see firsthand multiple structures in the Northridge area that suffered significant damage, several on the day of the earthquake (including the CSUN parking structure, Northridge Meadows Apartments, the parking structure & Bullocks at the Northridge Fashion center, and the medical office building at the Granada Hills hospital). The saddest one of course being the Northridge Meadows Apartment, where the first story of one of the buildings collapsed. I drove by the apartments the day of the quake on the way to check out a friend's house, since they were out of town, and did not even notice at the time. The building just looked like a two story building. It was later that I found out about the tragedy.

One experience in particular has stuck with me and influenced me as an engineer. Friends of our family with 2 little children (one of which had special needs) lived in an older apartment complex in the area. It was the older style of construction that had parking on the ground floor, with only columns along one side, with the apartments above. Their building experienced significant permanent racking and damage. The building was red tagged by the inspectors. I will never forget, two days after the quake, a group of us helped our friends get as much as we could out of the apartment before the inspectors arrived, so that they did not lose everything they had. This is one of the things that makes me take my responsibility as a structural engineer very seriously. Knowing and experiencing the affects such a major earthquake has always driven me to make sure I do the best I can when I design a building.

Having seen the affects of the earthquake, it was really neat to then



An apartment building on White Oak Avenue in Northridge was “red tagged” on Jan. 19, 1994, two days after the earthquake. Photo: K.Anderberg 1994, <http://web.resist.ca/~kirstena/pageeqnorthridge.html>

learn the principles behind what had happened as I finished college and in my early career. I got to see firsthand what can happen, not just the pictures in our text books, that illustrated the concepts I was learning. This just made the field of structural engineering come alive even more for me.

Although there was significant monetary damage to buildings in the San Fernando Valley and other areas in LA, there was relatively little loss of life as a result of this quake. This is a testament to the structural engineers of California. Ever since then I have been proud of the standard of design and construction in California, especially when I hear about other earthquakes around the globe and the death and destruction that results. This pride has only grown since I began working in the field and learned what is truly involved in making sure our structures are safe.

Thank you for this opportunity to share a little of my experiences.
John Whiteman, S.E.

Jim Miller, S.E.
J.R. Miller & Associates, Inc.
Member since 1988

At the time, I lived Diamond Bar where there was no damage, so I didn't have personal concerns. Instead, my first thought was about the buildings I had designed that were located at Van Nuys Airport, very near the epicenter. My first instinct was to immediately drive out there (from my office in Orange county), but I knew traffic and access would be problems.

I went early the next morning and was able to gain access to observe all of the buildings I had designed. What a relief it was to find out that those buildings (which were all steel-framed industrial, mostly pre-engineered metal buildings) had fared well!

During my observations, I took many notes and photos. I later wrote an article that was published in Metal Building News which contained information that led to design changes of diagonal bracing connections.

Thanks for doing this,

Jim Miller, S.E.

Max Moheb, P.E.
Structural Design Solutions
Member since 1992

I have lots of memories of Northridge E.Q. On Jan. 18, 1994, I was asked by a management company to inspect their buildings. I had no idea what to look for and it sure was a learning experience.

I remember checking a parking garage of an old multi-story apartment building in downtown L.A. and the concrete column had "exploded". Also driving East-West on valley main boulevards, you could see through blocks of houses as all masonry fence walls running in E-W had collapsed.

One interesting memory I have is of a house with a front porch and wood framed windows. As the building moved up and down during the E.Q., a circular stool on the porch had tilted and its top got trapped between the window sill and porch floor.

Also Northridge came at a bad economic time which helped lots of engineers make good money while learning and being of service to the community.

Max Moheb, P.E.

Mike O'Brien, S.E.
National Engineering & Consulting, Inc.
Member since 2008

During the earthquake, I was in grad school at Caltech in Pasadena. When it woke me up, I rolled over and hit redial on my phone to call my girlfriend (now my wife) in Irvine. A very groggy voice answered with a mumbled "Hello" followed soon after by her startled voice saying "Earthquake!". My phone call got there faster than the earthquake waves telling me that the epicenter was to the northwest nearer my grandparents' house. I called them next to check on them and see if they needed me to come over (they were fine). I then started filling my kitchen pots with drinking water in case of water main breaks because I had zero earthquake supplies.

The news showed many shots of the collapsed parking structures, downed bridges, the pancaked office building, Northridge Meadows, etc. so all of these seemed familiar when we visited them. The thing that really surprised me while going out on a windshield survey with the rest of the department was how many block property walls toppled. While driving through residential neighborhoods in the Valley, it seemed that almost all of the walls had toppled.

Mike O'Brien, S.E.

Liz Conklin, P.E.
KPFF Consulting Engineers
Member since 2013

I was at home in Costa Mesa fast asleep when I felt the start of the shaking – I thought it was my sister rolling around in the bed next to me. Then I heard the chandelier shaking at glasses moving around in the kitchen nearby, and I knew it was something more. I ran into the dining room & my dad and brother were also there checking it out.

The rest of the family (including my sister) slept through it completely. It felt like it lasted for several minutes, although now I know that wasn't true. I don't remember any damage to the house (I was only 8 at the time), and not much else aside from the shaking.

Liz Conklin, P.E.



San Fernando Valley Apartment Damage: Rear view of a damaged three-story apartment house with a first-level garage. The two wings of the building collapsed into each other across the formerly intervening courtyard during the partial collapse of the parking level. (photo: Southern CA Earthquake Data Center, Gregory Davis)

Felix Martin, P.E. **Marcon Forensics, LLC** **Member Since 1982**

Although based in Orange County, my firm did a lot of post-earthquake repair work. Initially our work was for commercial and retail clients. Later we worked for insurance companies resolving insurance claims. Here are some of my recollections:

- I was awakened the morning after the earthquake by the first call to go out and inspect damage. I remember driving to the San Fernando valley that day, and seeing damaged areas that seemed downright apocalyptic. Visible damage everywhere. Broken water mains and, more dangerously, broken gas lines spewing fire. People had spent the night out in tents on their front lawns, too afraid to go back in their homes. Driving home to Orange County, just an hour away, where there was absolutely no visible evidence that an earthquake had just occurred, and having a hard time convincing people of how bad things were in the Valley.

- Immediately after the earthquake, I had contracts with a number of retail chains to inspect their stores in the Valley. We drove out early in the morning and canvassed locations all day, assessing damage and sketching repairs. We then returned to our Orange County office to run calculations, finalize repair drawings, and prepare reports. We went home for a few hours' sleep and then repeated the cycle. This went on for months.

- At one large retail store, a concrete tilt-up building with a wood-framed entryway, the only structural damage was to the entryway. My recommendation was to keep people from entering the store, because the entryway was in danger of collapsing. The next day I drove by it, and a truck with a chain attached was busy tearing down the entryway. The retail people told me that keeping that store closed was costing them \$50,000 a day, and if the only thing keeping the store from being open was the entryway, they would be happy to rip it off. My thought was, with people sleeping in tents

on their front lawns because they were too afraid to go back into their homes, who would go shopping? But when I drove back and with the entryway a pile of rubble, I went into the store and people were busy shopping around broken glass and fallen ceiling tiles.

- At a retail store in an older brick building, the structural damage had been extensive and I declared the building unsafe. The retail chain people were unhappy about losing a sales store with merchandise still inside. A meeting was held in the parking lot with store executives where they tried to convince me the building was not that unsafe. I reluctantly agreed to go into the building with the top executive to show him the extent of the damage. Everything I showed him was followed by his comment "That does not look that bad", until an aftershock hit and the building became a swaying mass with debris falling everywhere. After the now white-faced executive and I made our way outside, he convened with the others and agreed the building was unsafe. A few days later and without disclosing the condition of the building, they hired an independent contractor with a crew of illegal workers to pull all their stock out.

- After the main quake, at a concrete tilt-up retail distribution center in Chatsworth, the nailed anchor straps tying the panels to the roof diaphragm had started to fail. The nails from the strap to the roof framing were so loose you could pull them out with your fingers. I declared the building unsafe, and overnight developed a repair where new anchors would be anchored into the panels and bolted to the roof framing. The retail chain hired a contractor who installed them within 48 hours working around the clock under a city emergency permit. A sister mirror-image un-repaired building across the street from the distribution center, collapsed during an aftershock a few days after repairs to our building were completed.

- At a three-story wood-framed condominium building on a concrete slab over a first level parking, some of the first level shear walls had failed, and the concrete slab had pancaked over the parking area. The wood superstructure had not collapsed, but was a twisted, failed mess. When I visited the property, a few days after the main quake, someone was in one of the units, playing a piano. In the pancaked parking area, there were people crawling under the collapsed slab, stealing radios from the cars in the parking area.

- In the days immediately after the earthquake, there were wide areas in the Valley without electricity or telephone service. This was before cellular service was in wide use. I got an understanding of the geographical extent of earthquake damage while inspecting a large retail store in Thousand Oaks. The store was closed, but most of the damage was in the form of fallen insulation and ceiling tiles. The phone at one of the registers rang, letting me know damage to telephone service did not extend to this store. The person calling wanted to know the store hours. After I hung up I called my wife to let her know I was OK.

- From personal experience, there are few things scarier than being in the crawl space of a 1920's house when an aftershock hits.

- I wrote my last earthquake damage report in 2001.

Felix Martin, P.E.

Steven Saunders
Saunders Construction, Inc.
Member since 1992

David Cocke, S.E.
Structural Focus
Member since 1995

I was in Nevada at that time and remember it well! For some reason I woke up at 3:30 am in the morning and could not sleep.

All of a sudden I felt an Earthquake that rattled the house what seemed to be about 10-15 seconds. I thought to myself that if this was in L.A. there are some real problems here. Nothing on the TV till about an hour later when I finally heard about the quake. I flew back to CA the next day to our office.

We received a call in our office about damage to a manufacturing company in Northridge. The damage was extensive to the structure but what was really shocking was the damage inside the building with all the exposed HVAC ducts (400 pounds a foot) that came down along with all the tenant's stored materials and equipment. When looking around I was very relieved that this happened during a holiday early morning when the building was not occupied. I think that very few of the people would have made it out alive if not seriously injured. Debris everywhere, you could hardly move inside the building.

We repaired the structural damage to the structure with out of plane concrete tilt up walls (walls pulled from the roof structure), Glue Laminated beam repairs, purlins, concrete repairs and some of the roof diaphragm.

In retrospect if this would have happened during working hours I know that many more lives would have been lost. In this scenario I am sure there would have been far more municipalities would have made structural retrofits mandatory.

Steven Saunders



I was living in Northern California when Northridge occurred. My wife had gone in to work early as usual and left me with our 7 & 3 year old sons to take to school and daycare. She called the house to inform me of the earthquake and I replied "OK, I'll see you in a week or so." I packed my bag and went into the Degenkolb office.

I remember thinking to myself "I wonder if this EQ will have as big an impact on my career as Loma Prieta did?" (it was bigger as a matter of fact.) By 2 pm I was on a Southwest flight to Burbank with several other Degenkolb engineers. However, when I landed and checked in (by pay phone, no cell phone), I picked up a message that the Oakland Search & Rescue team had been activated and I was to report as one of the team's "Structural Specialists" to the Los Alamitos Base to rendezvous with my team for instructions. So instead of spending the first night in the comfortable Burbank Airport Hilton with my friends, I spent it on an uncomfortable cot with 300 other snoring "friends" in the gym. Of course, they released us the next morning and I raced back to Burbank.....

The day after the earthquake, I went to the Cal State Northridge campus hoping that I could get some first-hand views of some of the damage. I walked into a big room that was full of facilities staff, claims agents and engineers. Dr. Charles Thiel saw me from across the room and shouted "Degenkolb finally showed up!" and motioned for me to come over to him. He then gave out assignments to everyone (he was the Chair of the Cal State University Seismic Committee at the time) and then grabbed me and said let's go for a walk.

We walked all over the campus and looked at numerous damaged buildings. While approaching the now famous collapsed parking structure we saw 2 guys in hardhats way down in the middle of the collapsed structure. We could not recognize them. Chuck yelled to them "Get the hell out of there right now!" and they yelled back "It's OK, we're structural engineers!". They of course could not tell who Chuck was and they never came out.....

David W. Cocke, S.E.

Failure of suspended ceiling system including lights and air diffusers in the 1994 Northridge Earthquake (Photo courtesy of FEMA; Wiss, Janney, Elstner Associates).

John Van Valkenburg, S.E. Saiful/Bouquet Structural Engineers Member Since 2007

I lived in Northridge during the Northridge Earthquake. I was only 12, and it wasn't my first big earthquake, but it was definitely the most memorable.

My school was shut down for 2 weeks. Elevated walkways between buildings had become separated from the buildings and had to be torn down before they collapsed on their own. My father's office was right near the epicenter, and everything in that office had been thrown to the floor.

Most of the houses in my neighborhood were fine, except the chimneys. Every chimney had collapsed. We were without power for two days, and got fresh water from an emergency tanker truck at a local school. We set up tents to camp outside, and had tables and chairs set up to have meals with our neighbors and friends. With no power, we had to eat the perishable food before it went bad.

I remember that my sister was supposed to spend the night at a friend's house. Where she would have slept, she would have been crushed and likely died.

We saw all the bridges that collapsed with a portable TV. We had friends that lived next to a collapsed freeway overpass, so we got to see it up close as well.

I remember driving down Reseda Blvd and looking at all the tuck-under apartment buildings that had fallen over. This was where most of the casualties occurred.

I remember driving by CSUN and seeing their collapsed parking structure, and the Northridge Mall where a department store had partially collapsed. The hospital up on Balboa that later had to be torn down.

I also remember that was the big year for earthquake insurance. Those that had it often had to fight with insurance companies to get money, and those without it sometimes had to pay thousands of dollars for repairs. After Northridge, everyone had earthquake insurance.



Are you prepared for an emergency?

"We were without power for two days, got fresh water from a tanker truck at school and set up tents outside."

My family learned earthquake safety. Even now, we secure all bookshelves or large objects to the wall. We secure cabinets so dishware and glassware won't fall out in an earthquake. We learned the difference between plate glass and tempered glass, and make sure that all windows and glass doors have the stamp on it. There are so many little things that can be done that will make a huge difference in an earthquake. It's been 20 years since our last big one, but that only means we're getting closer to the next big one.

Northridge was my first time looking into structures. Even though I was still a kid, I saw what earthquakes do. Walking around the neighborhood, I wanted to know why some houses were damaged and why some were not. I also wanted to know how to fix the damage, or prevent it from happening. I wasn't afraid when Northridge hit. I was old enough to understand that earthquakes are just a part of living in California.

Now that I am older, I feel safer because I am an engineer. I design buildings to withstand earthquakes. I design retrofits to make sure old buildings will withstand earthquakes. Where most people seem to forget about earthquakes as time passes, I know that we're only getting closer to the next big one. A thousand dollars in mitigation now can save tens or hundreds of thousands of dollars of repair later. Hopefully more people will realize that before the next one hits.

John Van Valkenburg, S.E.

Alan Hanson
 Simpson Strong-tie
 Member Since 1995

Alan Hanson submitted these scans of Los Angeles Times newspaper headlines. The top article can be read in its entirety at <http://articles.latimes.com/2003/oct/19/realstate/re-retrofit19/2>



Los Angeles Times

JOLTED: A sagging house in Fillmore, a town hard hit by the Northridge earthquake of January 1994, demonstrates the destructive power of quakes.

Bracing for a quake

A state grant program subsidizes retrofits for low- to moderate-income owners.



BRYAN CHAN, Los Angeles Times

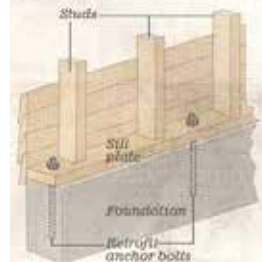
MORE SECURE: Phyllis Michel, with dog Molly, had her North Hollywood home retrofitted.

Retrofitting braces homes to stand up to temblors

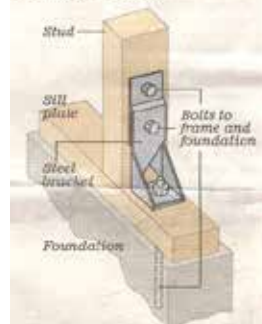
Quake-ready

Securing a home to the foundation can help prevent it from shifting off during an earthquake.

Anchor bolt



Hold-down anchor



Source: www.earthquakeinspector.com, www.mrdicker.com

PAUL DUBBERI, Los Angeles Times

2013-2014 SEAOSC Officers & Committees

Get involved! Members and interested parties are invited to join a SEAOSC committee.
Contact the chairperson for information on current projects and meeting times, dates and locations.

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	OPEN		

