The Northridge Earthquake

25 Years On

By John A. Dal Pino, S.E.

In the early morning of January 17, 1994, the ground shook hard in the northern San Fernando Valley area of Los Angeles. The structural engineering profession was shaken hard too. That was 25 years ago, and how have things changed!

The death toll was thankfully small (less than 75 people). Monetary damage, however, was considerable (estimated at between $15 and $40 billion). However, Los Angeles is a large place; after the earthquake, if you had just dropped into town and had not heard the news on the television or radio, you could have driven around much of the city and outlying areas and not have noticed that an earthquake had occurred. But, if you had a keen eye as any good structural engineer does, you would have noticed the telltale signs of an earthquake here and there (the usual toppled CMU walls, broken glass, brick parapets lying on the sidewalks, etc.). But you would have also stumbled upon a few severely damaged buildings nestled amongst otherwise unscathed structures. Occasionally you would have discovered a building tightly wrapped in yellow caution tape showing no apparent damage and asked yourself, "Hmm, what happened there?"

Looking back on the Northridge earthquake today, it was a truly once-in-a-lifetime event and, taken as a whole, the damage, both observable and hidden, changed the course of structural engineering. It changed the course of structural engineering for the second time, but more on that later. The earthquake occurred in a relatively young, western city full of mostly modern buildings. This made it the perfect laboratory for structural engineers to learn, albeit at society's expense. Earthquakes occur all over the world every year but, for the most part, few yield data applicable to U.S. practice because the buildings and construction techniques are too different. Now, twenty-five years later, it is important to reflect on what happened in Northridge, what the profession learned, and how life changed for a large segment of society, not just structural engineers.

Before Northridge, there was another Los Angeles earthquake that also "changed engineering," the 1971 San Fernando earthquake, located roughly in the same area as Northridge. For many engineers, this earthquake produced the first visual evidence of what a damaged but life-safe building looked like. The resulting damage led to significant changes in the building code (1976 UBC vs. the 1973 UBC) as engineers came to appreciate that design base shear levels were too low and detailing provisions, particularly for concrete tilt-up warehouses and concrete frames (buildings and highway structures), needed significant improvements. The earthquake also led to the creation of California's Office of Statewide Health Planning and Development (OSPHD) as a result of the near-collapse of the new Olive View Hospital in Sylmar.

Back to the Northridge earthquake. The most noticeable and significant damage consisted of wood apartment buildings "pancaked" onto cars, massive highway structures collapsed, toppled parking garages, and non-ductile concrete frames cracked and sometimes collapsed. The occasional heavily damaged building in a largely undamaged area signaled ground motion focusing in the bowl that is the San Fernando Valley. Yellow tape was drawn around buildings that sustained some unique damage, unexpected by a vast number of engineer practitioners. Behind the tape, stiff diagonal braces had torn apart like aluminum beer cans, welded steel moment resisting connections had cracked even in lightweight buildings with wood floors, the roofs of tilt-up buildings had collapsed (again), and one hospital designed to high seismic standards was damaged and out of commission.

In retrospect, it appeared that the profession was caught largely unaware by the 1994 Northridge earthquake and did not expect the kinds of damage that occurred, particularly in the newer buildings, since the code had been modified significantly just 20 years before, along with other improvements in the intervening years. Since the types of damage were generally unexpected, the structural engineering profession was again shaken from its status quo, and things changed again. The pressures of schedule and fee just do not allow engineers too much time for theorizing about how every aspect of a building will perform in an extreme event. The code also provided a life-safety banner that could be used as a protective shield.

Historians argue that, rather than smooth transitions, it is unexpected jolts to the system that change society. So it goes with earthquakes too. As the details about the damage emerged, it became apparent that many aspects of the building code were based on other than historical experience and test data, and that buildings designed to minimum code levels experienced a lot more damage than society was willing to accept. The results of a few tests on a small number of prototypes had been extrapolated to permit construction of large buildings that bore little resemblance to the original concept. A limited set of data had become codified, and buildings were built with little knowledge about their probable performance. To be fair, there are always a few visionaries who anticipate everything and knew this was going to happen someday. The author has had the pleasure to work for and with many such people but, in general, these are rare individuals.

For the 25th anniversary year of the Northridge Earthquake, STRUCTURE will publish a series of articles on what was learned from the Northridge Earthquake and how it changed structural engineering. The authors were carefully chosen from the most knowledgeable people in our profession. The articles will describe how the profession designed buildings before and how things changed. For younger engineers, the articles can serve as a history lesson and, for older engineers, a way to reminisce about the past and hopefully start a conversation with their staffs about engineering into the future.

Please share your thoughts about these articles with us as the year goes on.▪

John A. Dal Pino is a Principal with FTF Engineering located in San Francisco, California. He serves as a member of the STRUCTURE Editorial Board. (*jdalpino@ftfengineering.com*)