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Not My Fault: When buildings fall down

Lori Dengler/For the Times-Standard
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The number one cause of earthquake deaths is the collapse of structures. The key to reducing earthquake casualties is making sure buildings protect life.

There is nothing more fundamental to the well-being of society than confidence that buildings, bridges, dams, and other structures will stand as we work, sleep, eat and play. Most of the time it's not something we think much about. But we should as it's ultimately our support for building codes, code enforcement and retrofitting older structures that makes for a resilient built environment.

There are four steps to earthquake-resistant buildings: understanding forces, how structures respond to those forces, codes and code enforcement, and inspection/retrofitting of older buildings. I am in awe of my earthquake engineering colleagues. They need to understand all the forces acting on structures, the nature of the subsurface and what happens in different earthquakes. It's not just the ever-present pull of gravity, but also dynamic forces such as wind and ground shaking. Even something as subtle as daily and seasonal heating and cooling must be part of the mix.

There are also forces caused by the building use. Vibrations from machinery and even people moving in and out of spaces add additional loads. The people factor was something the City of San Francisco didn't consider back in 1987 when they opened the Golden Gate Bridge up to celebrate its 50th anniversary. Expecting a crowd of 50,000 people, the planners were aghast when ten times that many crowded onto the structure and flattened the normally arched roadbed, a load the structure was never intended to carry.

Earthquake engineering has its roots in four different countries. It shouldn't be a surprise that the US (California), Italy and Japan were important early players – all regions that suffer from relatively frequent major quakes. But the earliest quantitative studies go back to the British Isles, an area with very low seismicity when Robert Hooke the English physicist, chemist, mathematician, architect, and all-round genius presented a series of papers in the late 18th century about earthquakes and structures.

Over the next two centuries, earthquake engineering developed into a mature discipline. Every major earthquake provided new data and insights into how structures respond to strong shaking. 1971 San Fernando opened eyes to the vulnerabilities of unreinforced brick buildings and non-ductile concrete. The 1989 Loma Prieta earthquake shown a glaring spotlight on the weaknesses of ground floor garages (soft stories). The 1994 Northridge quake focused attention on welds in steel-frame buildings.

UC Berkeley was one of the powerhouses of earthquake engineering. The first modern shake table was built right about the time I was beginning my graduate studies. Several of my professors collaborated on experiments testing how structures responded to typical earthquake vibrations. There are now 12 major earthquake engineering centers in the US and dozens throughout the world. We know how to build structures that can withstand the strongest earthquake vibrations. The 2010 Chile M8.7 and 2011 Japan M9.1 were testaments to how well buildings can perform in big tremors IF they have been designed according to modern codes.

But that's a big if. It is more expensive to build structures to resist the strong side to side motions in earthquakes and include redundant design elements so that if one part fails, it won't collapse. An even bigger problem is what to do with older structures, the ones built before codes or built to meet older code specifications.

The 2011 Christchurch earthquake provides a sober example. New Zealand's building codes are as rigorous as any in the US. I visited Christchurch in 2001. It is a wonderful city and like most American cities, has a mix of older, middle-aged, and recently built structures. The Christchurch earthquake was only magnitude 6.2 but centered beneath the city in the middle of a workday.

When the dust had settled, 185 people lost their lives. It was no surprise that unreinforced brick buildings in the historic district were severely damaged, but what jolted me was several reinforced concrete structures built in the 1960s. The collapse of two buildings – the six-story Canterbury Television building and the four-story Pyne Gould Guinness House – accounted for over 70% of the deaths. Neither one of those two buildings could have been built today but, like most places in the world, building owners weren't required to bring them up to current code.

There are thousands of buildings not unlike those two Christchurch buildings in California, and many more in earthquake regions of the Western US. And we still haven't dealt with the stock of all our other problematic buildings such as unreinforced masonry or soft stories. West Coast states are acutely aware of the problem and a number of retrofit initiatives are underway. But the cost to upgrade every older building is staggering and without massive public support to pay for retrofits, progress will continue to be slow.

There are two reasons why structural engineering is on my mind this week. This first had nothing to do with an earthquake. The collapse of Champlain Towers South in Surfside, Florida was a horrific reminder of the consequences of building failure. We won't know the precise reasons for the failure for months or years, whether there was a flaw in the original construction or deterioration over time led to the collapse, but the resemblance to failures in past earthquakes was striking (https://temblor.net/earthquake-insights/opinion-florida-building-collapse-bears-similarities-to-other-tragedies-12923/).

The second was Thursday's M6.0 Antelope Valley earthquake south of Lake Tahoe. Fortunately, it was in a remote area and other than items toppling over and a few cracks, no damage or injuries have been reported. But this is the third M≥6 earthquake in California in a little over two years. We've been lucky that they have been far from densely populated areas of the State. In the not-so-distant future, a 6+ will strike the SF Bay Area, Southern California or near another metropolitan area, testing once again the resilience of our engineered structures.

Lori Dengler is an emeritus professor of geology at Humboldt State University, an expert in tsunami and earthquake hazards. The opinions expressed are hers and not the Times-Standard's. All Not My Fault columns are archived online at https://kamome.humboldt.edu/resources and may be reused for educational purposes. Leave a message at (707) 826-6019 or email rctwg@humboldt.edu for questions and comments about this column, or to request a free copy of the North Coast preparedness magazine "Living on Shaky Ground."