Editorial | *SEI and the Chile Earthquake of 2010*

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SEI sent a team of 18 engineers to Chile on April 5 through 10, 2010 to investigate the performance of structures in the great earthquake of February 27, 2010. The magnitude 8.8 earthquake occurred off the coast of the Maule region on the boundary between the South American and the Nazca tectonic plates that run down the west coast of Chile. The resulting earthquake lasted for approximately 3 minutes and released approximately 700 times more energy than the earthquake that devastated Haiti in January of 2010, making it one of the largest earthquakes recorded in modern times. The geologic setting is similar to the Northwestern United States, and the area with strong ground shaking extended along the coast of Chile a distance comparable to the entire coastline of the states of Washington and Oregon.

Chile has a history of frequent large earthquakes, and of designing and constructing their infrastructure to resist seismic effects. Their seismic design code is comparable to ASCE 7's provisions, their design requirements for concrete structures generally follow ACI 318, and their engineering profession participates actively in the international scholarly and research arena. Building and inspection practices in Chile, along with the materials used for construction, are considered among the best in South American. The economy is vibrant and there are thousands of modern, large, engineered structures in the strongly shaken area. The overall quality of the design and construction is generally on par with the United States. There was, and is, a lot to learn from this event that will benefit construction for seismic safety in the U.S.

The SEI team divided into six working groups:

A) John Hooper of Magnusson Klemencic Associates, Ramon Gilsanz of Gilsanz Murray Steficek, and David Bonneville of Degenkolb Associates focused on concrete buildings in Santiago and Talca, a moderately sized city nearest the epicenter

B) Ron Hamburger of Simpson Gumpertz & Heger, John Tawressy of KPFF, and Jim Rossberg of ASCE/SEI, focused on concrete buildings in Vina del Mar and Valparaiso, coastal cities northwest of Santiago

C) Jim Harris of J. R. Harris & Co., Jay Harris of NIST, and Martin Johnson of ABS Consulting focused on concrete buildings in Santiago and Concepcion

D) Jon Heintz of the Applied Technology Council, Bob Pekelnicky of Degenkolb Associates, Sergio Breña of the University of Massachusetts, Amherst, and Dominic Kelly of Simpson Gumpertz & Heger focused on concrete buildings rehabilitated following the 1985 earthquake, mostly in Vina del Mar

E) Bob Bachman of R.E. Bachman Consulting, Greg Soules of Chicago Bridge and Iron, and John Silva of Hilti focused on industrial structures near Concepcion

F) J. Dan Dolan of Washington State University, Steve Pryor of Simpson Strong Tie, Douglas Rammer of the U.S. Forest Products Lab, and John Van de Lindt (then) of Colorado State University focused on wood and masonry structures in the Concepcion region.

The initial purpose of the SEI team was to document and assess the performance of these types of structures. Ultimately, the purpose is to decide if changes to the codes, standards or practice in the United States are warranted, specifically changes to the seismic provisions of ASCE 7, *Minimum Design Loads for Buildings and Other Structures*, and the provisions of ASCE 41, *Seismic Rehabilitation of Existing Buildings*.

In the strongly shaken area there were nearly 10,000 buildings over two stories constructed since 1985, of which nearly 2000 were over eight stories. Four collapsed, and approximately 50 have been or are scheduled for demolition. In some areas, preliminary analysis of the ground motions indicate response accelerations for tall building were higher than the MCE ground motions in ASCE 7-2010 for downtown Seattle. In the same locations, the ground motions at shorter periods were comparable to the "design" motions in ASCE 7 for many of the large cities on the West Coast of the U.S. Comparing with the objective stated for our codes, the performance appears to have been very good. Much of the life loss was in an area hit by a tsunami. One should not directly compare to our 10% chance of collapse given an MCE ground motion, because many of the buildings in Chile did not experience the equivalent ground motion.

In spite of the success with respect to safety, there was much damage and economic loss. Given the frequency of large earthquakes in Chile (another great earthquake in 1960 and a large earthquake in 1985), the design objective there might well be modified to control damage in the 50 year event rather than avoid collapse in the very rare event. Among the lessons for design of concrete shear walls that could improve U.S. practice:

- Slender concrete shear walls can buckle perpendicular to their plane.
- Conventional details for confinement of concrete at the ends of shear walls were not fully observed in Chile, with poor results.
- Conventional bar sizes and spacings do not adequately confine the concrete at the ends of slender walls.
- Offsets in the vertical boundaries of shear walls at or near the base of the building require very careful consideration in detailing and design.
- The local distortion between walls without coupling beams should be studied, both in terms of reinforcement in the slab and detailing of nonstructural components to accommodate the high deformations.

There are also significant lessons from the performance of industrial structures, large anchors embedded in concrete, and repairs and upgrades to existing buildings, which will be explained in the forthcoming report of the team. The team will also present its findings in sessions at the upcoming Structures Congress, April 14 – 16 in Las Vegas.

We received substantial assistance from our colleagues in Chile, without which our journey would have been much less fruitful. We also received much assistance from U.S. colleagues on other reconnaissance teams, specifically including The Earthquake Engineering Research Institute (EERI), the Geotechnical Extreme Events Reconnaissance Association (GEER), and the Technical Council on Lifeline Earthquake Engineering (TCLEE). We continue to cooperate and coordinate with all.▪