

1.0 INTRODUCTION AND SCOPE OF RECONNAISSANCE

On February 27, 2010, a magnitude M_w 8.8 earthquake occurred off the coast of Maule, Chile. The epicenter was located 35.909°S 72.733°W at a depth of about 35 km. The earthquake took place at the boundary of the Nazca and South American plates where they converge at a rate of about 80 mm per year as the Nazca plate is moves below the South American plate. The effects of the earthquake were observed over a wide area from Valparaiso to the North to the Araucania region around Temuco to the South. Apart from the immediate consequences of the earthquake, the subduction of the Nazca plate resulted in a tsunami that affected a significant portion of the Chile coast from Iloca to the North to Tirua to the South.

GEER deployed a multi-phase team to Chile following the event with support from NSF. As is GEER practice, reconnaissance teams include both US based personnel as well as “in country” based personnel from academia and practice. This approach ensures complete sensitivity to local issues and concerns as well as the benefit of local experience and contacts to enable robust well coordinated reconnaissance activities to be undertaken.

GEER Team A was on the ground from Friday March 5th through Saturday March 13th. The focus of activities for Team A was to define the extent of geotechnical damage resulting from the strong ground motion. Team activities consisted of both aerial reconnaissance flights (conducted with assistance of Chilean Air Force) as well private fixed and rotary wing operators as well as extensive ground reconnaissance efforts that extended from the Santiago-Valparaiso region at the North to the Lebu-Collipuli region to the South, a distance of some 550 km and from the coast to East of Highway 5, a distance of some 120 km. The ground reconnaissance activities ranged from both regional level assessments of ground failure as well as earthquake and tsunami consequences to more detailed studies of specific failures of geotechnical interest including liquefaction and lateral spreading, embankment settlements and failures, geologic uplift/subsidence, tsunami scour, dam/tailings impoundment performance and landslide/slope failures.

Team A was led by GEER Co-Chair David Frost (Georgia Tech) and included US members Robb Moss (Cal Poly San Luis Obispo), Keith Kelson (Fugro William Lettis & Associates), Nick Sitar (UC Berkeley), Alfredo Urzua (Boston College), Gonzalo Montalvo (Washington State University and University of Concepcion). The US members were joined by Chilean colleagues Ramon Verdugo (Universidad de Chile), Christian Ledezma (Pontificia Universidad Catolica de Chile), Terry Eldridge (Golder Associates Santiago), Lenart Gonzalez (Golder Associates Santiago), Gabriel Ferrer (Pontificia Universidad Catolica de Chile) and Claudia Welker, (Golder Associates Santiago).

GEER Team B was on the ground from Saturday March 13th through Thursday March 18th. The focus of activities for Team B was to conduct extensive ground studies in some of the more heavily damaged areas such as Concepcion and the surrounding area as well as continue studies along the coast with a focus on both geologic uplift/subsidence as well as relationships between geologic hazards and urban planning/reconstruction. Additional efforts focused on the effects of ground failure on bridges, highways, railroads and lifeline systems. Specific studies focused on examining damage to bridge foundations due to lateral spreading, liquefaction and slope failures as well as building foundations due to liquefaction, settlement and slop failures. Observations made during both Team A and Team B ground reconnaissance efforts were also used to identify possible candidate sites for subsequent testing and study by Team C as noted below.

Team B was led by GEER Chair Jon Bray (UC Berkeley) and included US members Pedro Arduino (University of Washington), Scott Ashford (Oregon State University), Dominic Assimaki (Georgia Tech), Gabriel Candia (UC Berkeley), Tara Hutchinson (UC San Diego), Laurie Johnson (LJC Inc.), George Mylonakis (University of Patras), Kyle Rollins (Brigham Young University), John Stewart (UCLA) and

Rob Witter (DOGAMI, State of Oregon). The US members were joined by Chilean colleagues Ruben Boroschek (Universidad de Chile) and Sebastian Maureira (Universidad de Chile).

GEER Team C was on the ground from Tuesday March 23rd through Monday March 29th. Team C visited a series of sites identified by Teams A and B and conducted LiDAR, SASW and DCPT tests to characterize subsurface conditions and/or infrastructure geometry. To the extent possible, these studies focused on perishable data that could not be guaranteed to remain in the immediate post-event geometry or condition. The team worked predominantly on sites in the Concepcion area including bridge, embankment and structure failure case histories. They also conducted measurements at a tailings dam failure and at several highway embankments between Talca and Curico as well as at several bridge sites in Santiago.

Team C was led by Rob Kayen (USGS) and included US member Scott Olson (University of Illinois Urbana-Champaign). They were joined by Chilean colleagues Valentina Peredo (Universidad de Chile), Sabastian Maureira (Universidad de Chile) and Lenart Gonzalez (Golder Associates Santiago).

GEER Team D was on the ground from Monday April 12th through Saturday April 17th. Team D was tasked with visiting a number of sites where additional measurements were considered desirable based on observations of the earlier GEER teams as well as to make additional SASW measurements at selected sites. Additional emphasis on the performance of fill soils in some port facilities as well as transportation infrastructure was a focus of this Team.

Team D was led by Youssef Hashash (University of Illinois Urbana-Champaign) and included US member Jim Bay (Utah State University). They were joined by Chilean colleague Gabriel Ferrer (Pontificia Universidad Catolica de Chile).

Home base logistical and technical support for all phases of the GEER team deployment was provided by Katherine Jones (UC Berkeley) and Mesut Turel (Georgia Tech). Coordination with other organizations was facilitated by scheduled teleconferences arranged by the USGS Earthquake Hazards Program as well as directly with other organizations including Earthquake Engineering Research Institute (EERI), the Pacific Earthquake Engineering Research Center (PEER), the Ocean Sciences Tsunami Group and the Mid-America Earthquake Center (MAE).

This report summarizes the observations from the initial reconnaissance conducted by all phases of the GEER team. Given the potential importance of the findings of this event to similar tectonic settings in the US and around the world, it is expected that additional information and interpretations will be made available as they are collected.