Chile Earthquake of 2010

Assessment of Industrial Facilities around Concepción

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Appendixes

(The appendixes are available for download at http://dx.doi.org/10.1061/9780784413647.)

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ASCE/SEI Chile Assessment Team

John D. Hooper, P.E., S.E., *Team Leader*, of MKA, Seattle, WA

Robert E. Bachman, S.E., R.E. Bachman Consulting, Los Angeles, CA
David Bonneville, P.E., S.E., Degenkolb Engineers, San Francisco, CA
Sergio Breña, University of Massachusetts, Amherst, MA
J. Dan Dolan, Ph.D., P.E., Washington State University, Pullman, WA
Ramon Gilsanz, P.E., S.E., Gilsanz Murray & Steficek LLP, New York, NY
Ronald O. Hamburger, P.E., S.E., Simpson Gumpertz & Heger, San Francisco, CA
James Harris, Ph.D., P.E., S.E., J.R. Harris & Associates, Denver, CO
Jay Harris, Ph.D., P.E., National Institute of Standards and Technology, Gaithersburg, MD
John Heintz, S.E., Applied Technology Council, Redwood City, CA
Martin Johnson, ABS Consulting, Los Angeles, CA
Dominic Kelly, Simpson Gumpertz & Heger, Cambridge, MA
Robert Pekelnicky, P.E., S.E., Degenkolb Engineers, San Francisco, CA
Steve Pryor, P.E., Simpson Strong-Tie, Seattle, WA
Douglas Rammer, P.E., U.S. Forest Products Laboratory, Madison, WI
James A. Rossberg, P.E., American Society of Civil Engineers, Reston, VA
John F. Silva, P.E., S.E., Hilti Corporation, San Francisco, CA
J. G. (Greg) Soules, P.E., S.E., Chicago Bridge & Iron Company, Houston, TX
John Tawresey, P.E., S.E., KPFF Consulting Engineers, Seattle, WA
John Van de Lindt, Ph.D., Colorado State University, Fort Collins, CO

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Chapter 1
Introduction

On February 27, 2010 a magnitude (Mw) 8.8 earthquake struck off the coast of South-Central Chile (Maule, see Figure 1-1). It was the largest ground motion event in Chile since the magnitude 9.5 earthquake of 1960 and is listed by USGS as the fifth largest tectonic event ever recorded (as of February 27, 2010). The Structural Engineering Institute (SEI) of the American Society of Civil Engineers (ASCE) began planning for a reconnaissance mission to the affected zone with the intent of gathering information useful to code development. Several teams were formed, each consisting of three or more members tasked with a particular structure type or design issue.

This report, originally compiled in 2010, documents the finding of the Industrial Assessment Team, and was intended to inform code development activities connected with earthquake protection measures for industrial facilities. Accordingly, the inquiries of the Industrial Assessment Team were concentrated on identifying strengths and weaknesses in the response of industrial structures to the seismic event. It was anticipated that damage to industrial facilities had occurred, but that industrial structures designed to newer codes and standards would perform better than those designed to older codes and standards. Chile is unique in that it has a separate standard for industrial structures, NCh2369.Of 2003: Earthquake-Resistant Design of Industrial Structures and Facilities. Requirements in NCh2369 are similar to those found in the 1994 UBC for nonbuilding structures. Because of the similarity between US and Chilean standards, understanding how heavy industrial facilities performed in this seismic event is vitally important to US design practice because the design practice for nonbuilding structures has varied significantly from that employed for building structures since the publication of the 1988 UBC. Observations of the performance of industrial facilities in this seismic event provides a window to how heavy industrial facilities may perform in the next large seismic event in the western US and where US heavy industrial facilities should focus their retrofit efforts.

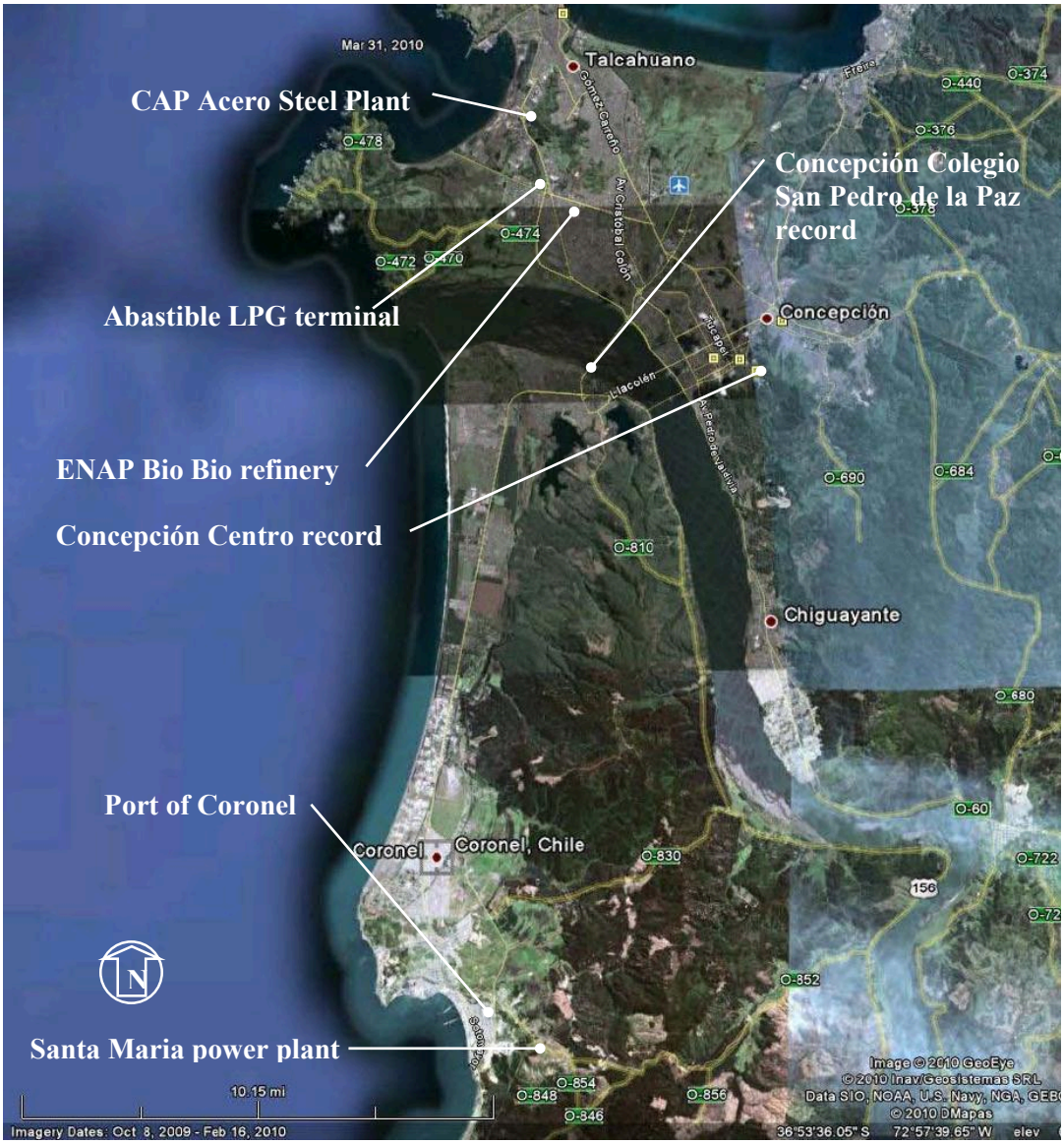

Figure 1-1: Locations of ground motion stations and of sites visited in the Concepción area (Source: GeoEye).

Chapter 2
Ground Motion Records

There are only two ground motion records for the Concepción area and no ground motion records that are particularly close to Coronel (see Figure 1-1). Figure 2-1 shows a close-up of the locations of the two ground motion records and the three facilities located near Concepción. While no ground motion records exist for the facilities visited by the Industrial Assessment Team, the two ground motion records noted above are representative of the ground motions experienced in this region. The actual ground motions experienced at the facilities visited may be different.

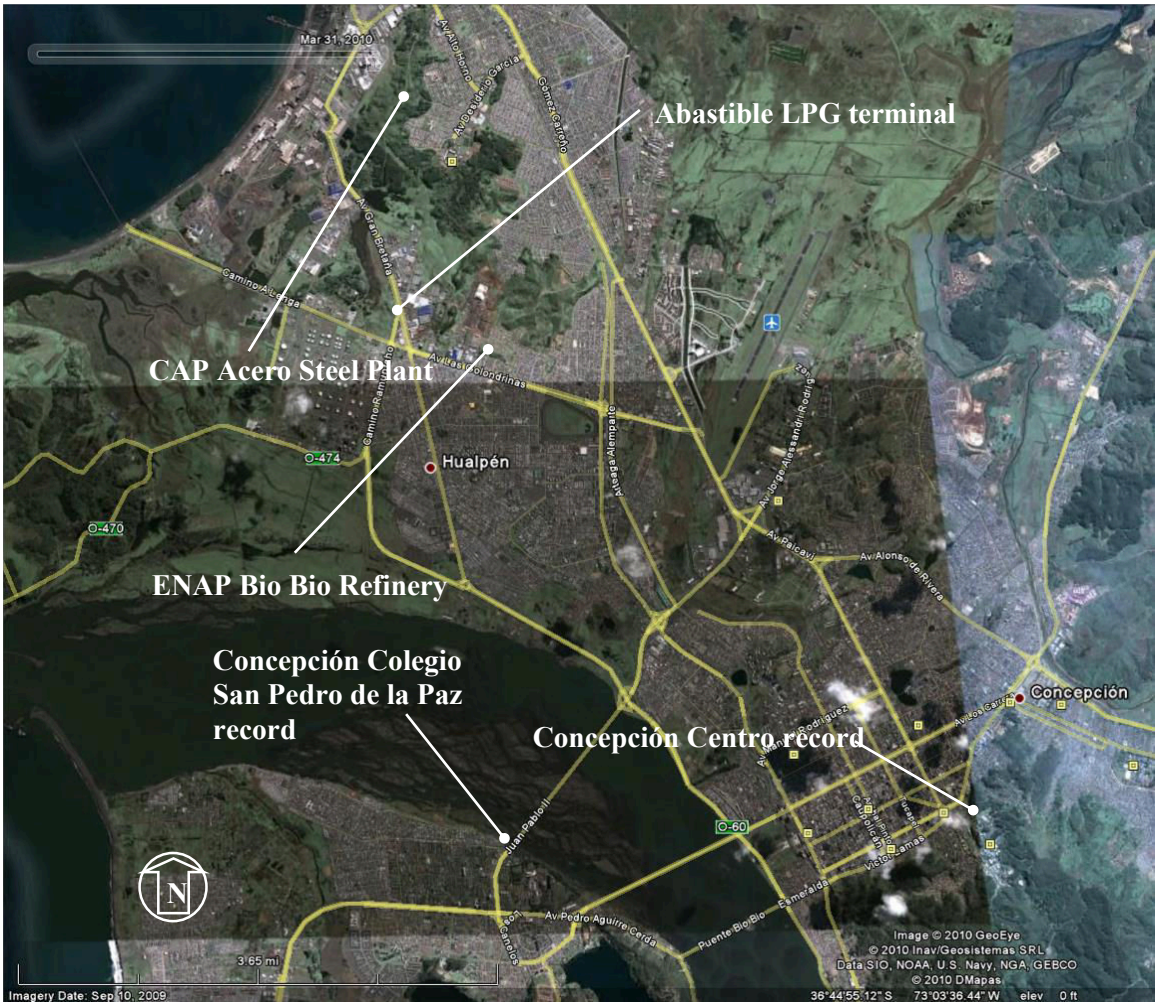

Figure 2-1: Detail of location of ground motion instruments and visited facilities in Concepción (Source: GeoEye).

The preliminarily determined response spectra, shown in Figure 2-2, were determined from data taken from a ground motion instrument located at a school near the intersection of San Martin and Anibal Pinto, 100 meters south from the main square in Concepción. The soil was identified as Site Class C as defined in ASCE/SEI 7-05. The preliminarily determined response spectra, shown in Figure 2-3, were determined from data taken from a ground motion instrument located at the Concepción Colegio San Pedro. The soil for this record was not identified. The preliminarily