



CHILE RECOVERS FROM 2010 M8.8 EARTHQUAKE

MRP Engineering Bulletin

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The M8.8 Maule earthquake of February 2010 impacted much of central Chile and resulted in over US\$30 billion in economic losses. As previously reported by MRP Engineering, this subduction zone event provided many important lessons in seismic performance of modern buildings, industrial structures, as well as infrastructure (additional information can be found at www.mrpengineering.com). MRP Engineering returned to Chile (Concepción area) in December 2010 to observe successes and challenges in rebuilding the region. As discussed in the following paragraphs, although nearly a year has passed since the mega-earthquake, this event continues to provide valuable insight on recovery and reconstruction issues.



December 2010: Construction is in progress on a new highway bridge over the Bío-Bío River in Concepción. This crossing will replace a bridge damaged by the earthquake. The city skyline (background) includes a number of vacant residential towers.

Concepción, Chile's second largest city, is located about 100 kilometers south of the earthquake epicenter. The region's built environment experienced significant damage due to ground shaking (lasting over a minute), soil failures (liquefaction), and tsunamis. Many modern high-rise residential and office buildings sustained major structural damage in the February event. Some of these structures remain vacant.



Concepción City Center: Collapsed grain bins have been removed but not yet replaced as shown in these two images taken in March and December of 2010. The 20-story residential tower in the background remains vacant. The right photograph includes the toppled Rio Alto tower (in the circle) which is still under investigation.

The region is home to important industries such as: fishing, shipping (ports), power generation, petroleum refining, and forest products. Some waterfront operations suffered extensive damage due to soil liquefaction and tsunami. Further inland, there are examples of relatively modern plants that sustained limited structural damage, but incurred significant business interruption losses due to damaged critical plant equipment or utilities (transformers, cooling towers, or turbines). Before returning to service, many such components or systems require post-event inspections and testing. Repair or replacement of specialized parts may take months to complete.

Most of Chile's central coast communities were affected by tsunamis that followed the February earthquake. In Talcahuano, a bayside community located directly north of Concepción, town center buildings housing important municipal and community operations were still in the midst of cleanup and repair from water and ground-shaking damage. Many streets were blocked off for reconstruction of pavement and underground utilities, as pre-Christmas street commerce was attempting to cope at the time of our visit. A new school (replacing a damaged and flooded waterfront campus) was due to open on an elevated site, just in time for the new school year which begins in March in Chile. Before the earthquake, Isla Rocuant's industrial zone housed an enclave of thriving fish processing plants. In December, post-tsunami cleanup continued and only a few plants were operating. The local fishing fleet looked depleted. On the other hand, the container shipping business at the nearby port of San Vicente appeared to have recovered.



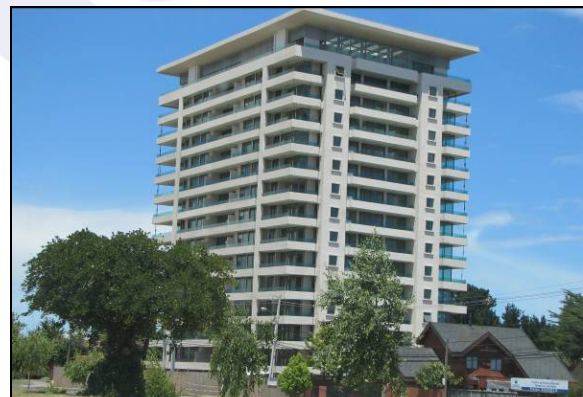
Street and utility reconstruction in Talcahuano city center is evident throughout the low-lying areas of this community.



Low-lying areas of Port of Coronel (south of Concepción) are surrounded by newly constructed flood walls.

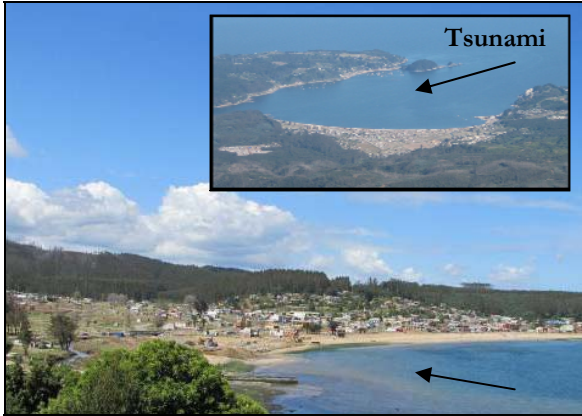


San Vicente Bay's industrial zone is recovering. A fish-processing plant (circled area) has been demolished.



Damaged condominium tower in San Pedro still stands vacant. Corner balconies remain shored up.

Further north along the coast lies Dichato, a beachfront community that once bustled with lively restaurants and shops along its crescent-shaped beach. Today, the waterfront feels like a ghost town. The devastation is reminiscent of coastal communities in the United States following Hurricane Katrina in 2005. It will be years before communities like Dichato will find their new future. Meanwhile, the displaced residents hang on. Some live in sterile fast-track or temporary housing that lacks the former appeal.



Panoramic view of the Dichato waterfront community devastated by the tsunamis that followed the earthquake



Fast-track community of wood-framed housing for residents displaced by tsunamis

Bío-Bío River (Chile's longest) bisects Chile as it flows from the Andes and empties into the Pacific Ocean near Concepción. Functioning river crossings (highway and rail) are of vital regional economic importance. The reconstruction of Concepción's highway bridges represents one of the success stories in the aftermath of the February earthquake. The Juan Pablo II Bridge, a two-kilometer-long four-lane highway crossing, sustained major damage to its foundations and columns due to soil liquefaction. This bridge was re-opened to traffic in October. Regional transportation system repairs are evident throughout the area as work continues on stabilizing bridge embankments and slopes along roadways.



Juan Pablo II Bridge damaged in the February earthquake was restored to service in October 2010. This photo from March 2010 illustrates some of the bridge foundation damage as evidenced by the sagging roadway.



The photo on the left shows Juan Pablo II Bridge fractured column caused by soil liquefaction and lateral spreading along the Bío-Bío riverbank. The photo on the right depicts the new bridge girder and columns.

EARTHQUAKE IMPLICATIONS

Chile is making headway in rebuilding its heartland following a massive subduction zone earthquake that affected modern structures as far away as Santiago (335 km from the epicenter). However, the recovery from a major earthquake need not be a lengthy process. Organizations with earthquake exposures can learn from this event and should consider proactive steps to enhance safety, reduce damage, and minimize downtime.

- Review business recovery plans to include dedicated resources (contractors, suppliers, and engineers).
- For existing operations, assess earthquake risks (buildings, contents, and critical lifelines) and identify specific areas of improvement relative to safety and business risks.
- For proposed construction, perform independent design reviews to verify the desired seismic performance. Building codes tend to focus on occupant safety rather than limiting damage in a major earthquake.
- Verify seismic restraint of equipment and contents. This is a cost-effective method of loss control.

MRP ENGINEERING SERVICES

MRP Engineering is a structural engineering and risk analysis firm (based in metropolitan Seattle, Washington) and provides proactive risk analysis for natural hazards, damage investigation, and upgrade design. We assist clients to protect their business operations from risks to physical assets resulting from extreme events such as earthquakes and hurricanes. Our philosophy is to listen to your needs and then provide you with practical and cost-effective structural engineering-based risk reduction solutions. For further information contact us via email at admin@mrpengineering.com.