

IMIA Short Paper on Chile's Earthquake

Provided by Mapfre Global Risks (Madrid)

This document has been prepared for IMIA and it describes the main aspects of the earthquake that occurred in Chile on 27 February 2010. The following points are developed in this document:

- 1) Brief introduction to earthquakes.
- 2) General information on the Chile earthquake.
- 3) The impact of the earthquake in Chile from the social, economic and insurance viewpoints.

1) Introduction. What are earthquakes?

An **earthquake** is a shaking of the ground that is generated by the collision of tectonic plates and the release of energy in the course of a sudden reorganisation of materials of the earth's crust when the state of mechanical equilibrium is exceeded.

The origin of earthquakes is found in the accumulation of energy that is produced when the materials of the earth's interior are displaced, seeking equilibrium, from unstable situations that are mainly the result of volcanic and tectonic activity, mainly occurring at the edges of the plate.

The point inside the earth where the earthquake occurs is known as the seismic focal point or **hypocentre** and the point on the surface that is directly vertically above the hypocentre and therefore the first place affected by the tremor is known as the **epicentre**.

Magnitude is a parameter that indicates the relative size of the tremors and it is therefore related to the amount of energy released at the tremor's source. It is a single parameter that does not depend on the distance from which it is observed. The scale that is most frequently used in Spain is the Richter scale. Said scale of magnitude is logarithmic, in other words each whole number in the scale represents an amplitude ten times larger than the earthquake described by the preceding digit.

As distinct from magnitude **intensity** is a variable parameter that describes the effects that a tremor causes on society and its structures. To determine intensity the effects perceived by people are considered as well as the damage caused by the tremor in the structures and the surroundings. As distinct from magnitude, which has a single value for any given tremor various intensities will exist, depending on the place where it is being observed. The geological conditions of the place of observation play a very significant role in the intensity of a tremor. In places with soft soil or in sedimentary surroundings the intensities can be two or three times higher than those observed in terrain of solid rock. The scale of intensity that is most used is the Mercalli scale.

The seismic movement spreads through elastic waves (similar to sound waves) starting from the hypocentre. Seismic waves occur in three main types:

- **Longitudinal waves, primary or P:** a type of body wave that spreads at a speed of between 8 and 13 km/s and in the same direction as the particles' vibration. They circulate through the earth's interior, passing through both liquids and solids. These waves are the first to be registered in the earthquake measuring equipment (seismographs).
- **Transversal waves, secondary or S:** these are body waves, slower than the previous ones (between 4 and 8 km/s) and they spread in a perpendicular direction to the direction of the particles' vibration. These waves only pass through solids and are the second to be recorded in the measuring apparatus.
- **Superficial waves:** these waves are the slowest of all (3.5 km/s) and are the product of the interaction between P and S waves throughout the earth's surface. These waves are the ones that cause most damage. They spread starting from the epicentre and are similar to the waves that are formed on the sea's surface. These types of waves are the last to be registered by the seismographs.

When a fault slips, generating an earthquake, the seismic waves spread in all directions, causing vibrations, firstly of very high frequency (body and transversal waves) and then low frequency (superficial waves). As a result buildings also vibrate. If these constructions cannot withstand the vibrations they suffer damage.

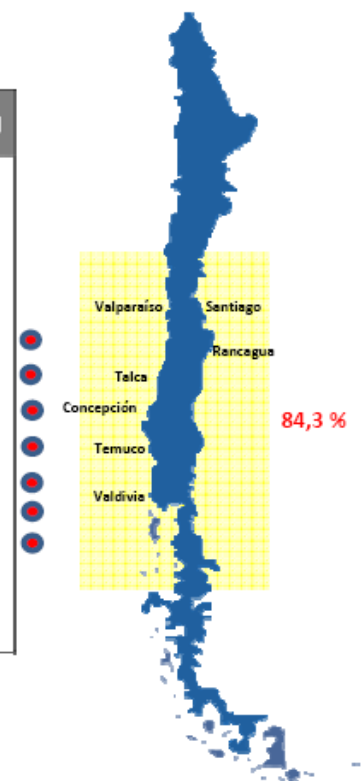
The compressed and transversal waves, of high frequency, cause most damage to low structures and the superficial waves (low frequency) cause more damage to high buildings and structures. Low frequency waves have larger amplitude and therefore they can cause damage in high buildings at a significant distance from the earthquake's focal point.

2) General information on the Chile earthquake.

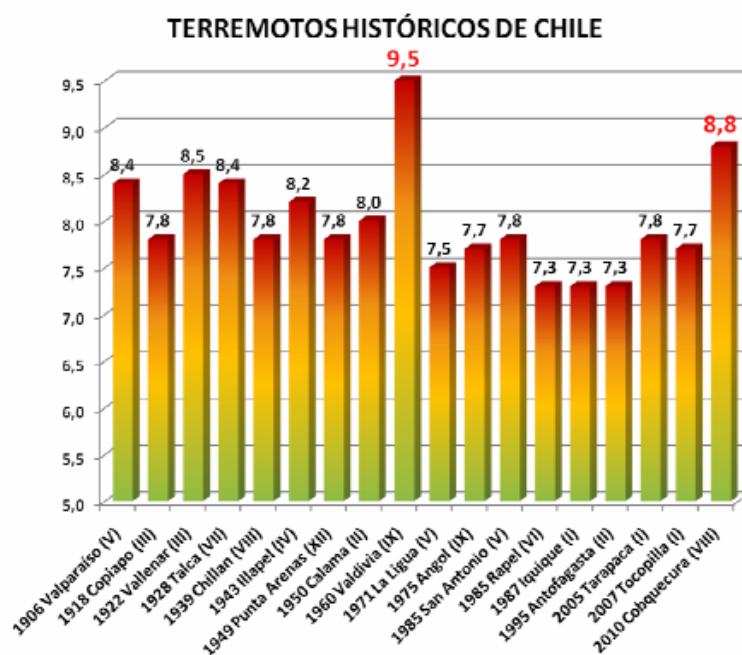
The 2010 Chile earthquake occurred at 03:34:17 local time on Saturday 27 February 2010 reaching a magnitude of 8.8^o on the Richter scale. The epicentre was located in the Sea of Chile, opposite the towns of Curanipe and Cobquecura, about 150 kilometres to the north west of Concepción and 63 kilometres to the south west Cauquenes, at a depth of 47.4 kilometres below the earth's crust. The earthquake had a duration of about 2 minutes and 45 seconds at least in Santiago. It was felt in most of South America with diverse intensities, from Ica in Peru to the north as far as Buenos Aires and São Paulo in the east.

The zones most affected by the earthquake were the Chilean regions of Valparaíso, Santiago Metropolis, O'Higgins, Maule, Biobío and La Araucanía, which have an accumulated population of more than 13 million people, nearly 80% of the country's population. In the regions of Maule and El Biobío the earthquake reached an intensity of IX on the Mercalli Scale, flattening a large part of cities like Constitución, Concepción, Cobquecura and the port of Talcahuano. In the regions of La Araucanía, O'Higgins and Santiago metropolis the earthquake reached an intensity of IIX, causing significant destruction in the capital, Santiago de Chile, Rancagua and rural townships. The fatal victims of the earthquake numbered approximately 500 dead. Approximately 500,000 dwellings were severely damaged and it is estimated that a total of 2 million people were affected in the worst natural tragedy lived in Chile since 960. The president, Michelle Bachelet, declared "catastrophic state of constitutional exception" in the regions of Maule and Biobío.

REGIONES	INTENSIDAD TERREMOTO	TSUNAMI
XV ARICA Y PARINACOTA	2	
I TARAPACÁ	2	
II ANTOGASTA	2	
III ATACAMA	3	
IV COQUIMBO	3 - 4	
V VALPARAÍSO	8	✓
XIII METROPOLITANA	8	✓
VI LIBERTADOR BERNARDO O'HIGGINS	8	✓
VII MAULE	8	✓
VIII BÍO BÍO	8,8	✓
IX ARAUCANÍA	8	✓
XIV LOS RÍOS	7	
X LOS LAGOS	6	
XI AYSÉN DEL GENERAL CARLOS IBAÑEZ DEL CAMPO	6	
XII MAGALLANES Y LA ANTARTICA CHILENA	5	



The earthquake is considered as the second strongest in the history of the country and one of the five strongest recorded by humanity. On a national level it is only exceeded by the cataclysm of the Valdivia earthquake in 1960, the one with the highest intensity recorded by man using seismometers. The earthquake in Chile was 31 times stronger and released nearly 178 times more energy than the devastating earthquake that occurred the month before in Haiti. The released energy is close to 100,000 atom bombs like that of Hiroshima in 1945.



After the earthquake replicas started to be felt of various localised intensities throughout the country. As at 3 March 2013 replicas that exceeded 4.9 degrees of magnitude had been recorded. The strongest occurred less than 2 hours after the main event and reached a magnitude of 6.9.

As a result of the earthquake a strong tsunami hit the coast of Chile, destroying various townships that were already devastated by the telluric impact. The archipelago of Juan Fernandez, despite not feeling the earthquake, was hit by the waves that flattened its only town, San Juan Bautista. The tsunami alert generated for the Pacific Ocean was later extended to 53 countries located throughout most of its basin, reaching Peru, Ecuador, Colombia, Panamá, Costa Rica, Nicaragua, the Antarctic, New Zealand, French Polynesia and the coasts of Hawaii.

Due to the underwater location of the epicentre and its proximity to the coast a large part of the devastation was caused by the tsunami associated with the seismic movement on coastal regions. This mass of rapidly travelling water hit the coasts of Chile in a matter of a few minutes, reaching the towns on the coast in the regions of Maule and El Biobío. In Constitución the seaquake's first waves arrived about half an hour after the main earthquake and according to witnesses the wave was more than eight metres high. Some minutes later it was followed by a second even stronger wave with a height of about ten metres and finally a third one, similar to the first. The sea went inland as far as places like Pelluhue and Curanipe, exceeding 150 metres inland in Pichilemu, Iloca, Duao and up to 200 metres in Coi Coi. In the post of Talcahuano waves of up to 5 metres flowed into the city centre and the sea level rose by 2.4 metres. The port of Valparaíso sustained an increase of 1.7 metres in the ocean level.



3) Impact of the earthquake in Chile from the social, economic and insurance viewpoints.

Social impact:

The earthquake's effects due to its high magnitude were devastating. A large part of the towns in the regions of Maule and Biobío were completely destroyed. The day after the disaster official sources estimated that half a million homes had been destroyed and at least another one and a half million houses were damaged to some degree. The

earthquake was felt with force by nearly 80% of the population, leaving an estimated two million people affected (more than 10% of Chile's population).

According to official Ministry of the Interior data the number of people killed as at 8 March was close to 500.



During the first days after the earthquake the basic services such as water, electricity and communications were cut off. Minutes after the earthquake occurred thieving and pillaging took place in buildings and houses in various affected cities, particularly those that had suffered most damage. Certain individuals took advantage of the fact that homes were damaged, walls had fallen down, owners had fled to a safer place and the absence of police presence, particularly following the collapse of many barracks and police stations. This situation forced the government of Chile to impose a curfew during the first few days until the situation slowly returned to normal.

Following the disaster the population of Chile has generally shown incredible solidarity and enormous will to continue with "normal" life. A large part of the population expresses extreme solidarity, (it is normal to see signs or graffiti with the words "cheer up Chile", "Chile will rise again" etc).



Fortunately the event occurred during the weekend and very early in the morning. This circumstance meant that the personal injuries and death toll were less than they could have been, because at that time of night most of the affected public installations were practically empty (airports, schools, libraries, shopping centres, etc). In addition, from the human viewpoint it was important that families were together at the time of the earthquake.

Where human resources are concerned the majority of workers are working 24 hours a day if necessary to help their companies recover the normal rhythm. Hundreds of families depend directly or indirectly on some affected companies and therefore it is fundamental for them to recover the activity as soon as possible (in order to prevent an irreparable loss of market share). This is why the workers have not hesitated to offer working double shifts voluntarily right from the beginning.

Where material and technical means are concerned strong optimism exists as to the companies' ability to respond where reconstruction is concerned.

Economic impact:

It is estimated that the total impact on the economy of Chile will vary between 15,000 and 30,000 million USD (Eqecat).

It is estimated that the number of dwellings destroyed is 500,000 and the number of dwellings with some degree of damage reaches 1,500,000.



Regarding buildings, according to the Chamber of Construction of Chile one hundred buildings were affected and 10 collapsed (0.1%).



It is estimated that the transport infrastructure damage will reach US\$1,200 million (Ministry of Public Works) mainly affecting airports, reservoirs, canals, aqueducts and more than 100 kilometres of roads and bridges.



The most affected industries have been:

- AGRICULTURE: 75% of the agricultural GDP is in the affected zone (fruit, cereals, rice).
- WINE MAKING: 20% of the production compromised.
- FORESTRY (paper making): stoppage of mills during various months.
- FISHING: Stoppage. 25% of the installed capacity rendered useless.
- COMMERCE: Reduction in sales of durable goods.



It is estimated that rebuilding will cost in the region of US\$6,000 million in housing, US\$4,000 million in health, US\$3,000 million in education and US\$ 1,200 million in transport infrastructure.

Business opportunities have arisen in the mining sector (increase in the price of copper), construction and associated industries, property (sale of new dwellings), insurance (incentive to buy insurance). The growth forecast before the earthquake was 4% and after the earthquake it is between 5 and 5.5%.

Impact on the insurance sector:

It is estimated that the losses suffered by the insurance sector as a result of the Chile earthquake will be between 5,000 and 10,000 million USD.

Hardening of the conditions for earthquake cover in Chile has started to be noted, materialising in:

- Application of lower sublimits for earthquake cover.
- Increase in deductibles: the current deductibles are 2% of the sum insured for industrial risks, frequently with a maximum limit. It is expected that in zones of maximum earthquake exposure the deductible will be increased and the applicable maximum limit will disappear.
- Premium increases.
- Exclusion of claims derived from earthquake (possible hidden damage).
- Restrictions on suppliers and customers cover (named, direct, Flexa cover, etc).

The official regulations issued in Chile established 30 April as the limit date for reporting damage caused by the earthquake. An enormous effort has been made by the insurance companies to handle such a large number of claims in such a short time.

Claims Reported by Region

Region	Capital	Claims	Inspected	Paid
Santiago Metropolitan	Santiago	57,903	18,831	3,912
Valparaiso	Valparaiso	8,238	2,242	305
O'Higgins	Rancagua	5,564	644	118
Maule	Talca	5,698	1,366	192
Biobio	Concepcion	21,061	5,062	631
Araucania	Temuco	2,601	633	63
Los Rios	Valdivia	166	412	7
Total		101,231	28,819	5,228

Source: SVS

Note: Claims data reported as of March 31st

The following table shows the largest facultative losses in excess of 40 million USD. As one can see the largest claims have affected major industries and infrastructures, in respect of both Material Damage and Loss of Profits.

Company	Industry	Estimated Loss (USD millions)	Type of Loss
Grupo Arauco	Pulp Producer, Plywood Manufacturer and Saw Mill.	400 to 600	Approximately 65% of the loss is from business interruption
Grupo Quinienco	Brewery, Winery and Manufacturing	300	60% from business interruption
Cintra	Infrastructure - Highway	200	Primarily physical damage
CMPC	Pulp and Paper Manufacturer	170	60% from business interruption
D&S (WalMart Chile)	Retail Stores	150	Primarily physical damage
ENAP	Oil and Gas	150	Evenly distributed between physical damage and business interruption
CAP	Steel Mill (Huachipato Plant)	140	60% from business interruption
Empresas Portuarias de Chile	Ports	140	Primarily physical damage
Viña Concha y Toro	Winery	110	Evenly distributed between physical damage and business interruption
Telefónica	Communications	100	Primarily physical damage
Grupo Claro	Winery, Communications - TV channel, Bottler	84	Evenly distributed between physical damage and business interruption
FFAA – Fuerzas Armadas	Armed Forces	72	Primarily physical damage
Censosud	Retail	72	Primarily physical damage
Carozzi	Food Manufacturer	60	Primarily physical damage
Pesquería el Golfo	Fishing	50	Primarily business interruption
SCL - Santiago Airport	Infrastructure	40	Primarily physical damage
Fallabella	Retail - Largest chain of retail stores in Chile	42	Primarily physical damage

Source: Aon Benfield Analysis