CoreLogic

The U.S. Earthquake Model

Delivered through RQE and Oasis Loss Modelling Framework

A Comprehensive Analytic View of Risk

Earthquakes have the potential to cause major loss and disruption to society. Damage caused by earthquakes can be catastrophic and can have both a human and financial impact. Earthquakes cause ground motion and displacement of the earth's surface, resulting in damage to the built environment, including buildings and their contents.

This damage—and the time it takes to repair it— results in financial losses to earthquake risk managers. The U.S. Earthquake Model from CoreLogic® offers a solution to aid in managing the financial consequences of earthquake risk.

30 Years of Experience

With over 30 years of experience in building earthquake catastrophe model solutions, the CoreLogic U.S. Earthquake Model has seen many iterations, with the current model based on the latest scientific consensus of earthquake hazard, engineering, and building practices.

The CoreLogic U.S. Earthquake Model offers a comprehensive analytical view to quantify the risk to a specific building or portfolio resulting in the allocation of appropriate pricing and capital reserves.

Comprehensive Earthquake Methodology

CoreLogic uses a bottom-up, physics-based approach to model earthquake losses, based on established principles of seismology, geology, geophysics, structural engineering, statistics and other related fields.

The model components are separated into three modules:

- Hazard
- Vulnerability
- Financial

Key Benefits

- Time-dependent recurrence frequency model
- Explicitly models damage due to liquefaction and earthquake-induced landslide
- Includes sophisticated modeling of deep sedimentary basins in California, Washington and Utah
- Includes Fire Following and Sprinkler Leakage sub-perils
- Offers a competitive advantage with sophisticated capture of correlation and uncertainty at the site level
- Validated with extensive claims data from historical events
- Transparent modeling process with breadth of documentation support to assist with regulatory requirements
- Enables confidence in risk management-based decisions

Seismotectonic Hazard Model

Incorporates the latest published science from the U.S. Geological Survey (USGS) 2018 National Seismic Hazard Mapping Project (NSHMP) for the continental U.S., in addition to the 2015 Uniform California Earthquake Rupture Forecast, Version 3 (UCERF3) prepared by the Working Group on California Earthquake Probabilities (WGCEP). These two datasets form the basis of the comprehensive seismic source model of the U.S. Earthquake Model.

For the seismotectonic model, each seismic source and its associated events are defined by:

- Location/depth/fault mechanism
- Geometry/fault area
- Magnitude-frequency relationship
- Minimum and maximum magnitudes

Time-Dependent Frequency Model

Modeled losses for earthquakes are significantly influenced by recurrence frequencies associated with large earthquakes in the stochastic event set. As a leader in the market, CoreLogic has implemented time-dependent recurrence frequencies when available since 1997 as they reflect the scientifically-accepted physical mechanism of stress build-up on faults caused by tectonic plate forces.

In regions such as California and the Pacific Northwest where large earthquakes are more frequent, time dependence represents not only the definitive scientific consensus—it also portrays risk within the foreseeable future, not just the theoretical long term.

Ground Motion Modeling

Ground motion intensity defines the hazard to a building, and this intensity changes as seismic waves travel outward from an earthquake rupture area. The U.S. Earthquake Model utilizes Spectral Acceleration (SA) as the hazard parameter to define ground motion intensity. An event footprint is calculated using ground motion prediction equations (GMPEs) and adjusted to local site conditions using site amplification and sedimentary basin response factors; and a site deformation model, which calculates the probability of deformation of the earth's surface due to liquefaction and earthquake-induced landslide.

As based on the 2018 NSHMP hazard model, multiple GMPEs are used to capture epistemic uncertainty with rock as a reference site condition. Multiple, weighted GMPEs are implemented for each of the following tectonic domains:

- California and Western U.S.: Active Shallow Crust
- Cascadia Subduction Zone: Subduction Interface
- Pacific Northwest: Subduction Intraslab
- Central and Eastern U.S.: Stable Continental Crust

Sedimentary Basin Response

This term is in addition to the standard shallow site factors that have typically been used to incorporate site effects and is used to capture additional three-dimensional wave-propagation effects. CoreLogic have employed this basin response in its ground motion model for the last 6 years. With the latest release, basin modeling has been updated as per 2018 NSHMP, covering California, western Washington and Salt Lake City region, accounting for their unique wave propagation effects.

Liquefaction and Landslide Hazard

The catastrophic sequence of earthquakes in the Canterbury region of New Zealand in 2010-2011 demonstrated the potential major impact of soil liquefaction in an earthquake. Although regions that are subject to major liquefaction potential are relatively rare, they can inordinately contribute to earthquake losses. Earthquake-triggered landslides can also have a large impact on losses if they occur in a heavily urbanized area. Based on the potential impact in the U.S., the U.S. Earthquake Model uses the Peak Ground Acceleration (PGA) hazard parameter to calculate and include both liquefaction and landslide hazard in the calculation of earthquake losses.

Vulnerability Informed by Engineering

CoreLogic uses an engineering approach, claims data, and expert opinion to develop the vulnerability functions within the model based on observed loss data, experimental research, and structural calculations performed by CoreLogic engineers.

The CoreLogic U.S. Earthquake Model incorporates vulnerability curves that are well-honed from thousands of seismic studies conducted by CoreLogic and its affiliated engineers over the past 40 years and are additionally founded on first-hand observations from more than 90 earthquakes worldwide.

Vulnerability is also calibrated to tens of thousands of claims and exposure data points from the Northridge (1994) and Loma Prieta (1989) events.

Multiple-Parameter Wood-Frame Residential Vulnerability

For residential structures, CoreLogic represents vulnerability using a three-dimensional surface to capture the phenomenon of damage acceleration—the more damage that occurs during a given earthquake, the more damageable a building becomes. By estimating damage from multiple input parameters rather than a spectral acceleration at a single period, the model more accurately reflects the reality evidenced by data from thousands of claims.

Informed Defaults for Building Foundations

For wood-framed houses, the most significant susceptibility driving earthquake damage is the foundation type, and particularly its connection to the structure above. For California, where the majority of U.S. earthquake risk is located, CoreLogic incorporates ZIP Code-level default values for foundation type, based on data made available in aggregate form by the California Earthquake Authority (CEA), for whom the U.S. Earthquake Model from CoreLogic is the selected model.

High-Fidelity Financial Modeling

The financial model is a full simulation model that includes sampling events to calculate and preserve uncertainty and correlation in the losses. 3G Correlation from CoreLogic is based on multiple features of locations: height, structure, age, occupancy, coverage abd distance. This allows for superior risk differentiation across portfolios.

Perils Covered

In addition to calculating losses from ground shaking, including damage due to liquefaction and earthquake- induced landslide, the U.S. Earthquake model covers associated perils, where insurance conditions can be captured by sub-peril.

- **Fire Following Earthquake:** Conflagration— widespread, uncontrollable fire that is initiated by an earthquake—can be the primary agent of damage. The model incorporates a ground-up methodology to model the physical mechanism of conflagration, ignition, spread, and suppression.
- **Sprinkler Leakage:** Water damage to contents from sprinkler leakage can exceed shaking contents damage. The model accounts specifically for the resulting sprinkler leakage losses.

Flexible delivery in RQE and Oasis Loss Modelling Framework

CoreLogic's US earthquake model can be deployed in either CoreLogic's proprietary Catastrophe Risk Platform – RQE, and in the Oasis Loss Modeling Framework where the Oasis implementation of the model preserves our loss simulation at the Ground Up Loss Level.

Adoption of the Open Exposure Data (OED) format

With a full suite of representative structure types and occupancy categories for each line of business, the model differentiates risk across hundreds of combinations. CoreLogic has adopted the Open Exposure Data (OED) format that allows importing of these defined exposure fields, including structure & occupancy types, and secondary modifier characteristics.

Catastrophe Risk Management from CoreLogic offers a comprehensive look at risk by evaluating probable events and verifying current and post event impacts.

Why Consider CoreLogic?

Increasing catastrophic events are challenging the P&C insurance industry to revisit existing catastrophic risk management and loss adjustment strategies by improving the overall understanding of all natural hazards. CoreLogic is dedicated to the science of understanding natural hazard risk and focused on delivering decision support data and products to the insurance industry. With a staff of Ph.D.-level scientists and engineers, we have taken risk assessment a step further by developing a proprietary methodology that enables a more granular level of risk management control and reporting.

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