PERILS ALL AROUND
AN OVERVIEW OF WC EARTHQUAKE AND HAZARDOUS FACILITY EXPOSURE

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Chris Ramarui
Senior Vice President

Chicago
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Earthquake Topics

• The risk of a catastrophic workers’ compensation loss arising from a large earthquake is not well understood, or even recognized. This session will provide an overview of the science, experience, and risk mitigation of these extreme events.

• Areas of focus:
  – Earthquake hazard
  – Building vulnerability
  – State of modeling
  – Mitigating risk

• As it pertains to workers’ compensation insurance
Earthquake Statistics

• Number of Earthquakes in the United States for 2000 - 2012
Located by the US Geological Survey National Earthquake Information Center

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• Great San Francisco Earthquake of 1906
  – If the same event happened today during a workday
    - Consensus is that this would cause a several-billion dollar WC loss
Earthquake - *Hazard*

Faults

U.S. Geological Survey

*in Google Earth*

(Historic, Holocene to Latest Pleistocene, Late Quaternary, Mid to Late Quaternary, Quaternary)
Earthquake - *Hazard*

**Background Seismicity**

- In addition to known faults, there is **background seismicity**
  - Unknown faults
  - Ancient faults
  - Uncertainty in location
  - Intraplate strain and stress
  - ?

- **Earthquakes can happen anywhere**

- **For many areas in the U.S., background sources are the only contributor to earthquake hazard**
  - Frequency of these earthquakes tends to be very low

*Earthquakes induced by human activity are not considered here*
Earthquake - *Hazard Footprint*

- **Footprint Factors**
  - Rupture type and length
  - Magnitude
  - Depth
  - Duration
  - Attenuation
    - Decrease in wave strength as it moves away from epicenter

- **Earthquakes in the Eastern part of the country tend to have larger footprints than earthquakes in California**
Earthquake - *Hazard*

Local Conditions

- **Local Factors**
  - Soil amplification
    - Soft soils amplify ground shaking
  - Liquefaction potential
    - A process by which water-saturated sediment temporarily loses strength and acts as a fluid
  - Landslide potential
    - Movement of surface material down a slope
  - Slope
    - Damage potential for structure

*U.S. Geological Survey*
Earthquake - *Hazard*

**Frequency**

- Frequency is another component of the hazard
- *What is the annual probability of a given earthquake event happening?*

- **Known faults**
  - Do we know the general rate of recurrence?
  - Time-dependent
    - Tectonic loading - Faults more likely to rupture as time goes on, and less likely after an earthquake

- **Background seismicity**
  - Low frequency
  - Gutenberg–Richter law
Earthquake - *Hazard*

Associated Perils

- **Fire**
  - Conflagration
- **Flood**
- **Landslide**
  - Direct injuries
- **Tsunami**
  - In vulnerable regions
  - Tohoku Earthquake and Tsunami, March 2011
    - Magnitude 9 (thought impossible for that fault)
    - > 16K fatalities (the majority due to the Tsunami)
    - Fukushima nuclear power plant meltdown

Associated perils represent significant casualty risk, yet our current modeling capabilities are even less advanced than those for earthquake (or even non-existent)
Earthquake - *Hazard*
Injuries from Shaking

- How are people injured in an earthquake?
  - Falling items or debris
  - Rescue and recovery
  - Accidents
  - Exposure to hazardous substances
  - Infrastructure (gas explosions, falling power lines, bridge collapse, etc.)
  - **Full or partial building collapse**
    - Potential for large number of casualties
Earthquake – *Building Vulnerability*

**Building Characteristics**

- **Structural system**
  - Seismic design characteristics
  - Example
    - Unreinforced masonry rare on the West Coast

- **Year of construction**
  - Building codes have become stricter over the years (and after events)
  - Retrofitting of older buildings

- **Building height**
  - Figures into the buildings natural period
    - Resonance with ground motion frequency
Earthquake – *Building Vulnerability*

**Earthquake Clustering**

- Multiple earthquakes can strike the same region
- Buildings could be weakened in a foreshock
  - More susceptible to mainshock (or aftershock)

*Christchurch, New Zealand Earthquake, Feb. 2011*

Nearby earthquake in Sep. 2010 damaged buildings prior to Feb. 2011 quake

*NASA Earth Observatory*
Earthquake – *State of Modeling*
Exposure Data Availability and Quality

- Generally, workers’ compensation exposure data quality is behind that of property
  - Property exposure was the focus of modeling originally
    - Especially after Hurricane Andrew
  - More difficult to capture modeling data for WC
    - Many applications forms do not capture the data necessary for modeling

- **Garbage in; garbage out**

- *Progress is being made*
Earthquake – *State of Modeling*

Exposure Data - Minimum

• **By location:**
  – Employee count
    - Or payroll
  – High-resolution geocoding information
    - Street address
    - Latitude/longitude coordinates
  – Occupancy/occupation information
    - Class codes, SIC codes, NAICS codes, etc.
  – Shift information
    - Or other indication of employee presence
  – Building construction
  – Year of construction
  – Building height
  – If excess policies: policy terms
Earthquake – *State of Modeling*
Importance of By-Location Exposure Data

**By-location data is not always available:**
- Policy-level or headquarters
- Industries where employees are generally off-site
  - Staffing agencies
  - Construction
- Campus locations
  - Where multiple buildings are assigned one address
    - University campuses
    - Hospital campuses

**By-location data is important:**
- Proximity to the earthquake event
- Diversification credit for having employees spread amongst locations
Earthquake – *State of Modeling*
Importance of Employee Presence / Shift Data

- In the absence of shift data, or maximum employee presence, models tend to weight the weekday shifts heavily
  - Resulting in higher tail-end loss estimates
    - Weekday earthquakes

- Some risk types tend toward more evenly-distributed shifts
  - Examples:
    - Universities
    - Hospitals
  - Capturing or estimating shifts may:
    - Increase loss estimates for night/weekend earthquake events
    - Decrease loss estimates for tail-end events
    - (Weekday events tend to drive the tail)
Earthquake – *State of Modeling*

Other exposure Data

- Structural type and year of construction
  - Can reflect strong underwriting standards

- User-defined injury cost estimates
  - Direct effect on overall loss estimates
  - Confidence in these estimates?

- Premium
  - Useful after modeling
    - Evaluate policies
    - Portfolio management
Earthquake – *State of Modeling*
Uncertainty in Workers’ Compensation Modeling

• Workers’ compensation earthquake modeling is subject to the same uncertainties as property modeling

  – Hazard
    - Magnitude, attenuation, soil conditions, liquefaction and landslide
    - Example:
      - Tohoku magnitude 9 earthquake
      - Maximum magnitude of 8?
  – Vulnerability
    - New designs
    - Substandard construction quality
  – Accuracy of exposure data

But WC modeling is also subject to additional uncertainties not seen in property modeling…
Earthquake – State of Modeling
Uncertainty in Translating Building Damage into Injuries

• Many workers compensation earthquake models are extensions of property models
  – Design codes save lives by resisting collapse
    - In a property model, a building may be a total loss and:
      1. Collapse (partial or full)
         Resulting in large number of casualties
      2. Remain standing
         Condemned and demolished
         But few casualties
  – This adds another layer of uncertainty when modeling workers’ compensation risk
Earthquake – *State of Modeling*
Uncertainty in Employee Presence

• **How many employees are present during the event?**
  – During workday
  – At night
  – During the weekend

• **Buildings don’t move; people do!**

• The time of earthquake occurrence, and presence of insured employees, is a major factor in estimating losses
  – This is yet another layer of uncertainty in WC modeling
  – Tends to be highly correlated across a portfolio
Earthquake – State of Modeling
Uncertainty in Injury Costs

• How much will injuries cost?

• Very little historical precedents
• Not enough information on insureds
• Post-event trends and political environment
Earthquake – *State of Modeling*
Implicitly Modeled Sources of Loss

- **Models tend to model only certain factors explicitly**
  - Earthquake shaking
- **But other hazards and sources of loss exist**
  - Falling items or debris
  - Rescue and recovery
  - Accidents
  - Exposure to hazardous substances
  - Infrastructure (gas explosions, falling power lines, bridge collapse, etc.)
- **These may be *implicitly* included**
  - By calibration using claims data
  - *However, there are less historical precedents for WC earthquake losses than for property, and claims data may be difficult to collect*
Earthquake – *State of Modeling*
Model Uncertainty is a Challenge

• **Greater uncertainty than property modeling**
  – Model output has less explanatory power

• **BUT, uncertainty is a valid concern**

• **Example:**
  – Christchurch, New Zealand earthquake of 2011
    - Half of fatalities from one building collapse
      - If it had not collapsed, much lower casualties
      - If another had collapsed, much higher casualties
    - Shallow earthquake; higher damage
    - Previous damage from earlier earthquake; higher damage
    - Questionable structural integrity; higher damage
    - Occurred during a workday; higher casualties
Earthquake – *Risk Mitigation*

**Challenges in Risk Mitigation**

- Generally compulsory earthquake coverage
  - As opposed to property earthquake policies
- Claims are not limited in the way that property policies are
- Hazard group information is not necessarily indicative of earthquake catastrophe risk
- Catastrophe reinsurance
  - Maximum Any One Life
- Portfolio management
  - Managing aggregations
    - Localized
    - Area
  - Policy underwriting risk
Earthquake – Risk Mitigation
Managing Aggregations

• Drivers of tail earthquake loss
  – West: Exposure aggregations around faults
    - Because of high frequency of known fault events
  – East: Exposure aggregations
    - Because of background seismicity possibilities everywhere

• Managing fault exposure not practical
  – Geographic areas
    - CRESTA zones
    - State
    - County
Earthquake – Risk Mitigation
Underwriting

• Examine:
  – Construction / structural system
  – Year of construction
  – Building height

• Detailed information on:
  – Number of employees
  – By location
    - High-resolution geocoding data
    - Placing of employees
  – Employee presence / shift information

• Faults and seismicity of the area
Earthquake – *Risk Mitigation*

Other Measures

• Catastrophe reinsurance
  – May have Maximum Any One Life Clause
  – Consider Per-Person Excess cover

• Remember
  – Some rating agencies may look at earthquake loss potential

• Model your portfolio
  – Understand the results
  – Gain insights into managing catastrophic risk potential
Section #2

HAZARDOUS FACILITY RISK
THE ELUSIVE SIDE OF INDUSTRIAL ACCIDENT
Hazardous Facility Risk
Industrial Accident

• Industrial accident catastrophes are a well-known risk
  – Information about insured facilities is readily available
  – Critical information gathered in the underwriting process
  – Premium can be gauged against this risk
Hazardous Facility Risk
Catastrophe Types

• Explosion / Fire
  – Central explosion
    - Blast strongest in epicenter, dissipates as it moves outward
  – Chain reaction
    - Gas or liquid build-up in surrounding area
    - Nearby facilities

• Chemical release
  – Gas clouds
  – Liquids

• Collapse
  – Buildings or mines
Hazardous Facility Risk
Injuries from Large Industrial Accidents

• Injuries from large industrial accidents may potentially be larger claims than typical WC claims
  – Burns
  – Chemical burns
  – Other trauma

• New and costly treatments are available
  – High tech skin grafts

• Moreover, likely correlation of injury types and claims costs across a large number of injured employees
Hazardous Facility Risk
Texas City Explosion, 1947

• Worst industrial accident in U.S.

• Fertilizer cargo ship

• In port
  – Other industrial facilities nearby
  – Caused chain reaction
    - Oil refineries and storage tanks
    - Chemical plants
    - Subsequent fires and explosions
  – > 4,000 injuries (with > 500 fatalities)

NBC News, April 18, 2013
Hazardous Facility Risk
Injuries from Large Industrial Accidents

• Insurers of industrial facilities are aware of the type of its risk
  – Through underwriting process

• But what about insurers of nearby locations?
  – Are they aware of the potential risk posed by adjacent facilities?
Hazardous Facility Risk
Fertilizer Storage Facility Explosion, West, Texas, April 2013

• 15 fatalities, > 200 injuries

• School, apartment building, hundreds of houses damaged or destroyed
Hazardous Facility Risk
Historical Examples - #1

- **Explo Systems, Inc. - Camp Minden, LA**
  - 6 million pounds of explosives
  - Improperly stored

![Google Earth image of Camp Minden](image_url)
Hazardous Facility Risk
Historical Examples - #2

• Oil train explosion – Lac-Megantic, Quebec – July 2013
  – 47 Fatalities
  – Destroyed half of the town

• In the U.S., train lines like this are running more frequently

Hazardous Facility Risk
Recognition of Hazardous Facility Risk

• The West, Texas fertilizer explosion highlighted the importance of managing this type of risk

• Subrogation potential is an important mitigating factor
  – But, the owners of the fertilizer storage facility only had $1 million in liability coverage
  – Whereas insured losses were probably in the hundreds of millions

• The challenge is how to quantify this type risk
Hazardous Facility Risk
Quantification of Hazardous Facility Risk

• Three tiers of catastrophe risk quantification
  1) **Identification of exposure accumulations near hazard**
     - Using GIS tools
     - Requires latitude/longitude coordinates of potentially hazardous facilities
     - This information may be difficult to obtain
  2) **Deterministic loss estimation**
     - “What-if?” scenario losses
     - Requires the above, and also knowledge of the facilities and perils, and likely losses
  3) **Probabilistic loss estimation**
     - Likelihood of achieving loss thresholds
     - Requires the above, and also an idea of frequency
     - Both for the industries in general, and the specific facilities
Hazardous Facility Risk
Using GIS Software to Identify Exposure Accumulations

Sources: Esri, DeLorme, NAVTEQ, TomTom, Intermap, increment P Corp., GEBCO, USGS, FAO, NPS, NRCAN, GeoBase, IGN, Kadaster NL, Ordnance Survey; Esri Japan; METI; Esri China (Hong Kong), swisstopo, and the GIS User Community
Hazardous Facility Risk
Gauging a Prospective Risk for Exposure to a Hazardous Facility
Hazardous Facility Risk
Key Take-Away

• Basic knowledge of where your portfolio is exposed is the first step to managing this risk!
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