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# Workers Compensation Catastrophes

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## Presentation Outline

- Sources of Risk
- Workers Comp Exposure Modeling
- Overview of Terrorism and Earthquake Model Methodology

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## World Trade Center disaster

- At the time, biggest insured loss to that date resulted from an “unknown” peril
- Estimated loss to workers compensation ~ $2.0 Billion
- There are a number of other events that could generate higher losses depending on a number of factors including event magnitude, time of day, and location

## Past Major Casualty Events

| Event | Description | Casualties |
|---|---|---|
| **Earthquake events** | | |
| Loma Prieta | Oct. 17, 1989; 5PM; $M_s$ 7.1 | 65 deaths; 3,800 injuries |
| Northridge | Jan. 17, 1994; 4:31AM; $M_w$ 6.7 | 60 deaths; 12,000 injuries |
| Kobe, Japan | Jan. 17, 1995; 6AM; JMA 7.2, $M_w$ 6.8 | 5,500 deaths; 42,000 injuries |
| Athens, Greece | Sep. 7, 1999; 3PM; $M_w$ 5.9 | 140 deaths; 2,000 injuries |
| Chi-Chi, Taiwan | Sep. 21, 1999; 2AM; $M_w$ 7.6 | 2,400 deaths; 11,000 injuries |
| Izmit, Turkey | Aug. 17, 1999; 3AM; $M_w$ 7.4, $M_s$ 7.8 | 17,400 deaths; 43,900 injured |
| Sichuan, China | May 12, 2008; 2:28PM; $M_w$ 7.9, $M_s$ 8.0 | 69,197 deaths; 374,176 injured |
| Tohoku, Japan | Mar 11, 2011; 2:46PM; $M_w$ 9.0. | 15,000 deaths (~90% drown); 5,250 injured |
| **Non-Earthquake events** | | |
| Oklahoma Federal Building | April 19, 1995; 9AM; (~4,000 pounds TNT) | 169 Deaths, 100s injured |
| World Trade Center | Sep. 11, 2001; 9AM | 2,700 deaths, Injuries unknown |
| Toulouse Plant Explosion, France | Sep. 21, 2001, 10:15AM, (~ M3.4 EQ.) | 31 dead, 2,442 injured |

## Modeled Losses to Workers Compensation

| Scenario | Fatal Injury | Non-Fatal Injuries | Total Casualties | Workers Comp Loss ($ Million) |
|---|---|---|---|---|
| Large Anthrax Release – New York City | 131,009 | 1,003,569 | 1,134,570 | $176,619 |
| Small Anthrax Release – Chicago | 26,980 | 433,759 | 460,739 | $52,300 |
| M7.0 Earthquake - Los Angeles | 4,958 | 38,573 | 43,531 | $8,400 |
| 10-ton Bomb - New York City | 2,045 | 20,467 | 22,412 | $2,881 |
| M6.0 Earthquake - New Madrid | 385 | 3,048 | 3,433 | $621 |

**Sorted by insured loss ($ Millions)**

- Assumes peak time of day exposure

## Workers Comp Exposure and Model Inputs

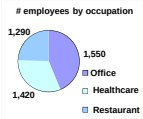
## Property vs. Workers Comp Exposure

| Property Exposure | Human Exposure |
|---|---|
| Static Exposure | Location Dependent |
| Known Values | Activity Dependent |
| Limits Specified | Time Dependent |
| Specific Covered Perils | Varied Payouts |

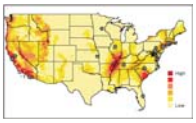
 

## Data Resolution and Availability

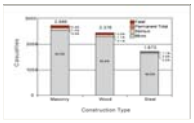
- The assessment of catastrophe risk requires understanding of three main areas




**1. How many people are insured?**



**2. Where are the insured located?**



**3. In what type of structure are the insured located?**

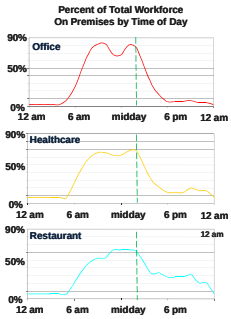
- Although a company may not have complete data, it is possible to estimate its risk using supplemental information

## Where is the Exposure?


… and When?



## Types of Buildings Occupied

- Type of building occupied during an event affects the severity of injury
- RMS Building Inventory
  - Example Only

| Building Class | CA | NY | TN |
|---|---|---|---|
| Light Metal | 2% | 3% | 8% |
| Reinforced Concrete | 30% | 14% | 20% |
| Reinforced Masonry | 18% | 2% | 4% |
| Steel | 21% | 34% | 33% |
| Tilt-Up | 8% | 3% | 5% |
| URM | 8% | 32% | 16% |
| Bearing Wall | 3% | 17% | 10% |
| w/ Load Bearing Frame | 4% | 16% | 5% |
| Wood | 13% | 10% | 14% |
| TOTAL | 100% | 100% | 100% |

## Workers Comp Modeling at RMS

- Six injury levels modeled


- All models capable of producing both number of casualties and dollar losses
- Perils that can model workers comp
  - Terrorism
  - Earthquake: U.S., Taiwan, Japan, China
  - Accumulation or concentration risk analysis

## Injury Levels; NCCI-based

| Injury State | Description |
|---|---|
| Medical Only | Minor injury that can be easily treated and will not cause any permanent impairment. For WC, this does not result in any indemnity benefit because the duration of the injury or illness falls within the "waiting period" for workers compensation benefits. |
| Temporary Total | Injury that results in an individual's inability to work and/or function for some period of time but from which the individual can fully recover within a reasonably short period of time (e.g., an individual breaks a limb). |
| Permanent Partial – Minor | A permanent injury that results in only partial disability, that is, the individual can continue to work or function normally in some fashion. Minor injuries might include loss of a toe or finger, respiratory problems, and so on. Typically, this is a 0%-25% disability. |
| Permanent Partial – Major | Similar to Permanent Partial – Minor. However, these injuries result in 25%-100% disability. Examples include loss of a leg, loss of an eye, etc. |
| Permanent Total | The most severe type of non-fatal injury, these individuals fall into a total (100%) disability state. Typically, this is the most expensive type of injury as disability is permanent & the individual is unable to work again. Examples include loss of all limbs, paralysis, & other debilitating injuries. |
| Fatal | Death |

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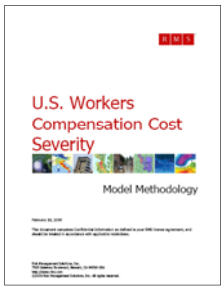
## U.S. Workers Comp Cost Severity Modeling

- RMS models state-specific cost severities, which include:
  - Indemnity
  - Medical
  - Vocational rehabilitation
  - Legal
  - Mean and std. deviation

  e.g., average fatal injury in CA ~ $390,000 with a coefficient of variation ~ 1.5)
- User-defined cost severities can be applied

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## Overview of Terrorism and Earthquake Model Methodology

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## RMS Workers Comp Earthquake Model Methodology

- The workers comp earthquake model follows a similar process to assess the impacts on people and the resulting losses as the earthquake property model


| Stochastic Event Module | Hazard Module | Geocoding/ Exposure Module | Vulnerability/ Casualty Module | Financial Analysis Module |
|---|---|---|---|---|

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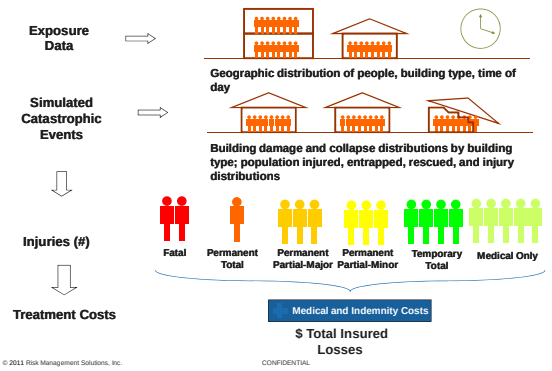
## Modeling Methodology (Casualties)

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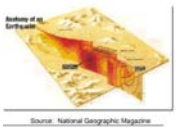
## U.S. Earthquake Casualty Model Highlights

- Incorporates the base U.S. earthquake peril and hazard model
- Reflects the latest research and assessment of casualties in building collapses
- Casualty rates linked to spectral displacement and collapse rates
- Includes geographically enhanced inventory databases
- Simulation-based methodology employed for the calculation of injury cost severities



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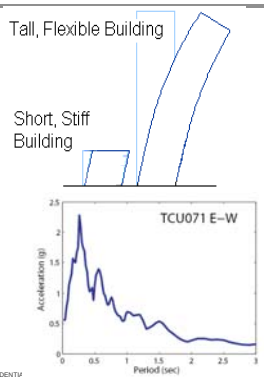
## Development of Casualty Rates

- Earthquake casualties are modeled using spectral displacement – an advantage over using Modified Mercalli Intensity (MMI)
- Research casualty statistics from over 135 earthquakes worldwide (including 35 from U.S.)
  - Correlate observed statistics with building construction and occupancy types
- Casualty rate curves are directly linked to probabilities of collapse and heavy damage by construction class allowing better modeling of extremes given a mean level of damage
  - Correlate observed statistics with building construction and occupancy types
- Calibration of casualty model against historical events (Northridge, Loma Prieta, past scenario studies for New Madrid, Charleston, Boston MA, Alaska, Hawaii, Washington State, etc.)
  - Includes detailed investigation of major events
    - Earthquake: Northridge, Loma Prieta, Kobe, Chi-Chi, Athens, Turkey
    - Non-EQ: WTC, Oklahoma Federal Building

## Spectral Acceleration (Sa)

- Spectral Acceleration is a instrumental measure of ground motion that includes building response
- Sa allows differentiation in the response of structures by height and structural type, which are used to classify the building's natural period, or response to motions of differing frequencies.



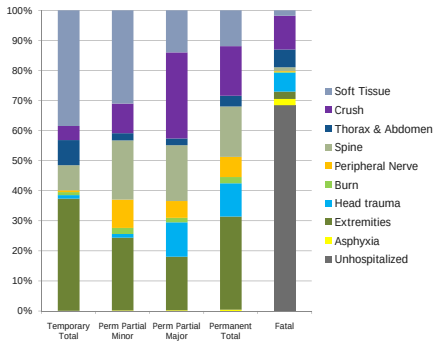
## High Rise Structures

- High-rise buildings have strict seismic codes – collapse is a low probability, high consequence event
- High-rise structures are more likely to collapse because of long period ground motion or ground motion amplification, which often occurs a long distance from the fault
- High-rise structures are most commonly found in central business districts where there are high concentrations of workers

## Injury Type Mix by Injury Class - Example for EQ

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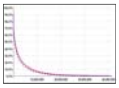
## Framework for Terrorism Modeling



**Exposure at Risk**
- Property exposed
- Population exposed
- Geocoding
- Building Attributes

**Quantify Hazard**
- Pressure waves
- Contaminant dispersal
- Debris
- Fire

**Assess Vulnerability**
- Distance vs. Damage
- Impact of hazard on the building environment
  - Building Damage
  - Nature of injuries

**Probabilistic Analysis**
- Relative likelihood of scenarios
- Multiplicity of attacks
- Frequency of attacks

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## Understanding Exposure to Terrorism Risk

- Amount insured
  - Does the policy include terrorism coverage?
  - Do standard fire policy regulations apply?
  - Do exclusions apply, such as CBRN?
- Location of insured assets and/or individuals
  - Geographically focused, small-footprint events create need for quality address info
- Vulnerability of insured assets and/or individuals
  - Mainly a function of building construction and height

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## Attack Modes Modeled

Conventional Weapons:

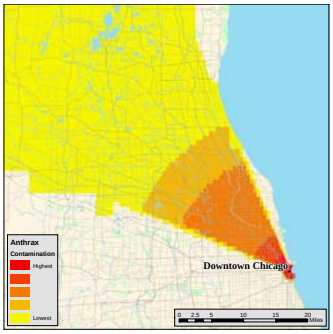
- Bombs
  - 600 lb
  - 1 Ton
  - 2 Ton
  - 5 Ton
  - 10 Ton
- Aircraft Impact
- Conflagration
- Industrial Sabotage (small, med., large)
  - Explosion
  - Toxic Release
  - Explosion & Toxic Release

CBRN Weapons:

- Chemical – Sarin Gas
  - Outdoor: 10/300/1000 kg; Indoor
- Biological – Anthrax Slurry
  - Outdoor: 1/10/75 kg; Indoor
- Biological – Smallpox
  - Small, Medium, Large
  - GE Medium, GE Large
- Dirty Bomb
  - 1,500 Curies Cesium 137
  - 15,000 curies Cesium 137
- Nuclear Bomb
  - 1 kiloton, 5 kiloton
- Hazardous Transportation Sabotage
  - 90 ton spill
- Nuclear Plant Sabotage

## Variable Resolution Grid (VRG) Hazard Footprint




**Large Anthrax release in Downtown Chicago**

***Better reflects local environment and orientation of footprint***

## Vulnerability of Terrorist Attacks

- Vulnerability represents the relationship between level of hazard and damage (effects on property, disruption of services, injury, and loss of life)

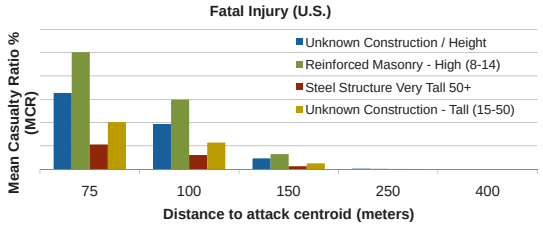
- Expressed as mean damage ratio (MDR) or mean casualty rate (MCR)
  - Property MDR = physical damage / value
  - Casualty MCR = # of people injured / # of people exposed
    - Injury levels: Medical only, temporary total, permanent partial – minor, permanent partial – major, permanent total, fatal

## Mean Casualty Rate by Distance to Target

- The nature of injuries will vary for the same level of hazard depending upon the characteristics of the building
- Mean casualty rate by distance for 2-ton bomb (U.S.)

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## RMS Probabilistic Model Framework

**Define Stochastic Attack Set**
- Based on utility of attack, target & attack mode prioritization
- Expert elicitation
- High Accuracy Loss Modeling (VRG Footprints)

**Determine Relative Likelihood of Attack Scenarios**
- Targets: prioritizing by category and city tiers
- Attack modes: logistical costs and likelihoods

**Determine Attack Multiplicity**
- Likelihood of having multiple attacks per event (swarm)
- Determined by attack mode groups

**Simulate Event Frequency**
- Distribution of attempted events
- Distribution of successful events
- Suppression factor given an event occurs

- Stochastic attack set definition
- Relative likelihood of attack scenarios (conditional probability of each attack)
- Likelihood of multiple attacks making up a single event (attack multiplicity)
- Number of events per year (event frequency)

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