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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

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

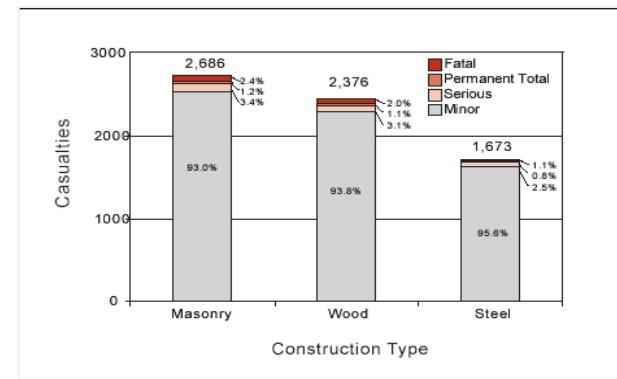
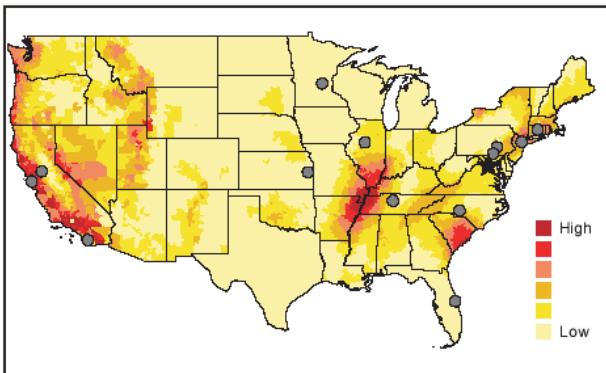
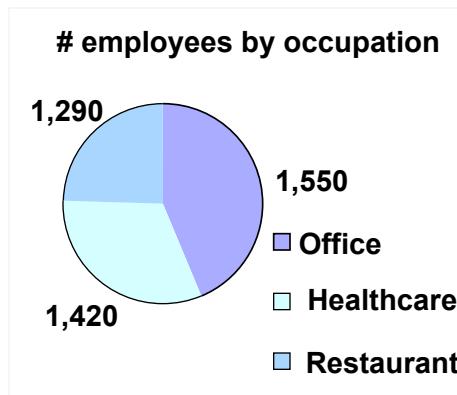
Workers Comp Exposure and Model Inputs

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



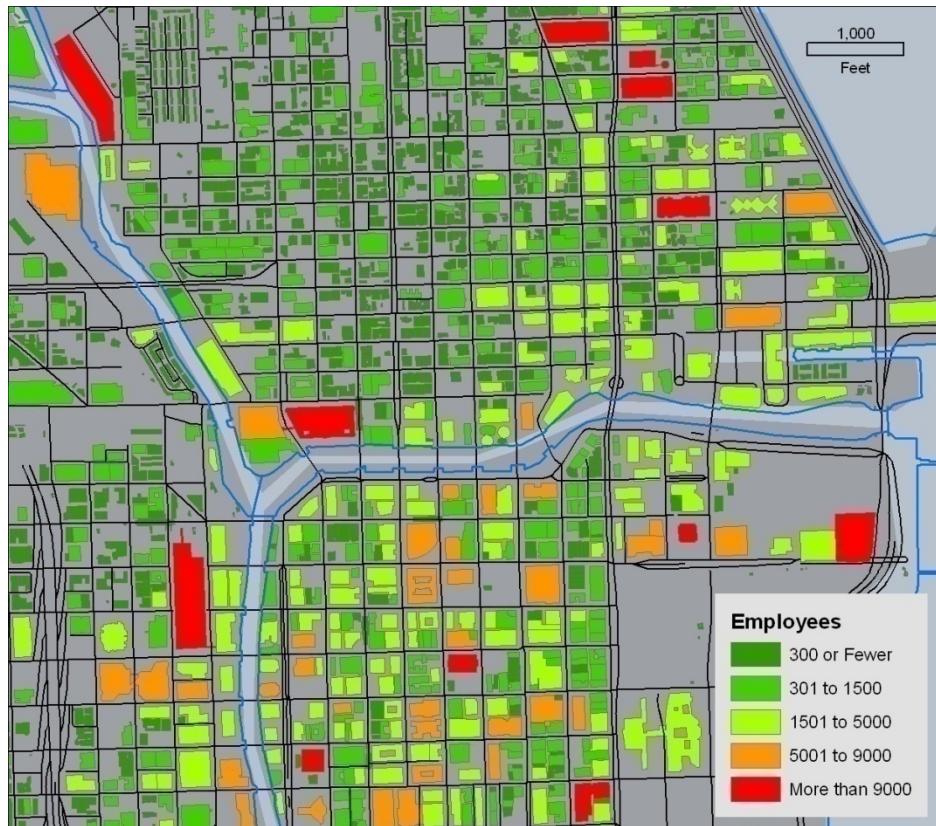
1. How many people are insured?

2. Where are the insured located?

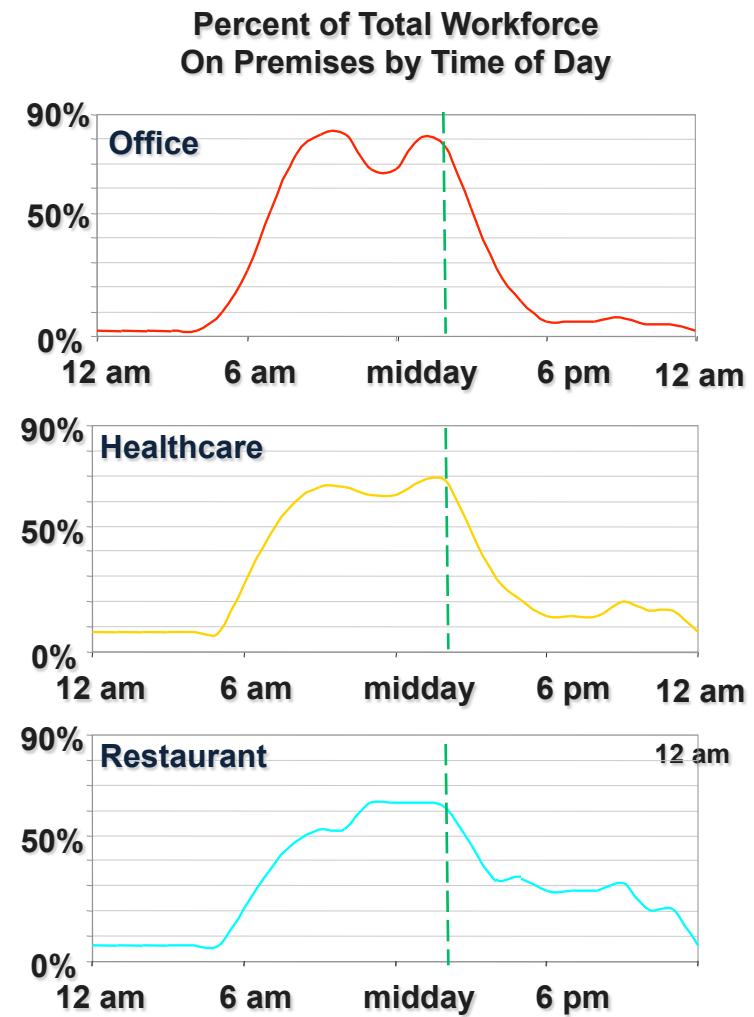
3. In what type of structure are the insured located?

- 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

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



U.S. Workers Compensation Cost Severity



Model Methodology

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Overview of Terrorism and Earthquake Model Methodology

RMS Workers Comp Earthquake Model

Methodology

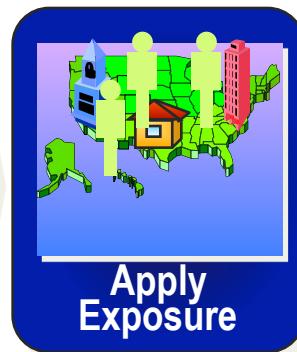
- The workers comp earthquake model follows a similar process to assess the impacts on people and the resulting losses as the earthquake property model



Define
Earthquakes



Assess
Earthquake
Motion



Apply
Exposure



Calculate
Damage



Quantify
Financial Loss

**Stochastic
Event
Module**

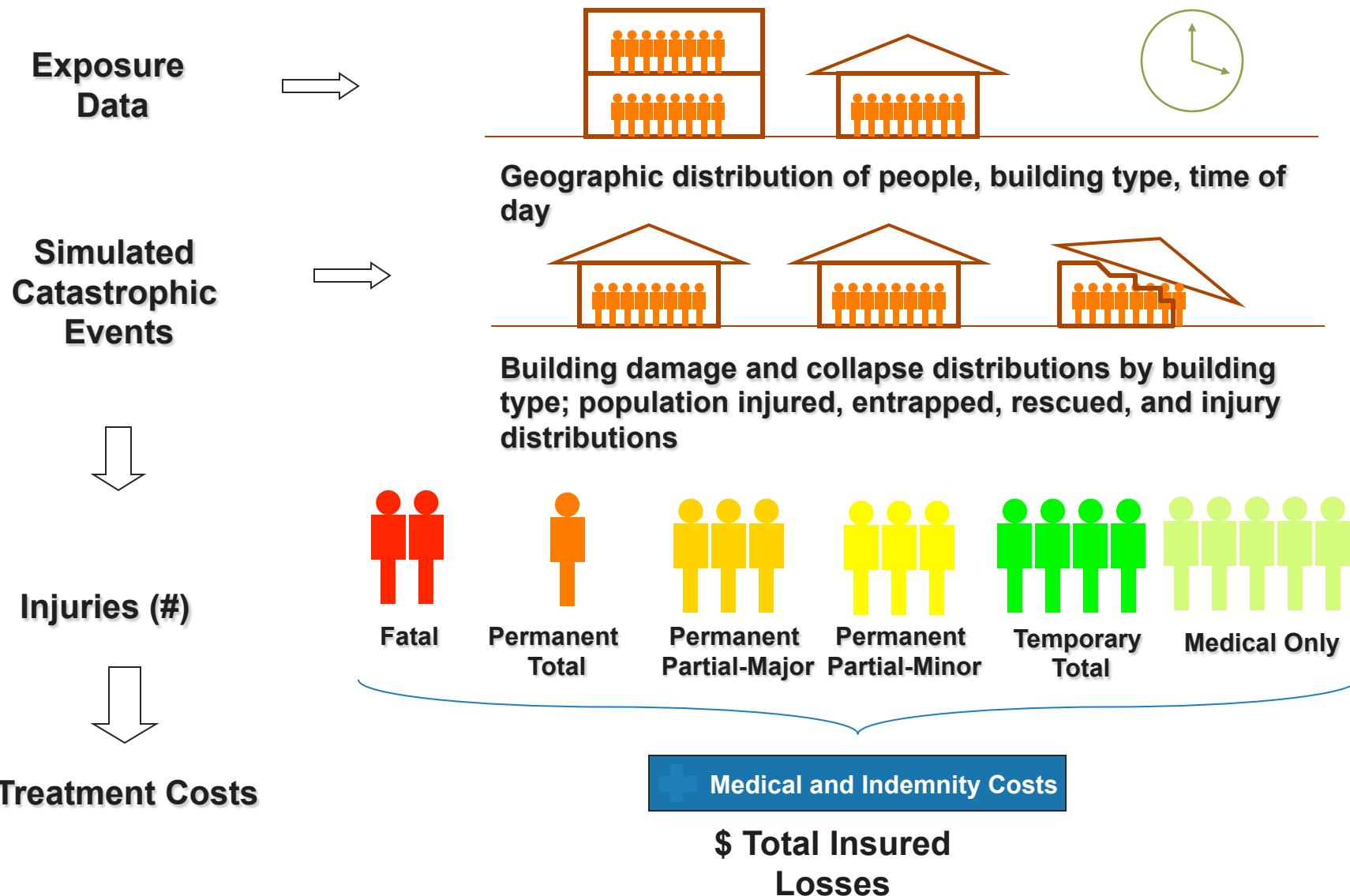
**Hazard
Module**

**Geocoding/
Exposure
Module**

**Vulnerability/
Casualty
Module**

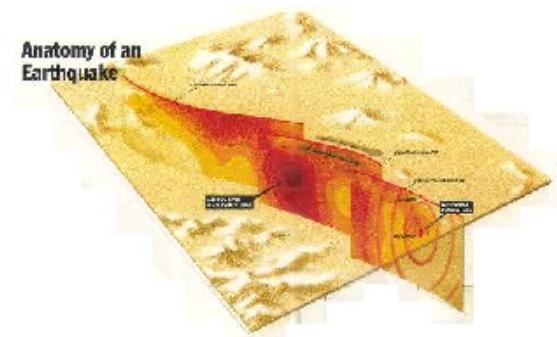
**Financial
Analysis
Module**

Modeling Methodology (Casualties)



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



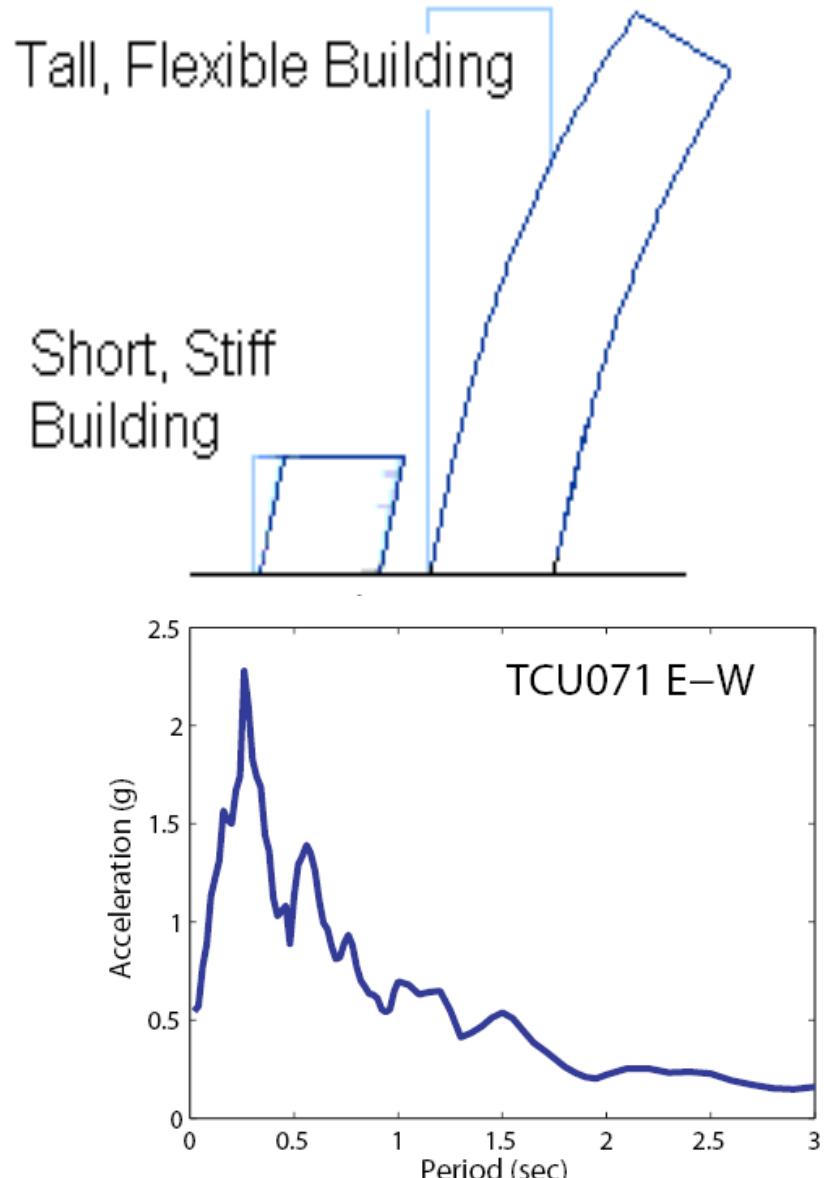
Source: National Geographic Magazine

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)

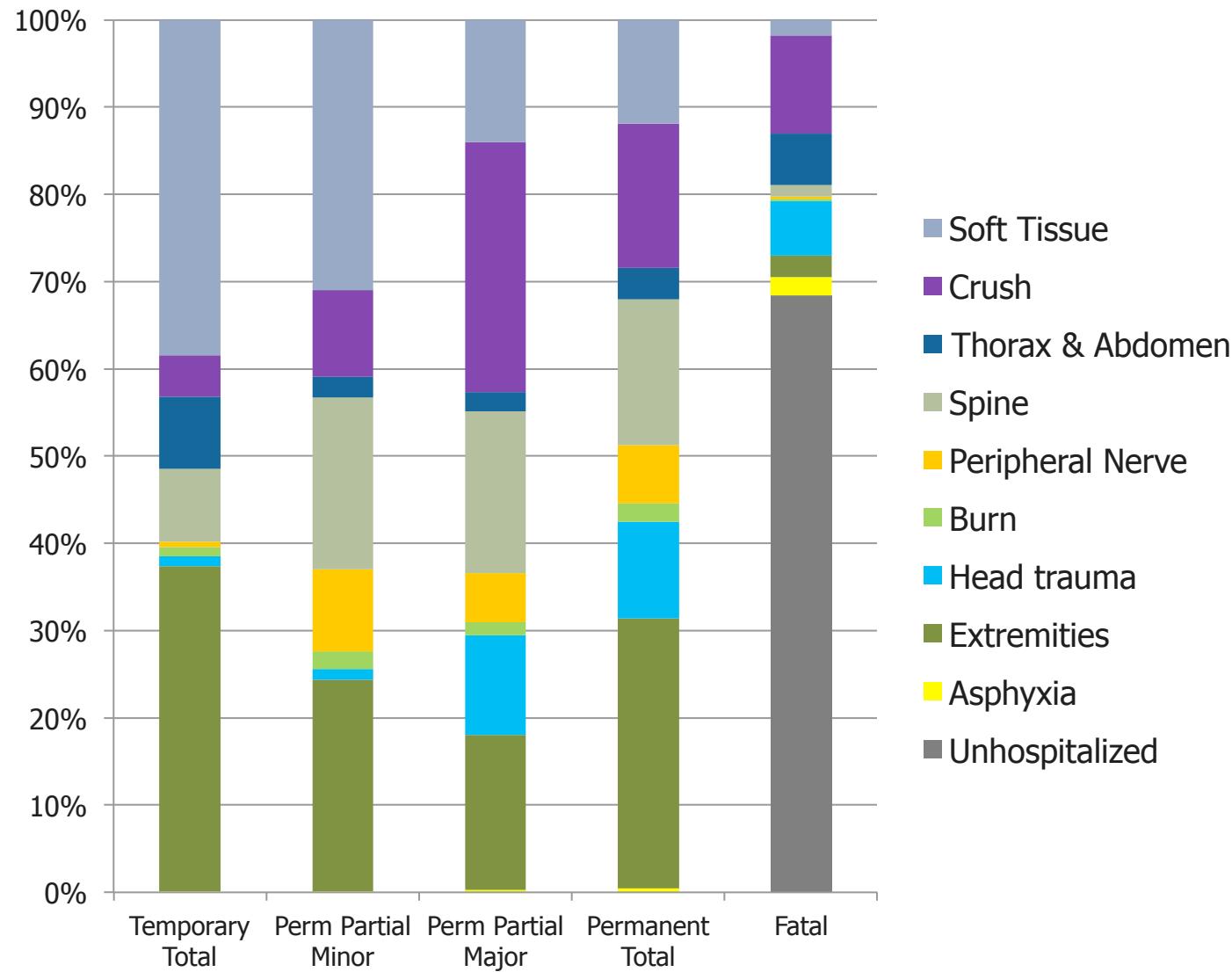
- Spectral Acceleration is a instrumental measure of ground motion that includes building response
- Sa allows differentiation in the response of structures by height and structural type, which are used to classify the building's natural period, or response to motions of differing frequencies.



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



Framework for Terrorism Modeling



Exposure at Risk

- Property exposed
- Population exposed
- Geocoding
- Building Attributes



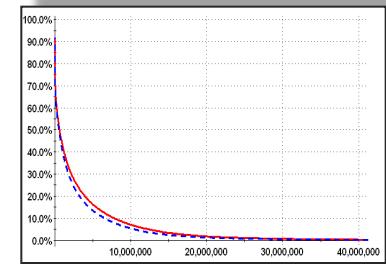
Quantify Hazard

- 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

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

Attack Modes Modeled

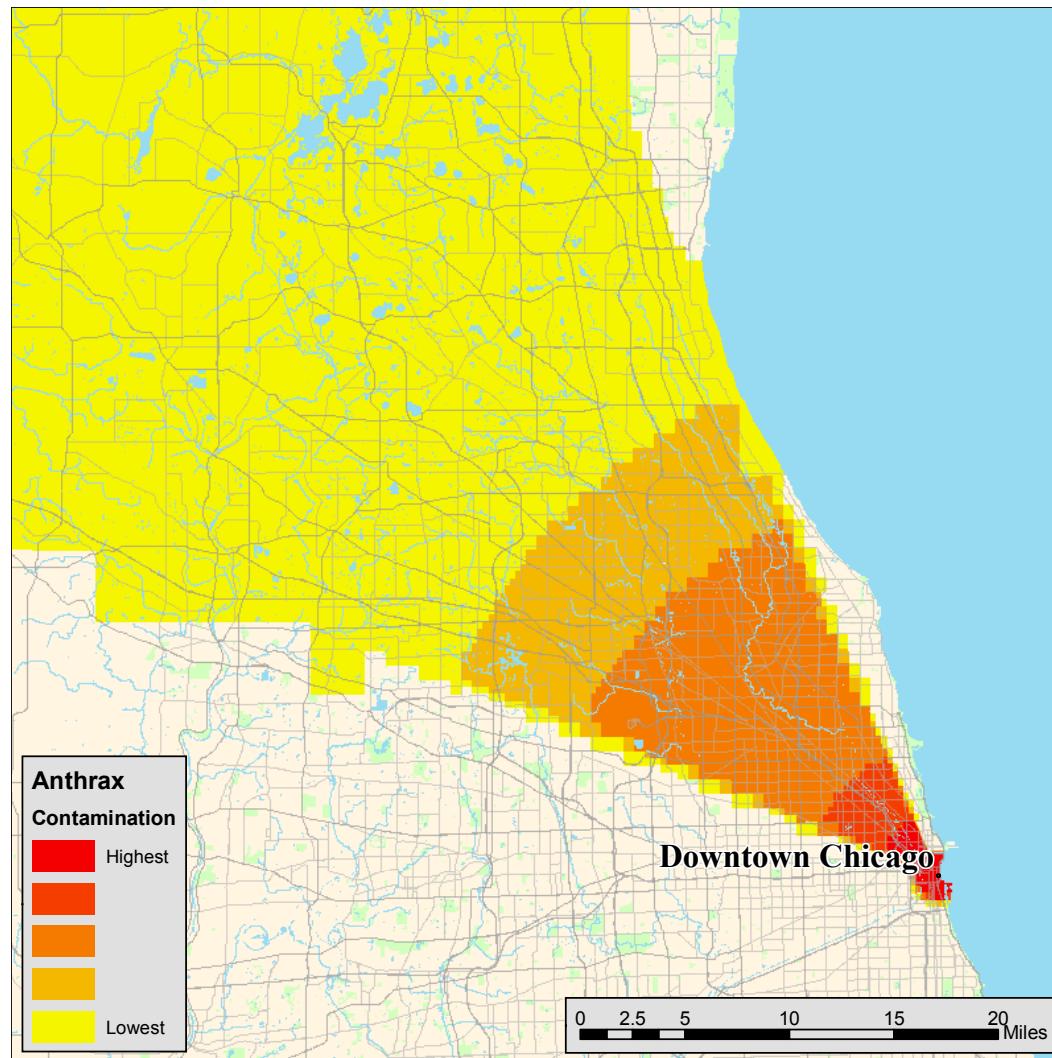
Conventional Weapons:

- 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*

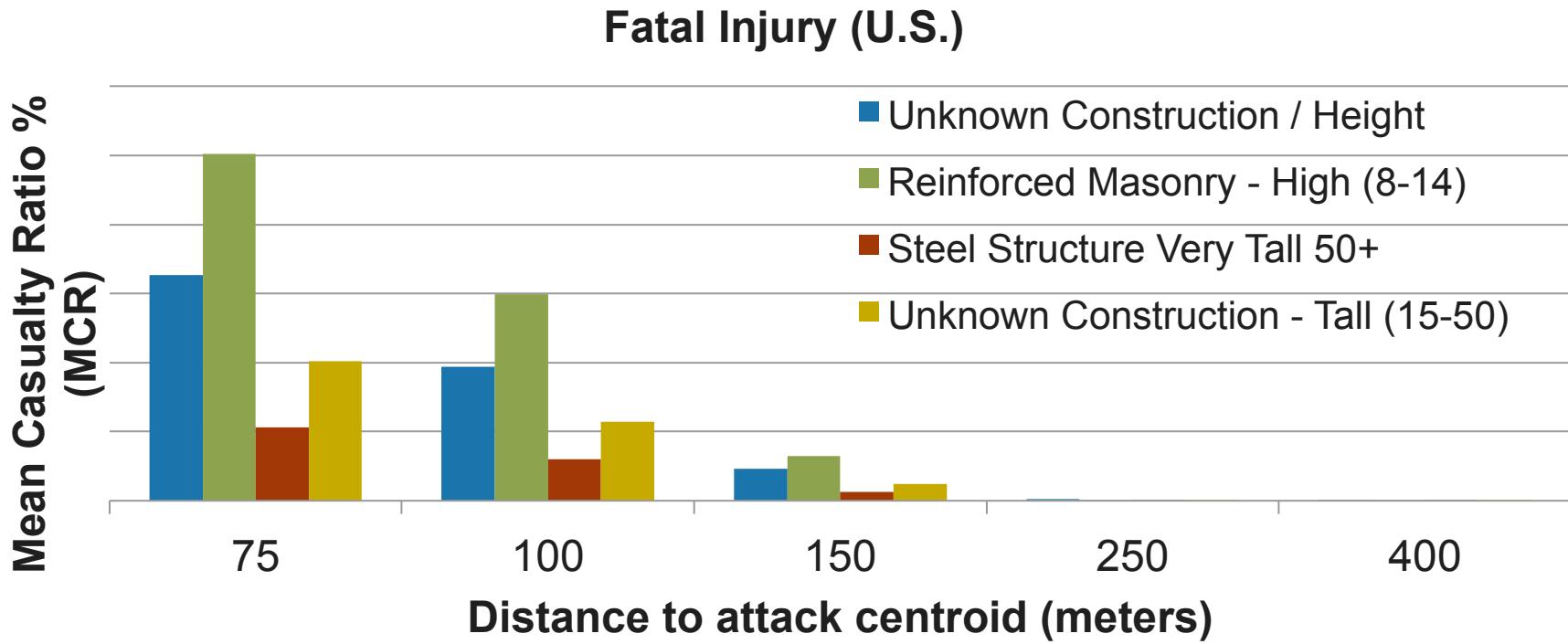
Vulnerability of Terrorist Attacks

- 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.)



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)