RISK ASSESSMENTS KNOWING YOUR PML

City of Los Angeles Resource Fair

STRUCTURAL ENGINEERS ASSOCIATION OF SOUTHERN CALIFORNIA
Kenneth O’Dell, S.E. (Partner : MHP, Inc. Structural Engineers)

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HOW DOES A RISK ASSESSMENT FIT IN WITH THE RETROFIT ORDINANCE FOR SOFT-STORY WOOD FRAMED BUILDINGS?

- Why do I need a Risk Assessment?
- What does it tell me?
- What is a PML?
- Why do I need the PML?
- What do I do with the PML?

DEPENDS ON THE VALUE OF “KNOWING” YOUR ASSET
Risk Assessment vs. PML Value

- The PML is not the Structural Risk Assessment
- The PML is an outcome of a Structural Risk Assessment
- An Assessment addresses three components of Risk
  - Hazards
  - Vulnerabilities
  - Exposure
- A PML quantifies results in terms of replacement $$s$$
THREE COMPONENTS OF RISK

• Site/Regional Considerations
• Building/Property Considerations
• Business/Community Considerations
THREE COMPONENTS OF RISK

Hazards

Vulnerability

Exposure

Hazards
THREE COMPONENTS OF RISK

Hazards
Vulnerability
Exposure

Landslide
THREE COMPONENTS OF RISK

Hazards

Vulnerability

Exposure

Liquefaction
THREE COMPONENTS OF RISK

Hazards

Exposure

Vulnerability

Fault Rupture
THREE COMPONENTS OF RISK

- Hazards
- Vulnerability
- Exposure

Intense Ground Shaking
THREE COMPONENTS OF RISK

Hazards

Vulnerability

Exposure

Intense Ground Shaking
THREE COMPONENTS OF RISK

Hazards

Exposure

Vulnerability
THREE COMPONENTS OF RISK

Hazards

Vulnerability

Exposure

Age
Condition, Detailing

Riley & Field Acts Passed

Benchmark 1976 UBC

Benchmark 1997 UBC

Future Developments


1906 & 1925 San Francisco & Santa Barbara Earthquakes

1933 Long Beach Earthquake

1971 San Fernando Earthquake

1989 & 1994 Loma Prieta & Northridge Earthquakes
THREE COMPONENTS OF RISK

Hazards

Vulnerability

Exposure

Materials
Ductility, Strength
Three Components of Risk

- Vulnerability
- Hazards
- Exposure

Load Path
Connections, Redundancy
THREE COMPONENTS OF RISK

- Hazards
- Vulnerability
- Exposure

Configuration
Shape, Mass/Weight, Stiffness
THREE COMPONENTS OF RISK
Three Components of Risk

- Vulnerability
- Hazards
- Exposure

Financial Investment
THREE COMPONENTS OF RISK

Hazards  Vulnerability

Occupancy/Income
THREE COMPONENTS OF RISK

- Vulnerability
- Hazards
- Exposure

Community
CHANGING THE RISK PROFILE

So How Do we Do this??

- Hazards
- Vulnerability
- Exposure

- Hazards are difficult to control
- Reduce/Mitigate Vulnerability
- Broaden Exposure
ASTM E 2026 and ASTM E 2557

“STANDARD GUIDE FOR SEISMIC RISK ASSESSMENT OF BUILDINGS”

“STANDARD PRACTICE FOR PML EVALUATIONS FOR EARTHQUAKE DUE DILIGENCE”

ASTM Defines:
• Scope of Assessments
• Terminology (PGA, SEL, SUL, PML)
• Level of Investigation (0, 1, 2, or 3)
• Qualifications of Reviewer

ASTM is the American Society for Testing and Materials
Considerations that are or can be addressed:

- **Seismic Ground Motion Hazard Assessment:**
  The objective of the seismic ground motion hazard assessment is to characterize the earthquake ground motions at the site(s) with a specified probability of being exceeded in a given time period and/or scenario earthquake ground motions associated with specific source events that are likely to impact the site(s).

- **Site Stability Assessment:**
  The objective of the site stability assessment is to determine if the building is located on a site that may be subjected to instability due to earthquake-induced surface fault rupture, soil liquefaction, subsidence, settlement, landslide, tsunami, seiche, etc.

- **Building Stability Assessment:**
  The objective of the building stability assessment is to determine if the building can be reasonably expected to remain stable under earthquake loadings. A building should be deemed stable if it is able to maintain the vertical load carrying-capacity of its structural system under the inelastic deformations caused by the earthquake ground motion prescribed for the building and site by the current edition of the International Building Code or other nationally applicable building code as specified by the User.
ASTM E 2026 - “STANDARD GUIDE FOR SEISMIC RISK ASSESSMENT OF BUILDINGS”

Considerations that are or can be addressed:

- **Building Damageability Assessment:**
  The objective of the building damageability assessment is to characterize expected earthquake losses associated with earthquake ground shaking and possible other earthquake hazards as prescribed by a User by performing an engineering analysis and evaluation of the damageability characteristics of the building(s) at given levels of earthquake ground motions.

- **Building Content Damageability Assessment:**
  The objective of the building content (contents) damageability assessment is to perform an analysis of the earthquake performance of contents within the building. This analysis is concerned with contents that are not part of the building systems.

- **Business Interruption Assessment:**
  An analysis of the site, building, equipment, contents, inventory systems, infrastructure, interdependent businesses, and all other relevant parameters to determine if the building will suffer business interruption from onsite effects such as direct damage to buildings, equipment or loss of critical contents & supplies; impacts to other facilities or services not part of the property; damage to buildings of interrelated businesses; lost availability of utility services, transportation modes, supplies, or services; lost availability or access to interrelated businesses, supplies or materials; and offsite damage to infrastructure, i.e. transit systems, telecommunications, utilities, water, power and waste supply and treatment facilities.
ASTM E 2026 and ASTM E 2557

“STANDARD GUIDE FOR SEISMIC RISK ASSESSMENT OF BUILDINGS”

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PML = PROBABLE MAXIMUM LOSS
Most commonly reported as a percentage of replacement cost
Earthquake Return Period: 225, 475, 2475 Years? …. 10% in 50 Years?

475 year Event – Code Basis
ASTM E 2026 and ASTM E 2557

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**Fragility Curves**

- Material 1
- Material 2
- Material 3

Thiel Zsutty, STRisk, ATC13, SeismiCat, HAZUS, FEMA P58
So Now What?

The goal of any study is to provide the user with important information from which to base critical decisions:

• Do I need to retrofit?
• Can I lower my exposure by transferring a portion (or all) of the risk to a third party…insurance?
• What do I need to do to ensure my property maintains rental income viability.
So Now What?
The goal of any study is to provide the user with important information from which to base critical decisions:

• Do I need to retrofit?
So Now What?
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So Now What?

The goal of any study is to provide the user with important information from which to base critical decisions:

- Do I need to retrofit?
Which One is Better?

Artificial, Completely Random, Made-up Case Studies:

A: One Level Over “Soft Story”
   Floor Framing Perpendicular
   Single Car Depth Parking
   “Long” 1-Story Shear Wall
   0.45g ground Acceleration
   Moderate Liquefaction
   Slender Columns with Grade Beams

B: Two Levels Over “Soft Story”
   Floor Framing Parallel
   Car & Half Depth Parking
   “Short” 2-Story Shear Walls
   0.25g ground Acceleration
   Negligible Liquefaction
   Pin at Column/Beam Joint

C: Two Levels Over “Soft Story”
   Floor Framing Perpendicular
   Double Car Depth Parking
   “Short but Uniform” 2-Story Shear Walls
   0.56g Ground Acceleration
   High Liquefaction
   Moment Frame
THANK YOU & QUESTIONS?

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STRUCTURAL ENGINEERS ASSOCIATION OF SOUTHERN CALIFORNIA
Email: seaosc@seaosc.org
WWW.SEAOSC.ORG
(562) 908-6131

KENNETH O’DELL, S.E.
MHP, Inc. Structural Engineers
Email: kodell@mhpse.com
www.mhpse.com
(562) 985-3200