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PML-SEL-SUL

What is it and why do we need it?

It is a standard of measure and calculations that Lenders, Insurance companies and Risk managers use to determine the damage that would be caused by an earthquake. There are different levels of criteria. Most lenders and risk managers are using the SUL to be safe.

Summary in laymen terms:
PML-Probable Maximum Loss

PML50=SEL- a lower standard meaning that it takes less work (cost) to meet these criteria.
This has a 50% change of exceeding the damage estimate.
PML90=SUL- A higher standard but one that all the lenders and insurance companies accept. It looks like most of them are going to this standard.
This has a 10% chance of exceeding the damage estimate.

Typically, lenders and insurance companies rely on what's known as a PML (Probable Maximum Loss) (or SUL and SEL) and they're looking for a building to achieve a PML of less than 20%. There's is no "universal standard"; however, this is most commonly the case.

Building damage estimates are given as a percentage of building replacement value. The average (50%) damage estimate is reported as a PML50 or scenario expected loss (SEL475). The estimate that is the upper bounds for 90% of the probability distribution is reported as a probable maximum loss (PML90) or scenario upper loss (SUL475).

To complicate matters further, keep in mind, that the PML/SEL and PML/SUL can be calculated differently by various PML companies/providers. After you review the design-build proposals and you select a winning contractor, you may want the 'peer review' engineer to confirm that the proposed/conceptual design will in fact yield the desired PML.

Loss Estimation Terminology

ASTM E2026 and E2557 define Probable Maximum Loss (PML) as a general non-specific term, which has
been historically used to characterize building damageability. A PML can be defined in a variety of probabilistic and deterministic approaches within the ASTM E2026 and E2557 standards. The following terminology is relevant for this evaluation:

Probable Loss (PL): Earthquake loss to the building systems associated with specified earthquake events on specific fault(s) affecting the building.

Scenario Loss (SL): Earthquake loss to the building systems associated with specified earthquake events (probabilistic return period or earthquake of specified size and location) on specific fault(s) affecting the building.

Scenario Expected Loss (SEL): Defined as the expected value of the Scenario Loss (SL) resulting from the specific earthquake ground motion of the earthquake scenario selected. In the SEL, the earthquake loss to a building would be represented by the average or mean amount of loss that a building is estimated to experience from a specified earth-quake ground motion. As the average loss, the SEL has an approximate 50% possibility of exceedance. For the purposes of this document, the SEL is defined as the expected or mean loss resulting from the damage experienced due to a 475-year return period earthquake. This from of the SEL is often referred to as the SEL-475. The SEL is also referred to as the PML50.

Scenario Upper Loss (SUL): Defined as the Scenario Loss (SL) that has a 10% probability of exceedance due to the specified earthquake ground motion of the scenario considered. It is also referred to as the 90% non-exceedance probability or the upper-bound loss. If 10 buildings of equivalent configuration and construction were subjected to the same earthquake ground shaking, the earthquake repair costs would be expected to exceed the SUL for only one of the ten buildings, or 10%. For all practical purposes the SUL will exceed the SEL for any given earthquake scenario. Similar to the SEL, the most common representation of the SUL is the SUL-475, associated with the 90% confidence loss estimation resulting from the damage experienced due to a 475-year return period earth-quake. The SUL is also referred to as the PML90.

Seismic Loss Estimation (PML) Probable Maximum Loss

The Probable Maximum Loss (PML) is defined as the Scenario Expected Loss (SEL) based on the 475-yearprobabilistic seismic ground motion as reported in the 2010 USGS seismic hazard database. The term is often referred to as the SEL-475 or PML50.

The Thiel-Zsutty (T-Z) method employs the following parameters and equation for determination of the SEL. The variables are discussed below. The SUL is determined using the BETA distribution function and the recommended baseline parameters documented in ATC-13-1. Partner modifies the BETA distribution parameters based on the uncertainty associated with this assessment.

More Detail:

Probable Maximum Loss (PML) is a term that was originally developed more than 30-years ago by the insurance industry as a gage of the exposure to losses in the event of an earthquake. Since the development of this term it has been broadly defined and misunderstood by others outside the insurance industry. The latest American Society of Testing Materials (ASTM) Standards E2026 and E2557 which were released in 2017 for use, are intended to help create consistency in the way seismic risk assessments and the corresponding loss estimates contained in the reports are defined and reported. The ASTM standards however do not provide any particular method by which the loss estimates are arrived at. This can lead to varying loss estimates provided by different consultants for the same property based many times on the level of investigation and engineering judgment. It was the goal of the ASTM Standards to simply provide a guideline for the reporting of the loss estimates based on different defined levels of investigation, by which means they were determined, what risk factors are included in the estimate, and a clear definition in the report as to what “PML” means in the report. PML can be any of many loss estimate values based on different return periods (frequency of events), different methodologies, levels of investigation, and defined structural vulnerabilities; the basis of the PML value must however be defined in the report. The standard of the industry is most of the time based on an event with a return period of 475-years or ground shaking at the site with a 10% probability of being exceeded in a 50-year time frame. Fifty (50) years is utilized because this is the accepted life expectancy of a structure as a standard of the industry. This does not mean that the seismic event utilized for the loss estimate is based on an earthquake that only occurs every 475 years but rather one that has an equal chance of occurring on any given day over a 475-year period. There can also be more events of this level or greater that can occur over this timeframe. Return periods of shorter length (e.g. 200-years or 100-years) yield lower loss estimates because they are based on smaller events of greater frequency. Return periods of greater length (2,475-years) will yield greater loss estimates because they are based upon much larger events that occur far less frequently. In other words, the longer the return period, the greater chance there is of having a major or more significant damaging event.

The reason there are terms such as SEL, SUL, PL, and SL is because the ground motion in a report can be reported for different defined seismic activity. For the SEL and SUL, the ground motion is typically derived using what is known as probabilistic ground motion. This method considers the likelihood of all possible events from all local sources (faults both known and unknown) and arrives at a ground motion that is likely to occur based upon all these events and sources. For PL and SL, the ground motion is typically derived using what is known as deterministic ground motion. Deterministic ground motion is that which is from a given single source that can affect the site and building(s) under investigation. This ground motion is often determined from the fault closest to the site with the most significant event possible when compared to other surrounding sources (faults). Loss estimates for this type of reporting are used when a client wishes to know what would happen to their holdings based on a certain magnitude event occurring on a nearby significant fault. This reporting is not typically utilized by lending institutions or insurance companies for general purposes. The values for the shaking at a site are available from public domain sources like the United States Geological Survey (USGS) and can be obtained by going to their website.

The losses are reported using terminology such as PML50, PML90, PL, SEL, and/or SUL and are based on the previously discussed and defined level(s) of ground shaking. In any case of reporting, the parameters that were used to arrive at the loss estimate(s) must be defined in the report as required by the ASTM Guidelines. These include the return period, level of ground shaking at the site or peak ground acceleration (PGA), the site hazards that may be included (liquefaction, surface rupture, hillside location, etc.). It should be noted that pga is affected by the type of soil at the site and this should be reported also. Softer soils tend to amplify the ground shaking while harder soils will attenuate the shaking. Regardless of the basis of the determined loss estimate(s), they are reported as a percentage of the total replacement cost of the structural components of the building. They do not include things like furniture, equipment, ceilings, lights, and other non-structural elements. As an example, if a building has a $1 million replacement cost and suffers a 10% loss, this represents $100,000 in losses. This example shows that these loss estimates are a gage of the financial risk to the property and do not necessarily represent the risk to the occupants for life safety or injury. It should be noted that the building codes are tailored to protection of the building occupants and do not address the financial risk aspect of a structure. Seismic risk assessments are a gage of the financial risk exposure and are used in decision making and planning when considering this risk and exposure. In some cases, the life safety risk is indicated in a seismic risk assessment but many times it is not.

To further define the terms; PML50 and Scenario Expected Loss or SEL are synonymous terms and are reported losses that are a median loss or one that has an equal chance of being exceeded as it does of being less than the reported value. Median is not the same as average which would be simply all defined levels of damage divided by the number of buildings damaged. These two terms, PML50 and SEL, are what was considered to be the probable maximum loss by many institutions for many years. Many different institutions have varying levels of risk acceptance and for this reason reporting has changed over the years to include the terms PML90 and Scenario Upper Loss (SUL). These two terms mean the same thing and represent loss estimates with only a ten (10) percent chance of being exceeded for the level of ground shaking under consideration. It should be noted that whether one or both the PML50/PML90 or SEL/SUL are indicated in a report, they must be based on the same level of ground shaking (return period and pga) under consideration. To reiterate, these losses are generally reported for an event with a return period of 475-years as this is normally the standard of the industry.

When loss estimates exceed a certain threshold (normally 20%), the user(s) have to evaluate their financial risk and determine how they are going to deal with it. There are essentially five (5) ways to address this risk: the first is risk acceptance or do nothing about it; the second is to walk away and not accept the risk; a third is to require an increase in the borrower's equity position to reduce the lenders exposure (this is true only for lenders as the users); and the fourth is to insure around the risk by acquiring earthquake or property and casualty insurance; and the fifth is to implement seismic retrofit measures to reduce the risk or loss estimate(s). Depending on the institution, the level of risk acceptance will vary. For the most part in today's financial world, the level of acceptance by institutional lenders is a PML90/SUL of 20% or less. For non-institutional lenders and other users, the risk acceptance level may increase to as high as a PML90/SUL of 30%. For some entities their acceptance level is based upon the PML50/SEL which has a lower value than the PML90/SUL. This acceptance level is also often 20%. When considering retrofit measures as a means of reducing the risk, a lesser amount of retrofit measures and corresponding costs would be required for acceptance levels with less conservatism.