Managing Seismic

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A MAJOR SOURCE of systemic risk—one that can produce not only regionally concentrated loan losses but also tragic loss of life—is *seismic risk.*

Lenders have long relied on a combination of insurance and due diligence to protect themselves from various forms of disaster, but earthquake insurance for commercial real estate has become cost prohibitive. In search of a substitute, lenders have increasingly relied on "probable maximum loss" reports to identify the risk of an asset being damaged in an earthquake. The purpose of this article is to help lenders understand how to craft an effective seismic risk management policy.

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California suffered astronomical losses after its last major earthquake in 1994. The Northridge earthquake was the most damaging seismic event in the U.S. (and for insurance companies as well) since 1906, resulting in a direct economic loss of $41.8 billion.[1] The Northridge quake also resulted in mortgage-related losses of between $200 million and $400 million, depending upon estimates; Freddie Mac, in particular, suffered an unprecedented number of defaults on condominiums.[2] In fact, many believe the perfect storm created by the Northridge quake and recessionary pressures led to the extra large loan losses taken by many Los Angeles lenders. In some instances, these losses contributed to bank failures.

State laws and political pressure force insurance companies to provide homeowners with earthquake insurance, but the same does not apply to commercial real estate. Moreover, earthquake insurance tends to be expensive and difficult to procure, so the vast majority of commercial/multifamily real estate owners do not carry it.

Lenders at agencies such as Freddie Mac, Fannie Mae, and FHA already analyze seismic risk and, increasingly, portfolio lenders are doing the same. The net result is that these lenders do not lend on the 10–15% of structures with the highest seismic risk. But lenders that fail to analyze seismic risk will have a much higher percentage of high-risk structures in their portfolios. And naturally, when the big earthquake comes, they will experience far more loan loss.

The Basics of Probable Maximum Loss Reports

The insurance industry's practice of predicting the likely damage to a given structure started in the 1970s. Much work was done by the Applied Technology Council (ATC). A document called ATC–13 was the original guidance document used in the practice of probable maximum loss (PML). The PML report ultimately predicts the damage in dollars that a structure will experience when "the big one" occurs.

How big is the big one? That depends on a property's location. Just as engineers can predict the largest flood in the next 100 years, geologists can predict the largest seismic

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event that will occur within a given period for a given location. Of course, property located near earthquake faults will experience greater seismic activity. Most PMLs are modeled to the 475-year event; the 475-year event has a 10% likelihood of occurring in 50 years.

The commercial real estate industry began using PMLs in earnest in the 1990s, and the PML became a standard due diligence tool for commercial mortgage-backed securities (CMBS) loans by the middle of that decade. While there are no regulations for the practice of PMLs, industry-recognized standards are published by ASTM, which first published the standard ASTM E2026–99 for the practice of PMLs in 1999 and recently replaced this standard with two standards—ASTM E2026–07 and ASTM E2557–07.

Most agency, insurance, and CMBS lenders require a PML report for commercial real estate loans whenever a property lies within seismic Zones 3 or 4, as specified by the Unified Building Code's Seismic Zone Map (Figure 1). This map classifies earthquake hazard areas based on seismic activity, with zones ranging from 0 (low risk) to 4 (high risk). All of California is either Zone 3 or 4.

The PML is also called the *damage ratio* and expresses the ratio of the building's expected damage as a percentage of the building's replacement cost. Historically, lenders have treated damage ratios (or PMLs) above 20% as high-risk properties requiring mitigation via insurance or seismic retrofit.

The ASTM standards do not specify a formula for calculation of PMLs, leaving the selection of the mathematical formula to individual engineers. The most common formula used by engineers for calculating PMLs is the Thiel Zsutty method:

$d = 0.554\,(b\ m\ s)a^{0.630}$

d = Damage ratio (a.k.a. PML)

a = Ground acceleration

b = Building vulnerability coefficient

m = Spectral response coefficient

s = Soil coefficient

While some engineers use their own proprietary formulas, all consider the same basic inputs: damageability of the structure, ground acceleration, soil stability, and potential for harmonic amplification between the building and soil.

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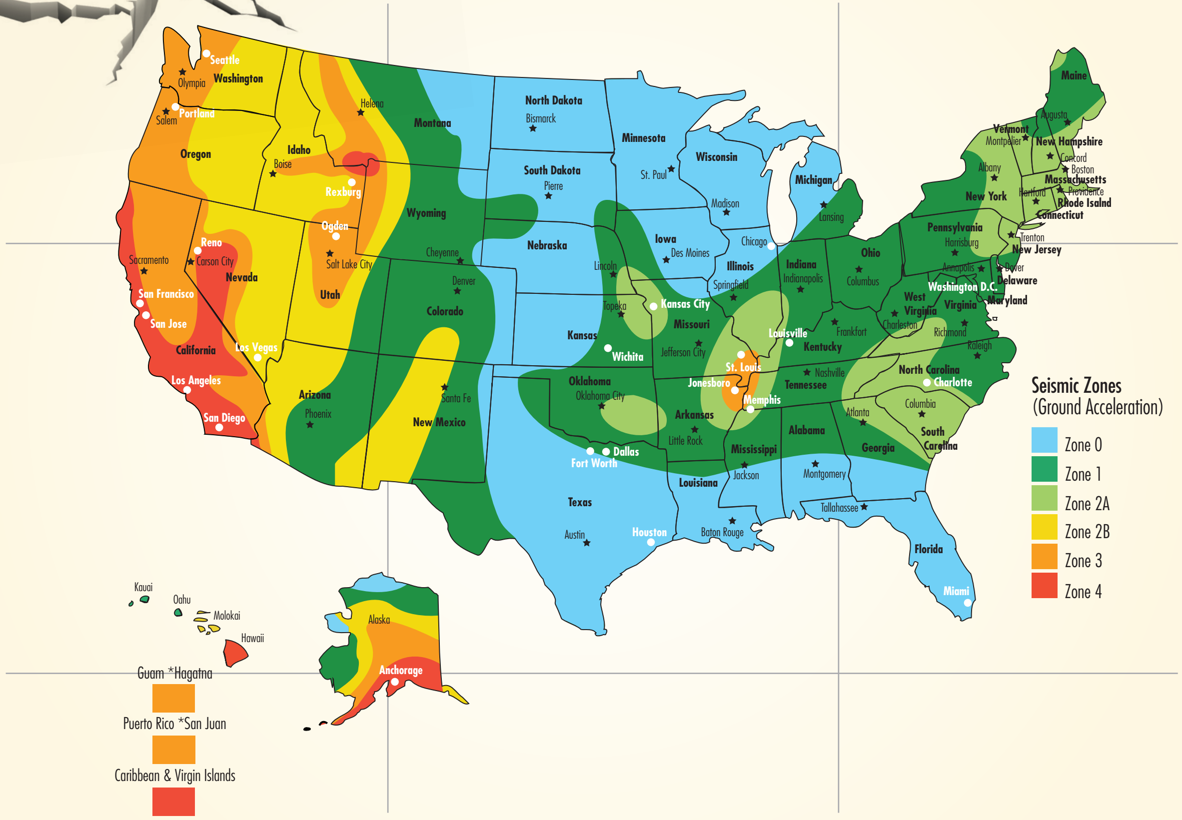
The PML can be expressed as the scenario expected limit (SEL) or the scenario upper limit (SUL), and the two numbers create great confusion. Engineers don't really predict a precise amount of damage. Rather, they develop a model expressing the probability of different levels of damage. These predictions ultimately take the form of a mathematical curve (Figure 2). The SEL is the center of the curve and represents the expected amount of damage. The SUL, always a large number, is at the 90% confidence interval on the curve.

Figure 1

U.S. Seismic Zones Map



Source: 1997 Edition UBC

Writing Your Seismic Risk Management Policy

The most thorough way to manage seismic risk is to require PMLs for all assets in Zones 3 and 4. At a cost of $1,000 to $1,500, PMLs are affordable. Nevertheless, many portfolio lenders do not want to incur this expense and look to avoid a PML on every deal. I have worked with several portfolio lenders to build a logic layer that underwriters can use to screen assets for structures requiring professional assessment.

A building's age and location are the best ways to perform a preliminary sorting of structures that need professional engineering assessment. The Unified Building Code (UBC) updates every three years. Therefore, it is recommended that lenders choose a cutoff date for requiring PMLs of two years after a code update. Take, for example, a significant code update that occurred in 1988. If lenders want to choose a cutoff date for requiring PMLs, they should consider 1990, since buildings constructed after 1990 generally have much less seismic risk than older buildings.

Another way to conserve precious due diligence dollars is by requiring a PML only for buildings in Zone 4. A more sophisticated lender also could consider areas of Zone 3 that are in government-mapped hazard zones, such as landslide zones, liquefaction zones, and earthquake fault zones. These types of seismic hazard zones are generally well mapped in California, but may not be mapped in other states.

Some lenders order PMLs only for high-risk structures, such as apartments with tuck-under parking or unreinforced masonry structures. This type of analysis faces two challenges. First, even a simple structural classification requires building-systems knowledge by bank personnel. Second, these lenders often consider only two or three of the 20 types of common structural flaws. If the bank is comfortable with missing a few structures here and there and has a reasonably sophisticated credit staff, screening assets on structure type can be effective.

Finally, a desktop PML done by a licensed engineer is another great way to screen assets for half the price of a Level 1 PML. ASTM E2026 calls these desktop PMLs a Level 0 PML, and they can be reasonably accurate if the engineer has provided enough data.

How to Order a PML

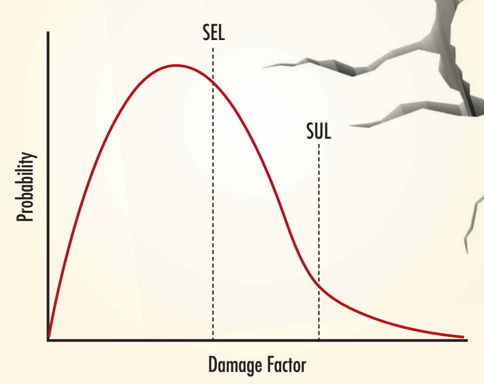
Many firms provide PMLs, but some have no engineers on staff and others do PMLs in their own way. If a lender wants consistent PMLs, he or she needs to be very specific when ordering the PML and should properly vet the engineering firm providing it. The basics include requiring that the PML meet the requirements of ASTM E2026–07 and ASTM E2557–07. These new standards have gone a long way toward creating consistency.

The ASTM standards are not a cure-all, however. ASTM E2026–07 is a very flexible standard, and there are a lot of different ways to do an ASTM PML. For example, ASTM did not specify the formula for calculating the PML. Most engineers use the Thiel Zsutty method, but other engineers use their own formula or proprietary software. For a banker, PMLs that are calculated differently cannot be compared with one another, which creates unwanted inconsistency in the underwriting process.

Risk managers can easily control for inconsistencies by being very specific when ordering PMLs. There are six important scope items to specify:

1. Following the two ASTM standards is an obvious first step.
2. ASTM E2026–07 allows for several different levels of investigation. Level 0 is a desktop and Level 1 requires the engineer to go to the site. You may want to order a desktop. If not, be sure to specify that you want a Level 1 PML, or you may get a desktop when you are paying for a Level 1.
3. Order from a qualified engineering firm. A PML is an engineering practice, and the bank should make sure that the firm has an in-house registered engineer. Also, make sure the firm has significant internal quality-control systems.
4. Require that the engineers use the Thiel Zsutty method to calculate the PML. As stated previously, this is the most commonly used method in the marketplace; moreover, it is more transparent than software programs in which calculations are invisible to the end user.
5. Specify for the engineer to model to the 475-year event, by far the most often used return period. Failure to specify this will allow other participants (borrowers, brokers, etc.) to game the system by modeling to a lower return period and reverse-engineering reports to reach a passing number.
6. Specify how you want the PML expressed. Three reasonable choices are SEL, SUL, or both. Accept the recommendation of ASTM E2557 and require your engineer to report the PML as the SEL. Many lenders also will want to see the SUL because it is more conservative, but it should be included deeper in the report and not be referred to as the PML in order to avoid confusion.
7. Show the math. This seems obvious, but half of the firms performing PMLs do not show their math. You cannot do a meaningful peer review on a report when there are no mathematical calculations. How can anyone discuss or refute a computation that is missing? Showing the basic mathematics of the Thiel Zsutty calculation is fine, but the engineer should go a step further and explain the "b" value, the building vulnerability coefficient, clearly the most controversial variable in the Thiel Zsutty calculation. The engineer should explain how the "b" value was chosen.

Figure 2



PMLs prepared to this scope will be internally consistent and sufficiently transparent for peer review. If bankers instruct the engineers very precisely, the PML products provided will feel less like supposition and more like science.

If lenders do not want to fill their portfolios with a double-helping of seismic risk, they should craft a seismic risk management policy that includes a logic screening process and the use of carefully ordered PMLs to evaluate assets proposed as collateral. The result will be far less loss if a major earthquake hits a populated area. ❖

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Notes

1. Risk Management Solutions, "The Northridge, California Earthquake: RMS 10-Year Retrospective," 2004. Available at http://www.rms.com/publications/northridgeeq_retro.pdf.

2. Committee on the Economic Benefits of Improved Seismic Monitoring, Committee on Seismology and Geodynamics, and National Research Council, *Improved Seismic Monitoring, Improved Decision-Making: Assessing the Value of Reduced Uncertainty,* 2006. Washington, D.C.: The National Academies Press.