A NEW ASTM STANDARD FOR SEISMIC RISK ASSESSMENT OF REAL ESTATE PORTFOLIOS

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A new ASTM subcommittee, WK55885, is developing a new standard for seismic risk assessment of real estate portfolios. The subcommittee brings together users (lenders, owners, public agencies), engineering service providers (engineers and other consultants), catastrophe risk model developers and vendors, along with insurance brokers, insurers and regulators.

Real estate portfolios for mortgage lenders and property owners generally include many properties distributed across many regions or multiple states. Seismic risk assessment for a group of real estate properties (a “portfolio”) differs from “PML” investigations for a single building [1, 2]. The geographical diversification of the portfolio is a fundamental characteristic that differentiates it from the investigation of a single site. The strategic risk picture provided by portfolio risk is needed to inform risk management and earthquake insurance purchase.

Upon completion, the standard will assist users as they engage engineering professionals to assess aggregate losses from earthquake hazards. The guide will encourage standardized terminology and approaches in seismic risk assessment and reporting of risks, and establish guidelines for the assessment of site conditions and building damageability. The standard will establish guidelines on what a Provider may be expected to deliver in seismic risk assessment of building portfolios. It will promote the effective use of software, and communication of risk results and the uncertainty of those results to users in a manner that is clear, complete and meaningful.

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Purpose

Real estate owners and mortgage lenders with geographically distributed sets of properties (“portfolios”) in active earthquake regions need to know and manage their seismic risks. They may need to report the risks to company managers, shareholders, investors, regulators and rating agencies, and they may choose to purchase earthquake insurance. A new ASTM standard is under development to help lenders and owners work with engineering professionals to adequately assess financial and other exposures, site hazards and property seismic vulnerabilities.

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and, using sophisticated catastrophe models, accurately estimate financial and other relevant risks to portfolios from future earthquakes, and properly disclose the uncertainty in the estimates.

This new standard is related to, but distinct from ASTM E2026 and E2557 [1,2] with a more diverse set of users and providers. The technology for seismic risk assessment is more complex, and stakeholder concerns are largely financial. Nevertheless, findings from PML evaluations can provide valuable input data for improved modeling of the important buildings and sites in portfolio risk assessments, and the terminology and other technical approaches have many shared elements.

We note that current practice in portfolio seismic risk assessment for insurance can continue without interruption, and that the new standard is intended to assist those users who desire a higher level of service to receive better results and a more complete and detailed picture of risks by requiring that studies be completed in conformance with some or all of the standard. Owners, lenders and others can continue to have “desktop” studies done by insurance brokers and insurers without the use of independent engineering professionals, without invoking the standard.

Background

Current Practice in Portfolio Risk Assessment

At present, owners and lenders seeking earthquake insurance for real estate portfolios work with their insurance brokers or risk management consultants to assess the seismic risks to the portfolio and to decide on the amount of coverage to seek. The brokers then turn to insurers and reinsurers to obtain pricing with various coverage options. The insurers and brokers use sophisticated catastrophe software to model the seismic hazards and the vulnerability of the buildings and other insured assets, without the input or assistance of Civil and Structural Engineers. The relationships for damage and downtime often rely on the location, age, height and usage or occupancy of the buildings (e.g., residential, office, commercial, or warehouse), rather than the details of the design and construction of the buildings. This type of generic modeling results in high levels of uncertainty that inflate the earthquake damage estimates that insurers rely upon to set insurance premiums and establish prudent reserves.

Meanwhile, in property acquisition and real estate mortgage lending, engineering professionals are engaged for seismic risk assessments (“PML” studies) to assess the seismic stability of the site and buildings, and to estimate the damage that will occur under specified earthquake motions. This due-diligence activity, when performed per ASTM standard by qualified engineers with site visits and design drawing reviews, provides high-quality, site-specific data on the buildings and site geology, and may identify structural weaknesses that may cause high losses or collapse. Such reviews can also substantiate positive design features such as pile foundations to mitigate damage from soil liquefaction. However, the approach to seismic hazards and the type of damage relationships are distinct and different for single-site studies and portfolio studies, with portfolios requiring complex software and advanced computational methods.
These two seismic risk activities are at present conducted separately. In some cases, past PML reports may be reviewed in an attempt to improve the modeling for high-value properties as a part of portfolio risk assessment. The new ASTM standard attempts to improve portfolio seismic risk assessment, integrating professional engineers into the process to improve the data on buildings and sites, using information from property transfer due-diligence, to the benefit of owners and lenders.

Multi-Site Earthquake Risk Models

Most multi-site earthquake catastrophe models are a part of the multi-peril risk assessment systems developed and licensed by a number of commercial vendors who serve the insurance and reinsurance industry and their supporting broker community.

The objective of portfolio seismic risk assessment is to find the losses to a geographically distributed group of properties in future earthquakes. The most common approach in multi-site analysis is to simulate individual potential earthquakes one at a time, each one with its spatial distribution of ground shaking and other hazards. FEMA’s HAZUS software [3, 4] follows such an approach, and is used for the analysis of large earthquakes (e.g., the ShakeOut scenario) useful in regional response planning (e.g., Hazard Mitigation Plans required by FEMA). But focusing on any individual scenario fails to provide the comprehensive picture needed for owners to make balanced decisions on earthquake insurance coverage. Insurers also need this more complete picture to establish premium rates and adequate reserves.

To meet this need, comprehensive earthquake risk models were developed by large commercial vendors [5, 6]. To account for the potential risks from earthquakes in a region in a comprehensive and balanced way, the locations and magnitudes of the full range of future earthquakes are compiled into a comprehensive set of earthquake simulations (or scenarios), sometimes referred to as an ‘event set.’ Each event or earthquake simulation attempts to accurately reproduce the geographic distribution of ground shaking and other hazards from a possible future earthquake. Since geographic correlation of damage is of primary concern in the seismic risk assessment of a geographically distributed system, the physical size of the source rupture must be properly modeled. The affected area need also be modeled with appropriate ground motion attenuation relationships. Each event is associated with an annual frequency of occurrence (number of events per year, typically << 1), where the annual frequencies are derived from fault activity, magnitude and fault rupture location “sampling.” The ‘event set’ systematically exercises the full range of earthquake magnitudes and rupture locations for each seismic source, including known faults and background seismicity. The set of scenarios is carefully constructed so that the ensemble accurately reproduces the earthquake hazards’ severity and frequency for the region of interest. These simulations usually involve tens of thousands of scenarios in each complex tectonic region, such as southern California, where numerous known and unknown faults exist and produce frequent earthquakes.

For each earthquake simulation in the event-set, damage for each affected building is estimated, and the losses are allocated to the stakeholders (insurer, owner, lender, etc.) using actuarially sound financial models. Losses are summed throughout the portfolio for each
stakeholder, with careful accounting for event probabilities and loss uncertainties, to build relationships of loss versus annual exceedance probability, and to estimate average annual loss. Given the size of large portfolios, and the number of earthquake simulations to be evaluated, sophisticated numerical techniques are needed to capture the high consequence, low probability “tails” of portfolio loss distributions [6, 7].

Commercial catastrophe models typically address multiple perils (fire, flood, hurricane, earthquake) and consider such effects as demand surge (or loss amplification), damage from fire sprinkler systems that leak from earthquake, and damage from earthquake-initiated structure fires.

Despite their sophistication, the quality of the output from a commercial catastrophe model is limited by the quality of the input (“GIGO”). Therefore a key goal in the ASTM standard for portfolio seismic risk assessment is engaging a professional engineer to improve the accuracy of modeling of the sites and buildings within the portfolio, by properly identifying the structural systems and features of the buildings that drive the risks. The engineer can also make sure the Site Class, liquefaction and other hazards drawn from the geologic databases that are a part of the software accurately reflect site-specific conditions that are revealed through engineering investigation. As a service provider, working with brokers, the professional engineer can more fully leverage the capabilities of the catastrophe software to the benefit of owners and lenders.

**Stakeholders and Subcommittee Membership**

Seismic risk assessment for real estate portfolios involves finance and investment strategies, insurance and actuarial science, seismology and geotechnical engineering, structural engineering and computer science. Each stakeholder group brings different interests, experience and knowledge to the effort to quantify seismic risks, and the subcommittee to develop the new standard reflects this diversity in expertise and interest.

Subcommittee WK55885 is linked to ASTM through two representatives, the Committee E06 Chair and the Subcommittee E06.25 Chair. As shown in Figure 1, the subcommittee is composed of:

- Users – real estate lenders, owners and public agencies
- Service Providers – Civil and Structural Engineers
- Catastrophe risk model providers and developers
- Insurance Brokers, Insurers and Regulators
The Users are large commercial lenders and equity property owners who are interested in active risk management of their portfolios, through seismic risk screening upon acquisition, purchase of earthquake insurance for individual properties or groups of properties, and in some cases seismic retrofit.

The service providers are largely engineers who performed many seismic risk assessments for individual sites (PML studies), and some have done portfolio seismic risk studies for real estate portfolios. Service providers may be engaged by insurance brokers and make use of major commercial catastrophe models, or may be engaged directly by Users, particularly when the service providers also provide PML studies to the User and have familiarity with all or some of the important buildings in the portfolio.

Property insurance brokers are engaged by equity property owners and lenders to obtain earthquake insurance. Large brokers typically license one or more of the large commercial catastrophe models to organize property locations and values (exposure information), and assess risks from a number of perils (e.g., wind, flood, earthquake). The technicians who model site geologic conditions and building vulnerability most often are not engineering professionals, and typically do not review structural design documents for the facilities. These technicians may attempt to supplement basic modeling with “secondary modifiers” where such information may favor the insured. Some conscientious brokers may visit the facilities and may gather past PMLs to provide to the seismic risk analyst.

Insurers typically receive the exposure and vulnerability information directly from insurance brokers in standard formats intended for use with large commercial catastrophe models. Insurers often have dedicated engineering staff who evaluate these data files, to identify and correct errors and improve the modeling.

Insurance regulators are interested in understanding the process used to quantify seismic risks accepted by insurance companies they regulate. They are concerned with insurer solvency and the adequacy of reserves to cover future losses. Regulators are typically actuarial
professionals with advanced skills in statistics and finance.

**Overview of the New Standard**

The new ASTM standard is similar in organization and presentation to E2026 Standard Guide for Seismic Risk Assessment of Buildings, and E2557 Standard Practice for Probable Maximum Loss (PML) Evaluations for Earthquake Due-Diligence Assessments. At present, it has 10 chapters or sections:

1. Scope
2. Reference Documents
3. Terminology
4. Significance and Use
5. Assessment Methodology, Approaches and Tools
6. Individuals Involved and Their Responsibilities
7. Damageability Assessment
8. Level of Investigation and Impact on Uncertainty in Risks
9. Report Requirements
10. References

The body of the standard is followed by appendices describing some of the technical details needed in seismic risk assessment and the limitations of the current state-of-the-art and practice.

**Challenges**

At this point in the development of the practice and the software tools, there are some significant “disconnects” that limit the effectiveness of the portfolio risk assessment process.

Structural engineering professionals involved in single-site PML studies use simple risk assessment tools. Single-site studies are more concerned with building and site stability, and the details of seismic design. Structural engineering professionals are generally unfamiliar with commercial insurance software which is expensive to license. They are familiar with the design process and deterministic design procedures, and are often uncomfortable with probabilistic techniques and the treatment of uncertainty required for risk analysis of portfolios and the application of insurance. The engineers who provide portfolio risk assessment services must adapt to the more strategic view needed for portfolio seismic risk assessment and work closely with Users (owners / lenders), with insurance brokers and with catastrophe modelers to be able to offer effective services.

Catastrophe modelers should work more closely with engineers and adapt their earthquake risk tools accordingly. Their software should be able to identify the sites and assets that drive portfolio-wide risks, and provide effective feedback to the engineering professional regarding the hazards and vulnerability in play for each building at each site. Cat models should be able to accommodate engineering findings to improve modeling.
Progress – Schedule for Issuance of Standard

The subcommittee has been diligently working on the new standard for more than a year.

At the outset of subcommittee activity, a webinar was held to familiarize the members with all of the diverse aspects of modeling seismic hazards, structural vulnerability and risk analysis for geographically distributed portfolios of real estate properties. Typical catastrophe models were discussed and their ability to make use of site-specific and building specific information to improve modeling. The seminar discussed the sources of uncertainties in seismic risk modeling and the value of the engineering professional working with insurance brokers and owners / lenders to reduce uncertainties and identify risk-reduction opportunities.

An initial version of the standard was drafted prior to the launch of the subcommittee to provide a starting point and allow the subcommittee members to review and provide feedback. The document was structured to follow the order and logic of the PML standards (E2026 and E2557) and to build upon that basis, but to define the roles of the larger set of stakeholders, to establish a different set of objectives, where the individual building is less important, and where the concerns are related to the financial survival of the lender or owner’s organization. Much of this draft document was also devoted to explaining complex portfolio seismic risk methods and describing the available tools, since few consultants are capable of constructing their own probabilistic software on a par with the commercial catastrophe models.

The subcommittee decided that the “strawman” document was too long. It did not effectively specify the scope of work for typical studies, and devoted too much space to technical explanations. It identified the existing commercial catastrophe models by name, but did not allow for simple, deterministic scenario studies, such as might be done by a structural engineering firm. With this feedback, each of the chapters from the draft document was assigned to a team of individuals to draft a shorter, more focused chapter. With the completion of the new chapters, work will be needed to harmonize and coordinate the chapters to produce a coherent document for endorsement by the subcommittee and presentation to ASTM.

Upon completion, the standard will assist Users as they engage engineering professionals to assess aggregate losses from earthquake hazards. The guide will encourage standardized terminology and approaches in seismic risk assessment and reporting of risks, and establish guidelines for the assessment of site conditions and building damageability. The standard will establish guidelines on what a Provider may be expected to deliver in seismic risk assessment of building portfolios. It will promote the effective use of software and communication of risk results, and the uncertainty of those results to Users in a manner that is clear, complete and meaningful.

References


2. E2557, Standard Practice for Probable Maximum Loss (PML) Evaluations for Earthquake


