Vibration Isolation and Seismic Control
Manufacturer's Association
994 Old Eagle School Road -- Suite 1019
Wayne, PA 19087-1866
www.viscma.com

MANAGE YOUR RISK IN SEISMIC AND WIND DESIGN

Non-structural components such as HVAC equipment, pipe, duct, electrical systems, fire protection, etc., are essential for a building to operate as needed during and after an event such as an earthquake or storm. If building equipment or systems fail, the cost in public safety, and economic loss can be beyond the value of the building. To reduce risk of failure and exposure to liability, building owners and design professionals should insist the seismic and wind restraints for equipment and building systems in their projects be designed by a licensed professional engineer with unique experience in this specialty.

Public Expectations

When is the last time you walked into a building and wondered if it would fall down around you? Public expectation is virtually 100% confidence that building design is safe. Driving a car can be risky, and the public accepts that risk. But it assumes there is virtually no risk in daily use of buildings, even if subject to events such as earthquakes or high wind. And, for the most part, that confidence holds true for the building structure. Twenty to fifty million people will be injured in a car accident each year. There are only about 10 to15 fatalities per year for building failures. Why? Licensed professional engineering design is a primary reason. The public expects, and most government jurisdictions require, a licensed professional with experience in the field to protect public safety.

Over a hundred years ago, anyone could "engineer" a building in the United States, but events such as the 1906 San Francisco earthquake, which claimed over 500 lives and destroyed the city revealed that better design was needed. As a result, all 50 states, four territories and Washington DC have had engineering licensure laws in place since the 1960's. However, recent events such as the 2010 earthquake that leveled Haiti and resulted in over 200,000 lives lost, demonstrate the danger of unlicensed design. By contrast, the embassy in Haiti, designed by licensed engineers, had only minor damage and was operational to serve as a base for relief efforts. The education, experience, and code of ethics required emphasize that failure in design is not an option. Attention to engineering principles, codes, and details are essential underpinnings of a Professional Engineer. Design out of compliance can result in injury, fatality, economic or environmental loss. Decades of P.E. practices have resulted in more robust buildings with a measurable increased record of life protection and building structural performance. That has become the expected norm by the public.

What About Equipment and Systems?

In contrast, seismic and wind resistant design for non-structural components (HVAC equipment, pipe, duct, electrical, fire protection, etc.) had been overlooked in the P.E. design process. Evaluation after 1964 Prince William Sound, Alaska; 1989 Loma Prieta, California(world series); and 1993 Northridge (Los Angeles), revealed poor performance of equipment and distribution systems. Up to 80% of damage and replacement costs were for non-structural components. Essential building systems failed, crippling or completely shutting down buildings.

In response to the high cost of these deficiencies, the National Earthquake Hazards Reduction Program (NEHRP) was formed and consists of four agencies – FEMA, NIST, NSF, and USGS. This organization developed the provisions which eventually became the International Building Code adopted by all states. It was determined that standard installation methods or rules of thumb did not work. Special engineered design was needed to develop installations that would have a high probability of success. The engineering community began to search for professionals with the unique design expertise to address the increased design loads for non-structural components, and develop design that would have a higher probability of success.

Professional engineering staff of VISCMA member companies along with licensed mechanical engineers in ASHRAE began an ASHRAE Technical Committee to address the need. This committee, TC2.07, Seismic and Wind Resistant Design, pioneered the first seismic and wind restraint design application chapter for the HVAC&R industry. Committee members wrote the "Practical Guide to Seismic Restraint" published by ASHRAE and three Installation Guides published by FEMA. No longer an acceptable risk, failure of non-structural systems is too big of an impact on life safety, economic loss, and environmental danger. The design must be performed by a licensed engineer.

Significance of Licensed Professional Engineer.

The term engineer can be used in many contexts. The meaning behind the word is what is important. It can mean guide, steer, or pilot. An engineer drives a train. An entrepreneur can engineer a great business plan. But even though one may have skill in problem solving, it does not mean they possess the knowledge and experience expected by the public to design building systems that meet the low risk standard. To ensure public safety, property protection, and environmental protection, each state adopts professional engineering laws and regulations. The first engineering licensure law was enacted in 1907 in Wyoming. Now every state regulates the practice of engineering to ensure public safety.

To become licensed, an engineer must demonstrate special knowledge and ability to apply the mathematical, physical, and engineering sciences and the principles and methods of engineering analysis and design, acquired by an engineering education and engineering experience. To ensure a high standard, an engineer must achieve several milestones before they can be licensed. Earn a four-year degree in engineering from an accredited engineering program. Pass the Fundamentals of Engineering (FE) exam. Complete four years of progressive engineering experience under a licensed PE, and pass another test, the Principles and Practice of Engineering (PE) exam. Once licensed, a PE must also continuously demonstrate their competency and maintain and improve their skills by fulfilling continuing education requirements (in most states). In addition to technical requirements, P.E. laws and regulations enact high ethical standards of practice due to the responsibility for not only their work, but also for the lives affected by that work. Licensure for an engineer is not something that is merely desirable; it is a legal requirement for those who are in responsible charge of engineering work. Only a licensed engineer may sign, seal and submit engineering plans and drawings to a public authority for approval, or seal engineering work for public construction clients. Requiring a licensed engineer registered in the state of the project is the best way to ensure the seismic and wind restraint design of non-structural compounds and systems meet high standards and demands.

Limiting exposure to Liability,
There is financial risk to building owners that fail to provide adequate protection for the equipment and systems against seismic and wind loads. Personal injury can result from falling objects, blocked exit paths, fires started by broken gas lines, etc. Loss of essential equipment needed to maintain building function can result in injury or loss of life. If emergency generators or any related life support systems fail, health care facilities cannot care for patients. Failure of smoke evacuation or fire suppression systems can be catastrophic. First responders such as paramedics, firemen, and police cannot react to emergencies if the equipment in their building is lost to earthquakes or wind. The economic costs of a data center equipment failure can cripple a local economy. These are cost liabilities that are not acceptable to the building

owners or their insurers. In addition to cost of damages, many states have passed legislation or judicial rulings that hold a builder responsible for costs to the owner to remedy any installation not in compliance with Seismic/Wind codes. Money at risk includes cost to get a building up to code, diminished value of building, and possible punitive damages for gross negligence. To limit exposure, owners, contractors and design teams engage licensed engineers experienced in the non-structural component seismic/wind specialty. The professional engineer should also have adequate errors and omissions insurance. This reduces the risk of liability to the purchaser of the services.

Which Engineering Branch?

Which engineering discipline is responsible to design seismic and wind restraints for building equipment systems? The simple truth is that there is no one discipline that best covers seismic and wind resistant designs for equipment and distribution systems. This type of engineering crosses over multiple disciplines. It is a common mistake in boilerplate specifications to specify a single discipline such as structural engineering. All P.E.s are required to practice in their area of competence and must be proficient in their field, regardless of discipline. Only a P.E. experienced in the design of seismic and wind restraints for building equipment and systems may stamp the restraint design.

Engineering laws and regulations require licensed specialists to be competent in the subject area. Many practitioners in structural or civil engineering typically only have experience and proficiency in seismic and wind design for structures, and not for non-structural components such as building equipment. A P.E. in these branches may not be as familiar with building equipment and related systems and may be less qualified or comfortable with designing restraints for such non-structural systems. Seismic and wind design for equipment is different than for structures. The dynamic considerations and load paths are different and restraint design requires experience in these systems. Knowledge of multiple building equipment manufacturers and the idiosyncrasies of mounting methods and load path failure points requires experience typical of mechanical engineers. Water distribution systems, electrical systems and fire suppression systems all have unique design features that affect restraint design. Rooftop equipment installations have special considerations to maintain weather resistance. Thus, it is best practice to defer restraint design of non-structural components to engineers of any discipline familiar with building equipment and more experienced in component design. To be compliant with typical state professional engineering regulations, a

PE experienced in the specialty must perform the work. Requiring a particular discipline such as Structural PE does not meet the intent of such regulations and may encourage some to practice outside their area of competency.

Precedence in the engineering community nationwide has historically favored multiple branches of PEs to perform the design for building systems (e.g., mechanical, electrical and plumbing). One of the most widely used texts is "The Practical Guide to Seismic Restraint" published by the American Society of Heating, Refrigeration and Air-conditioning Engineers (ASHRAE). That document was written by a Mechanical PE and included a multidisciplinary technical review committee. The FEMA Guides 412, 413, and 414, "Manuals for Seismic Installation of Electrical and Mechanical Equipment, Duct and Pipe" project contracted with ASCE (Reference: FEMA contract EMW-2001-CO-0379) were written by Mechanical Engineers, and included a review committee with P.E.s from mechanical, electrical, fire protection, and structural disciplines. The BSSC (Building Seismic Safety Council), and ASCE 07 Seismic Subcommittee, which authors the Chapter 13, Seismic Design Requirements for Non Structural Components, are multidisciplinary, too. AHRI Standard 1270, "Requirements for Seismic Qualification for HVACR Equipment" is the ISO consensus standard approved in the ASCE 7-2016 for IBC seismic compliance. It was also written by a Mechanical PE with a review committee made up of multiple disciplines. Licensed P.E.s in IEEE, SMACNA and NFPA are also involved in this type of design. As further evidence, the NCEES, which administers PE tests used by all 50 states, has included a problem to calculate the seismic restraint anchorage requirement for equipment in various disciplines. This is just a small list of the contributions of multiple PE branches to the advancement of the engineering specialty of seismic and wind resistant design for non-structural building equipment and systems.

Instead of specifying a discipline, a specification should require a licensed professional engineer with a minimum 5 years' experience in the field and require a list of projects to demonstrate the experience.

Conclusion

To protect public welfare, limit liability, and maintain the low risk that is expected, it is essential to use a licensed and qualified PE to design seismic and wind restraints for non-structural components. Reference the VISCMA suggested specification for guidance, and work with VISCMA member companies as they maintain a broad range of licensed professional engineers qualified in the unique specialty of seismic and wind resistant design for non-structural components.

VISCMA is a non-profit association representing the manufacturers of seismic restraint, vibration isolation and noise control equipment. The primary objectives of the organization are to educate the construction industry on the proper use and application of vibration isolation and seismic restraint and to develop standards to continually improve the industry.

In partnership with FEMA and ASCE, VISCMA also publishes three Seismic Installation and Inspection Manuals designed to assist field personnel.

The association office is located at 994 Old Eagle School Road, Suite 1019, Wayne, PA 19087-1866 and can be reached at 610-971-4850 or info@viscma.com.