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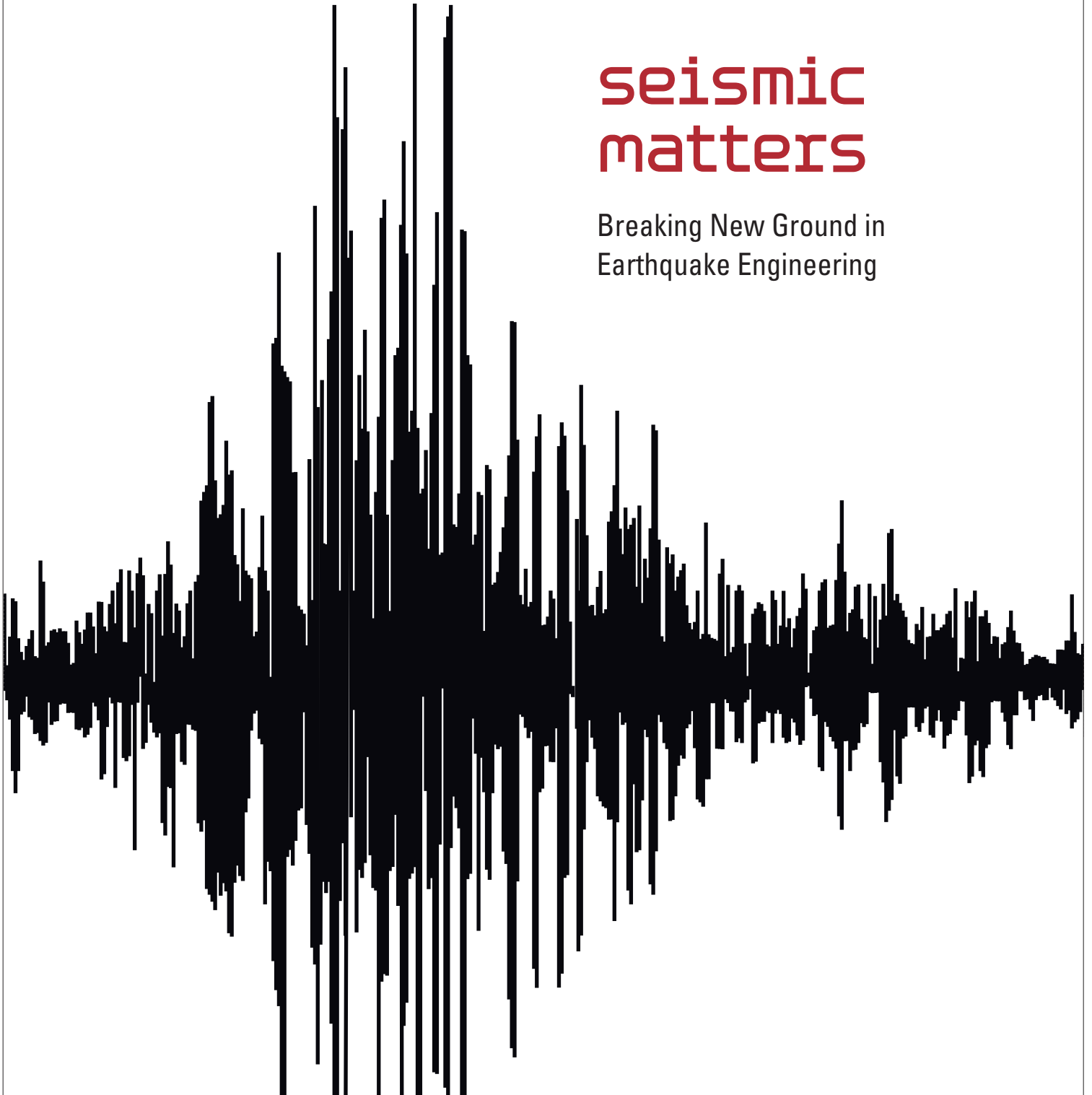
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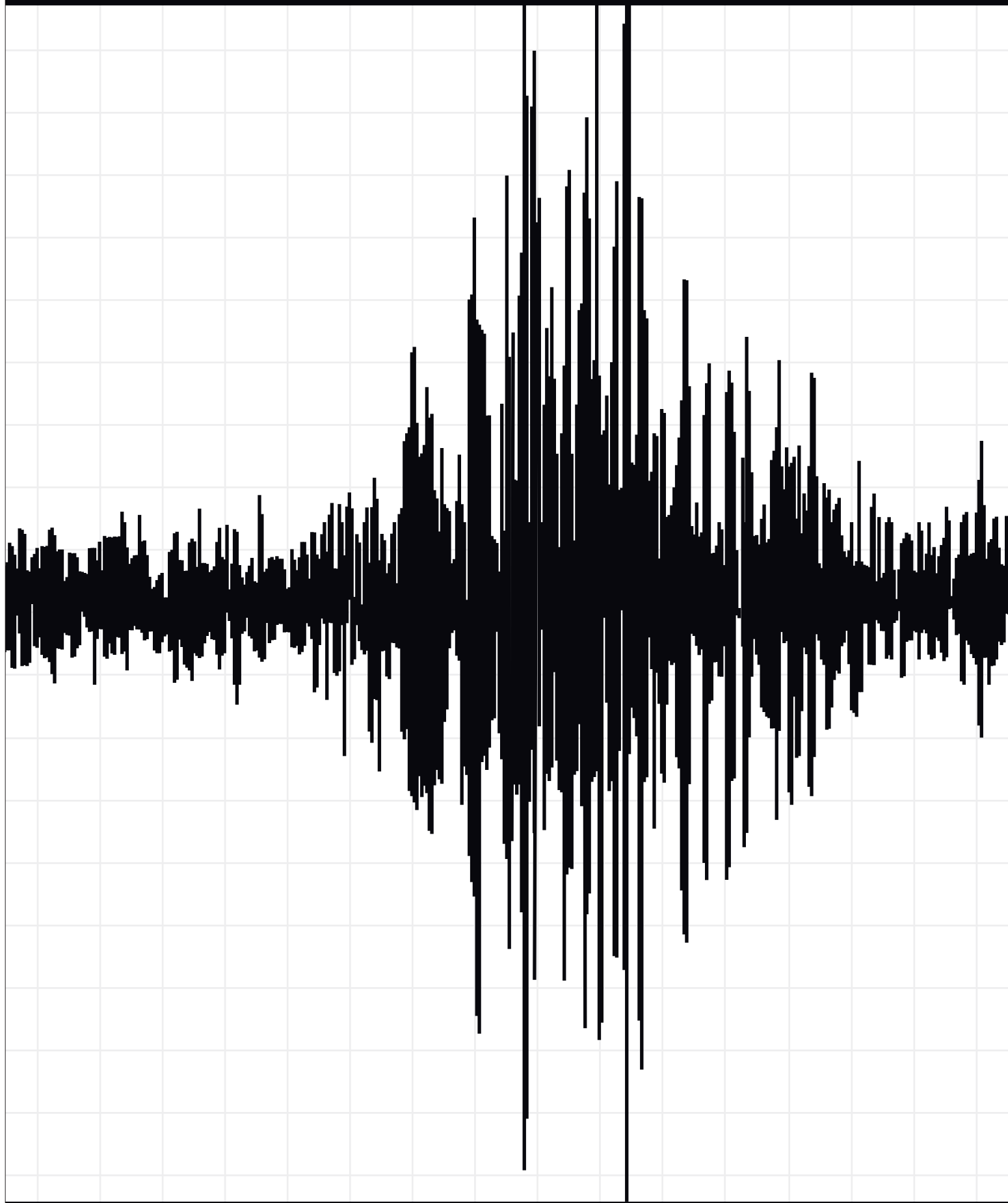
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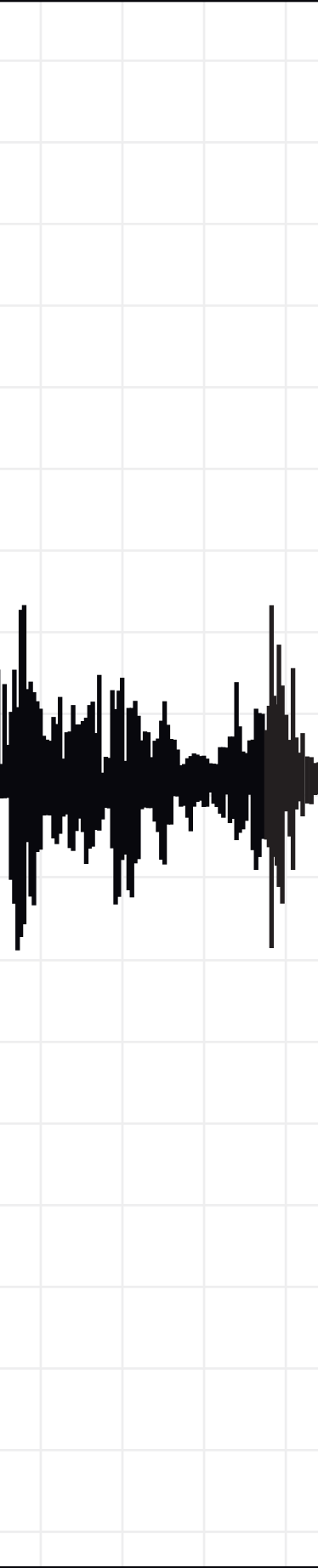
property risk and insurance solutions for a complex world

seismic matters

Breaking New Ground in
Earthquake Engineering







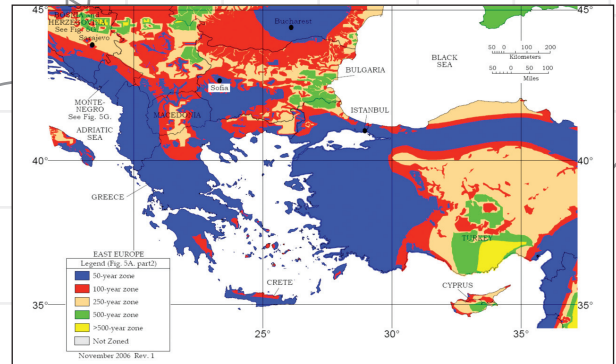
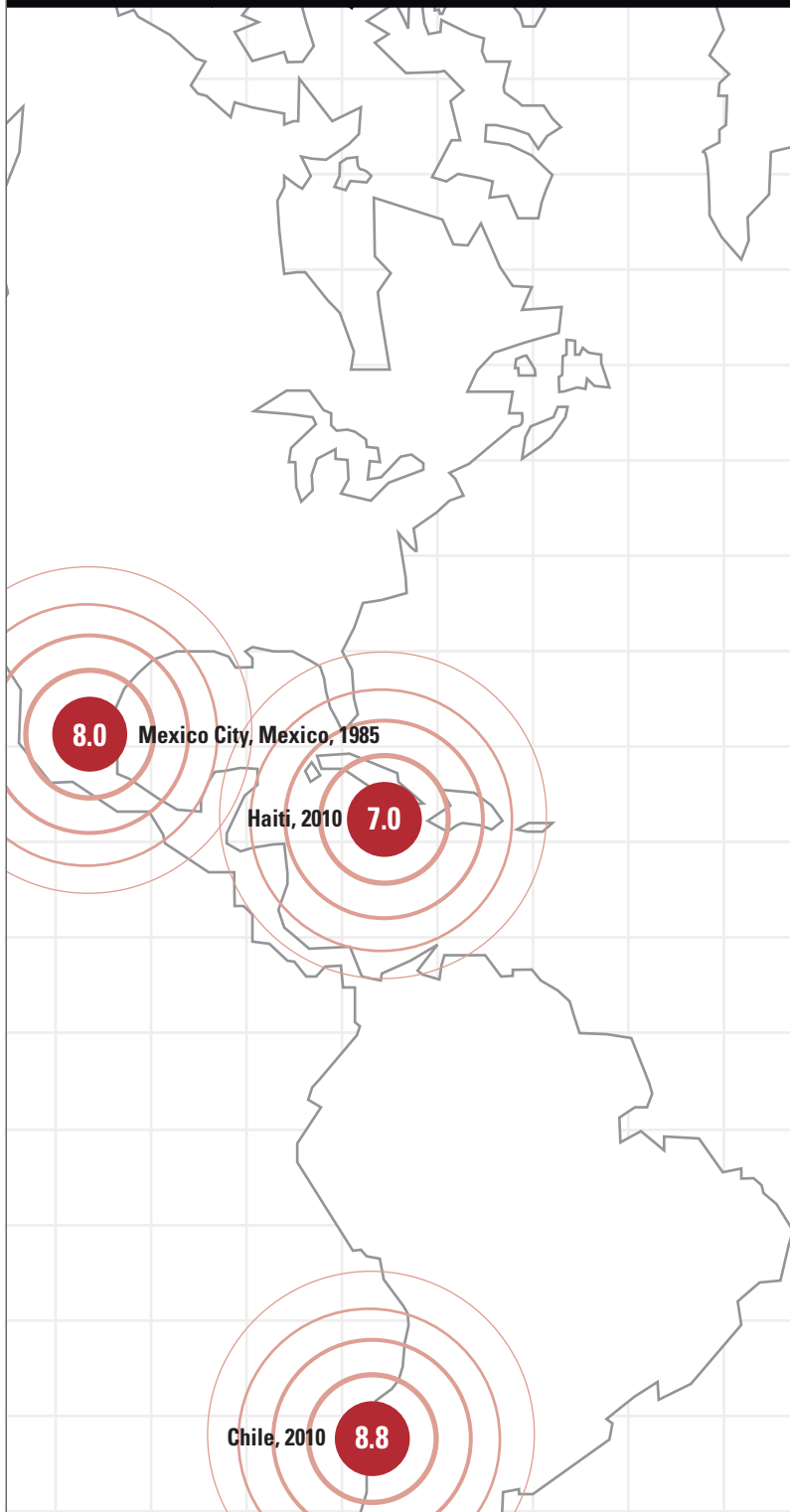
with devastation in Haiti and Chile topping news headlines in recent months, a renewed focus surrounds earthquakes and the utter havoc they wreak. Since 1998, FM Global has offered clients in certain earthquake-vulnerable regions targeted engineering services designed to help them protect their facilities from damage. Now, the company is embarking on the worldwide rollout of its most comprehensive earthquake engineering services yet.

seismic

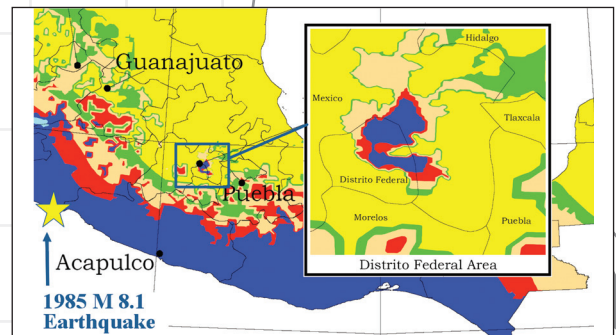
matters

“The over-arching motivation for FM Global to roll out a program like this is to further support our clients in their loss prevention strategies,” says Marc Surleraux, EMEA/Asia Pacific division engineering manager. “We have very effective engineering solutions that can help mitigate the consequences of an earthquake for clients exposed to the tremor of earth movement, and we want to ensure these solutions are presented to them consistently around the world.”

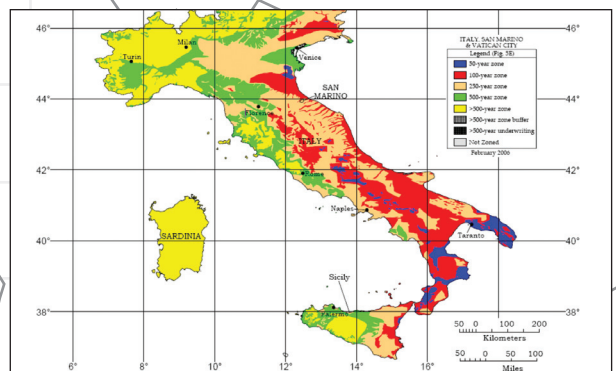
“Since the mid-’90s, we have been helping clients in earthquake-prone areas like the west coast of the United States to safeguard their facilities and their contents,” says John Preli, assistant vice president and manager, natural hazards underwriting, earthquake and terrorism. “We started our research in California, because the risk of earthquake-related loss potential was substantial and had the biggest potential impact to our business. During that time, our engineering focus was validated by several major events.”



Newly detailed risk maps have made the best use of available science to make it easier for clients to assess earthquake risk worldwide.



This map shows how Mexico City, built atop unconsolidated lake bed sediment, becomes a significantly greater risk due to its soft soil conditions.



Pre-determined damage thresholds for weak structural systems are applied to identify zones over which damage will occur at different mean return periods. Earthquake zones generated like this provide a consistent picture of risk worldwide.

shake table

A shake table is used to simulate earthquakes and test the response of structures to verify their seismic performance. "FM Global's shake table is used for testing and to validate our computer models," said Dr. Hosam Ali, director, structural hazards and response research. "We can replicate shaking from an historical or hypothetical earthquake. We use the table

to test reduced-scale models of structures and full-scale, as well as reduced-scale, models of equipment and non-structural components."

"Our shake table is driven by six hydraulic actuators, moves in three dimensions, and has a 34 by 36-foot (10.4 by 11 meters) reinforced concrete foundation that is 13 feet (4 meters) deep and weighs two million pounds

(910,000 kilograms)," he said. "The table can handle loads of up to five tons (4.5 metric tons) and move them at three times the acceleration from gravity. We can apply horizontal and vertical accelerations to simulate the motion of an actual earthquake, as well as rotate the table. This allows us to test how structures and equipment will behave in an earthquake."



“Over time,” says Preli, “we have expanded these services in the New Madrid area of the United States (Missouri, Illinois, Arkansas, Kentucky, Mississippi and Tennessee), as well as in New Zealand, Mexico, Central America, South America and parts of Asia.”

“Little by little, we have added to the earthquake engineering services we offer,” said Christopher Deneff, senior engineering specialist, FM Global engineering standards. “In 2002, the company broadened its earthquake services to clients by helping them understand the risks that result from fires that can ignite following an earthquake, fueled primarily by flammable gas and liquid. In 2004, we began making recommendations to ensure adequate earthquake emergency planning by clients located in 50- and 100-year return-period earthquake zones.”

“In 2006, the company began offering an examination of certain building contents that can easily topple in an earthquake,” he continued. “Currently, we are focusing on two key equipment types: electrical/electronics cabinets and storage racks.”

“Today, we have the research and resources in place to allow us to roll out the full range of services to all clients located within FM Global-designated 50-year through 250-year earthquake zones around the world,” he said.

Earthquake engineering services, evolved

Beginning in May 2010, FM Global’s three-pronged earthquake engineering services—fire protection systems, fire-following and

FM Global’s shake table, located in the Natural Hazards Lab at the company’s expansive Research Campus in West Glocester, R.I., USA, “is scheduled to begin research projects related to plastic and metal piping systems, seismic bracing, and base-isolated equipment, to name a few,” Ali said. (For large-scale testing of structures, FM Global collaborates with the University of

California at San Diego, which operates a larger table that moves only horizontally in one direction.)

“Our researchers analyze data from these tests to determine both what occurred and why,” Ali said. “We aim to validate, refine, improve and expand the earthquake-related loss prevention guidance we give to our clients.”

“In order to provide consistent, worldwide earthquake engineering servicing, we needed to map the global earthquake risk and then train our engineers worldwide so they could effectively evaluate that risk.”

building contents—will be available to all clients with locations exposed to earthquake per the FM Global earthquake maps. This enhanced servicing is part of the company’s effort to provide consistent, worldwide application of detailed earthquake inspections.

According to the U.S. Geological Survey, each year, worldwide, more than 55,000 earthquakes of a magnitude greater than 3.0 can be felt. The cost of resulting damage to buildings and property is astronomical. One single earthquake—the magnitude 6.9 Kobe, Japan, temblor in 1995—produced loss costs estimated at US\$200 billion.

But, according to Dr. Hosam Ali, director, structural hazards and response research, FM Global research shows that most earthquake-caused damage to commercial and industrial buildings is preventable. “Our ultimate goal of our rollout is to advance our ability to help clients limit damage in an earthquake.”

Now, FM Global field engineers will examine the following:

Fire protection/sprinklers

FM Global will determine the earthquake adequacy of a facility’s fire protection system. Christopher Deneff explains. “For example, this includes looking at whether sprinkler piping is sufficiently braced to the structure, whether flexibility and clearance are provided where needed, and whether water supply equipment like tanks, pumps and controllers are adequately restrained.”

Fire-following

To lessen the risk of an out-of-control fire after an earthquake has occurred, FM Global will check to see whether proper fire-following-earthquake protection is present. “This may include determining whether seismic shutoff valves are provided on flammable gas and liquid systems that are piped into buildings, and looking at whether equipment supplied with flammable gas or liquid is adequately restrained,” he said.

Building contents

FM Global will look at practical, cost-effective ways to reduce shake damage to key building contents. The company is concentrating on two equipment classes for which restraint would be practical and affordable. These critical items are electrical/electronics cabinets and storage racks, which can easily topple during an earthquake and lead to both significant damage and potentially major business interruption losses. “Damage to a building’s contents can occur with far less shaking than is needed to inflict structural damage, so even a building that withstands an earthquake may suffer significant loss if the contents are not properly restrained,” Deneff said.

maps, updated and enhanced

FM Global’s earthquake maps provide clients with better assessments for the potential severity of property loss from an earthquake and allow the company to offer more accurate and consistent loss prevention earthquake servicing on a worldwide basis.

“In order to provide consistent, worldwide earthquake engineering servicing, we needed to map the global earthquake risk and then train our engineers worldwide so they could effectively evaluate that risk,” Surleraux said.

“Our maps are innovative,” he continued. “Most existing building code or insurance maps show only the hazard based on ground shaking intensity for a single return period assuming uniform ground conditions of dense soil or rock. Our maps show the risk—that is, the effect of an earthquake on our clients’ property. That makes our maps essential to risk managers to identify their locations susceptible to a given earthquake ‘damage level’ and then to associate the location with a probability or a return period of such damage occurring.”

“FM Global’s maps are similar in concept to local building code maps in terms of the information used for earthquake sources and ground motion attenuation models,” Ali added. “But, we use a consistent methodology applied all over the world, regardless of political boundaries, based on state-of-the-art seismic information from refereed journals and established government authorities. Our new maps have several key differences that help set them apart from other maps. The most significant difference is our inclusion of local soil condition data within the maps.”

“This is an important point, as a building constructed on ‘soft’ soil will experience different shaking from an earthquake of the same magnitude than a building constructed

on 'hard' soil," Ali said. "Ground motions represented in building code and other earthquake maps must be adjusted by the design engineer for local soil conditions; therefore the maps themselves do not fully reflect the risk of damage to property. As site soil goes from more competent, such as rock (Soil Type A), to very poor soil (Soil Type E), the performance of a building or equipment can change significantly."

In the real world

"Because all areas do not have the same soil conditions—and the soil profile dramatically affects the behavior of a structure during an earthquake—FM Global classifies the soil and reflects that directly in our maps," Preli added. "Knowing the soil conditions helps us pinpoint where the risk lies."

Here's an example: According to FM Global's map of Mexico, Mexico City is situated in a more severe earthquake zone (50-year) than the area immediately surrounding it (greater than 500-year zone). "That's because poorer soil conditions exist in Mexico City than in nearby environs," Preli says. "Mexico City and its surrounding area are an excellent example of the impact varying soil conditions can have on a client's experience in an earthquake."

The magnitude 8.0 earthquake, which occurred in 1985 about 210 miles (340 kilometers) from Mexico City, illustrates the effect of poor soil on shaking intensities. At 210 miles (340 kilometers) away from the epicenter, unconsolidated lake-bed sediments underlying parts of the city amplified the shaking, resulting in a far higher level of damage in these areas, according to Ali.

"The intent of our maps is to reflect the earthquake risk in addition to the hazard by considering system vulnerabilities to offer both the detail needed for effective property risk assessment and enough information to help clients in their risk management decision-making," he added.

Ali explains, "Besides using ground motions that account for the broad variations of local soil conditions, FM Global's earthquake maps stand apart for other reasons. FM Global risk maps rely on spectral accelerations, or simply the building response, a better measure of the damage potential of ground motion than the peak ground acceleration or Modified Mercalli Intensity used by most building codes and other hazard maps," he says. "FM Global's maps present return periods (50-year, 100-year, 250-year, 500-year or greater than 500-year) for a specified damaging ground motion intensity, while other hazard maps present ground motions, damaging or not, for a specified return period, typically 475 years."

Training supports rollout

To ensure that all FM Global field engineers have the background to execute the comprehensive earthquake engineering service plan, the company has developed an online self-study course, which all field engineers must complete. Mentors in local offices then help guide and advise field engineers as they execute client servicing.

"We are confident that this training undertaken by our field engineers," says Deneff, "combined with the insight offered by highly experienced earthquake engineer mentors, will allow our staff to effectively and knowledgeably carry out FM Global's earthquake engineering program in locations around the world."

"Our engineers will not make recommendations that a building be made earthquake-resistant if it is not, but rather we will make recommendations for avoiding sprinkler system impairments, preventing fires from ignitable liquid and gas piping leakage, and avoiding damage caused by equipment tipping over," adds Surleraux. "For clients in areas with a high frequency of earthquakes, our engineers can also advise on how to build an appropriate emergency response plan.

Those focused efforts will help our clients recover more quickly from a moderate shake event."

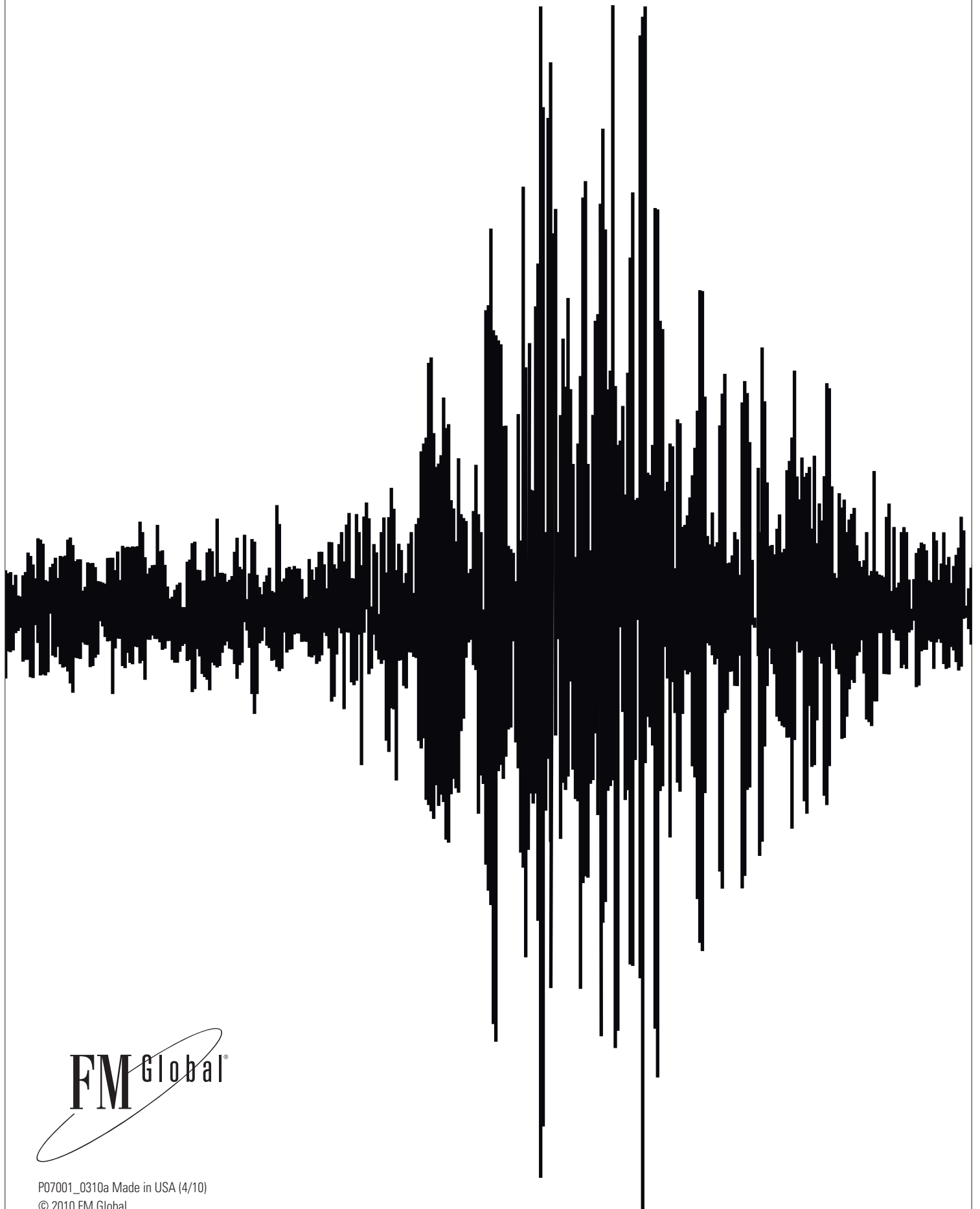
metrics of success

"We will consider the program a success if clients adopt our earthquake-related recommendations for risk improvement as appropriate," says Deneff. "It is important to make shake improvements, because that's where major damage from an earthquake occurs. The total collapse of earthquake-designed industrial buildings is rare. But shake damage can be extensive."

"Even if clients choose not to adopt all of our recommendations, whether for business or financial reasons, we feel the program is a success if they better understand their risks," he continues. "Armed with this knowledge, they may elect to carry out risk improvements at a later date and in the meantime, can make informed risk management decisions."

"In addition to classic underwriting methods, implementation of worldwide engineering services will allow us to use site-level risk assessment and risk improvement to manage our aggregate risk," says Preli. "This will allow us to reward our high-quality earthquake risk clients with better terms and conditions, such as more insurance capacity. Most important, our clients will be aware of their exposures and will have the opportunity to reduce these exposures at all of their locations through risk improvement."

Look for the rollout of FM Global's earthquake engineering service to begin worldwide in May and continue for several months until these services are available to client locations in all earthquake-susceptible areas. [R]



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