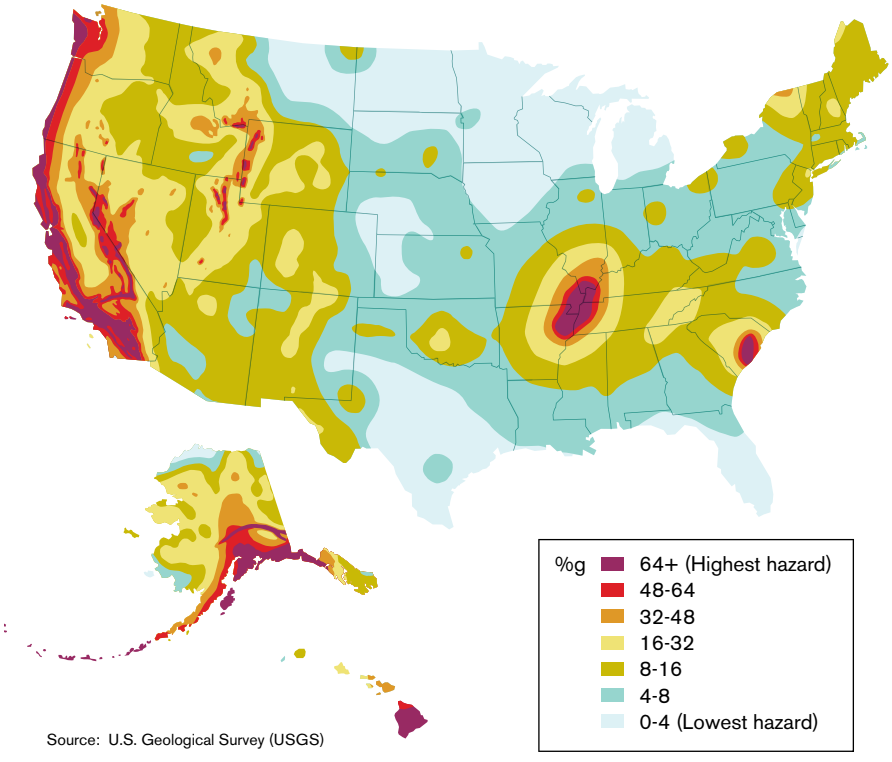
Secure rack against

In the wake of catastrophic earthquakes around the world, and here in our own backyard, *Modern* looks at how to keep warehouses and distribution centers standing tall in the event of a seismic episode.

By Lorie King Rogers, Associate Editor

High-risk seismic areas

High-risk seismic areas across the country are identified based on the frequency and intensity of ground motion.



Source: U.S. Geological Survey (USGS)

Seismic areas across the United States pose varying degrees of risk, from low to extreme. Current technology can dissect these areas by zip code and can even pinpoint the risk of a specific street address.

Terra firma isn't all that firm. Every minute of every day there's an earthquake rumbling beneath the surface of the earth. In fact, the United States Geological Survey (USGS) locates about 50 earthquakes daily, or 20,000 annually. However, it estimates that millions of earthquakes go undetected each year because they happen in remote areas of the world or measure such a small magnitude on the Richter scale.

Those earthquakes aren't the ones that worry us. Here in the United States, in 2011 alone, we experienced 22 earthquakes measuring between 2.9 and 7.3 in magnitude. And they happen in all states, not just California. From Alaska to Alabama, Oregon to Ohio, an earthquake can hit anywhere at anytime.

"The earth is always shaking and moving," explains Sal Fateen, a structural engineer and the president of Seizmic Material Handling Engineering. "It's actually a good thing for the earth to release tension, but the problem is that nobody knows exactly when the earth will decide to misbehave."

That erratic behavior can wreak

seismic events

At this testing facility, the goal of seismically engineered rack is to make it able to absorb the shock caused by a seismic event.

havoc with our warehouses and distribution centers if we aren't prepared. Rack systems that support the materials handling industry are particularly vulnerable to damage caused by seismic events. But, there are strategies and solutions that can protect people, property and products.

Identifying high-risk seismic areas, conducting inspections, and keeping rack equipment in good repair can help minimize the damage caused by an earthquake.

Seismic areas

Over the years, high- and low-risk seismic zones have been identified based on history and testing. Being in a low-risk area, however, doesn't guarantee you'll be spared. For example, in October of 2011, low-risk southern Texas experienced a 4.8 magnitude quake.

Still, the zones are a valuable guide. "When we consider seismic forces, we reference the zip code of where the rack will be built, and, depending upon the area, significant upgrades may be required to comply with the seismic forces," explains Bob Novak, area market manager for Interlake Mecalux.

But because every rack installation is unique, there are no hard and fast rules for specific upgrades in any particular area. According to Dave Olson, national sales and marketing manager for Ridg-U-Rak and president of the Rack Manufacturers Institute (RMI), highly refined values for specific locations, which are publicly available, weigh heavily into rack designs. And, along with the rack structure height, depth of the frame, load weight, application, and type of rack, these values play a vital roll in seismic consideration.

The purpose of the identifying high-risk areas and establishing building requirements within those areas, however, is not to "earthquake-proof."

According to Fateen, that's not possible. The purpose is to minimize the damage that may occur from an earthquake. "It all boils down to developing a force that gets applied to a structure. Once you get that force, you have to develop equipment that can stand up to the test," he says.

The force is calculated using a formula that includes a number of factors. While the calculations are extremely complex, Fateen explains, the force is a percentage of the weight of the structure and the load it carries. The rack

structure has to be designed to resist the forces applied to it, including seismic ones.

Seismic solutions

The goal of seismically engineered rack is to make it able to absorb the shock caused by a seismic event, but engineers can't make blanket statements about achieving that goal because every job is different. "We look at all the specifics of a project and compile the data that leads to the most economic set of components to meet the structural requirements of the job," says Jim Courtwright, Ridg-U-Rak's director of engineering.

One component in the equation is the metal used to construct the rack system. Either rolled form or structural steel can be used to construct seismically designed rack systems. "It's simply a customer decision based on the application," says Olson, "but both types can be effectively designed for most applications. Depending on the height and load of the rack, a heavier gauge steel may be required."

At rest, the yellow marks on this rack support structure are in alignment. During an actual test on a seismic shake table, the marks show how far the upright frame can travel during a seismic event.

Seismic upgrades to the rack frame can be done in a number of areas. For example, the beam can require additional weld at one or all elevations, explains Interlake Mecalux's Novak. Additionally, large beam connectors can be added for additional connection points to the frame and to provide additional lateral support. "Frame reinforcement, heavy or special strut panels are generally associated with capacity, and can be used for seismic conditions when the load requires additional lateral support than was intended for the standard capacity frame," Novak adds.

In some seismic rack applications, a more substantial footplate may be used to support the rack uprights. "The larger, thicker footplates not only spread the load across a larger floor area, but they

Iron Mountain: Still standing in the wake of a quake

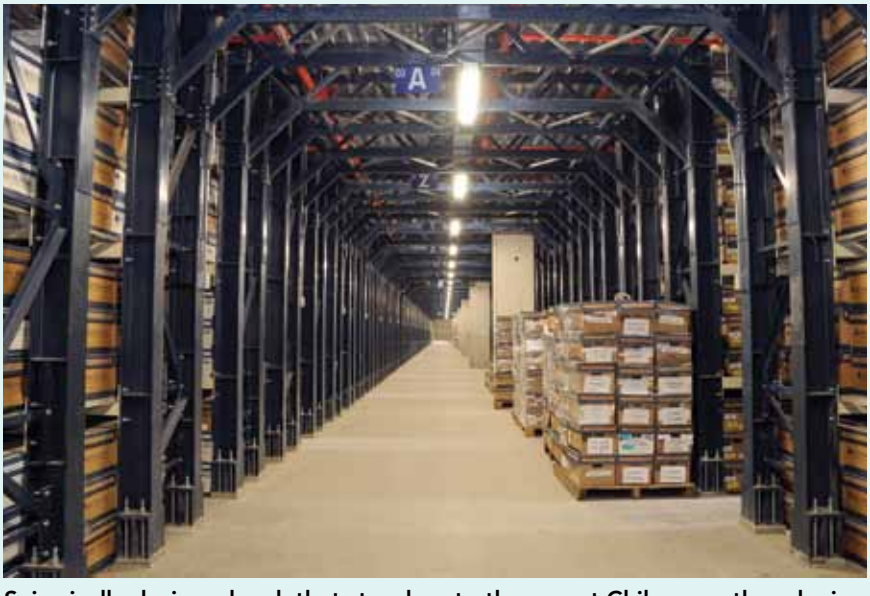
On Feb. 27, 2010, an earthquake measuring 8.8 on the Richter scale rocked the South American country of Chile. It was the world's sixth most powerful quake ever recorded and lasted about 2 minutes—long enough to claim hundreds of lives and cause an estimated $30 billion in damage to residential property and commercial businesses, including Iron Mountain.

For more than 60 years, Iron Mountain has protected the vital records of more than 1,200 businesses around the world. Its dual-campus in Lampa, Santiago, includes high-height record management facilities with large selective rack systems used to store massive quantities of paper documents. Damage from the earthquake resulted in Iron Mountain razing seven buildings and the racking systems in each.

But one of its buildings, a 1.4 million-box warehouse with a multi-level, high-density rack installation (Interlake Mecalux, interlakemecalux.com) still under construction, stood tall. Because it wasn't yet complete, it wasn't carrying any loads. However, subsequent inspections concluded that it would have remained undamaged had it been completed and loaded.

While the company suffered damage, Iron Mountain was one of few businesses able to remain productive in the earthquake's aftermath; literally a port in the storm for clients looking to relocate their important documents to secure facilities.

Faced with the urgent job of simultaneously rebuilding and growing its business, Iron Mountain turned to the supplier to build two maximum-capacity warehouses because, according to Doug Berry, Iron Mountain's director of construction and facilities, its proven seismic designs that have stood the test of time and the test of an earthquake.



Seismically designed rack that stood up to the recent Chilean earthquake is being using to rebuild document storage facilities on Iron Mountain's Lampa, Santiago, campus.

will resist tearing or bending to a much greater extent, and offer a larger area in which to place required floor anchors," says Weiker Kline, senior product manager for Penco Products.

Another solution used to secure the frame to the floor is a housing called a base isolator that is anchored down using bolts that meet the area's requirements. The upright rack frame is mounted to a plate within the base isolator. During an earthquake, the plate allows the frame to slide back and forth to mitigate the energy of the seismic wave. In this case, the bottom of the rack moves to prevent the top from swaying.

The floor anchors, or bolts, used to secure the footplates or the base isolator components to the floor are not specifically designed for high-risk seismic areas. The bolts are available in different sizes and capacities.

There are a number of ways to repair and replace damaged columns—doing so without having to unload the rack is key to maintaining productivity.

Proceed with caution

The ability of any rack component to withstand the force and tremors of an earthquake can only be discovered through testing. Whether you're buying new or used rack or transferring your rack from one facility to another, a rigorous testing process should be applied to the rack structures to ensure it is performing properly.

Testing is also important when connecting components manufactured by different suppliers. "The beam-to-column connections on pallet rack systems from manufacturer to manufacturer are usually proprietary," says Courtwright. "That doesn't mean they won't fit together, it means the only way to know how the beam-to-column connection will react to applied seismic forces is through testing."

Being able to mix and match rack components manufactured by different suppliers creates rack options for end users and adds to functionality and versatility within the four walls, says Kevin Curry, national accounts manager for Steel King Industries. It can work for rack shelving for storage, as a mezzanine to create a second floor, and to support picking operations.

Versatility is especially beneficial if your operation has seasonal product. But you can't move rack around and assume you will maintain the same seismic integrity. "Be very careful that any rack installation is compliant with current code," says Don Derewecki, senior business consultant at TranSystems. "Many firms get into trouble with code compliance when they try to relocate or modify rack. They may violate the grandfathering they have with existing code."

Prevention and repair

Surviving an earthquake with minimal damage not only depends on the rack design and materials, it depends on regularly scheduled inspections and maintenance. "Preventative measures are always a good idea," says Interlake Mecalux's Novak. "Column protection, end of row protection, and guide rails are all good safety features. However, the customer should consult with a qualified supplier first to determine whether or not additional equipment will infringe on the aisles and create issues with lift equipment, traffic or throughput."

Even with the most diligent preventive measures, accidents and damage happen. Any rack damage that is significant enough to create a crease should be repaired or replaced. A weakened segment is susceptible to breakage and could snap during an earthquake. Damaged frames should always be repaired or replaced.

Novak also suggests inspecting beams regularly to confirm the original locking mechanism is in place. This prevents accidental lift-out from the frame. If the lock is not in place, the beam should be bolted in or replaced.

RMI suggests that facilities with rack structures have a comprehensive inspection plan in place. The details of that plan will vary from company to company depending on the needs of the environment, including the volume of traffic and throughput, but safety is always the bottom line concern. ☐

Companies mentioned in this article

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