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Protecting Telecommunications Equipment in Seismic Areas

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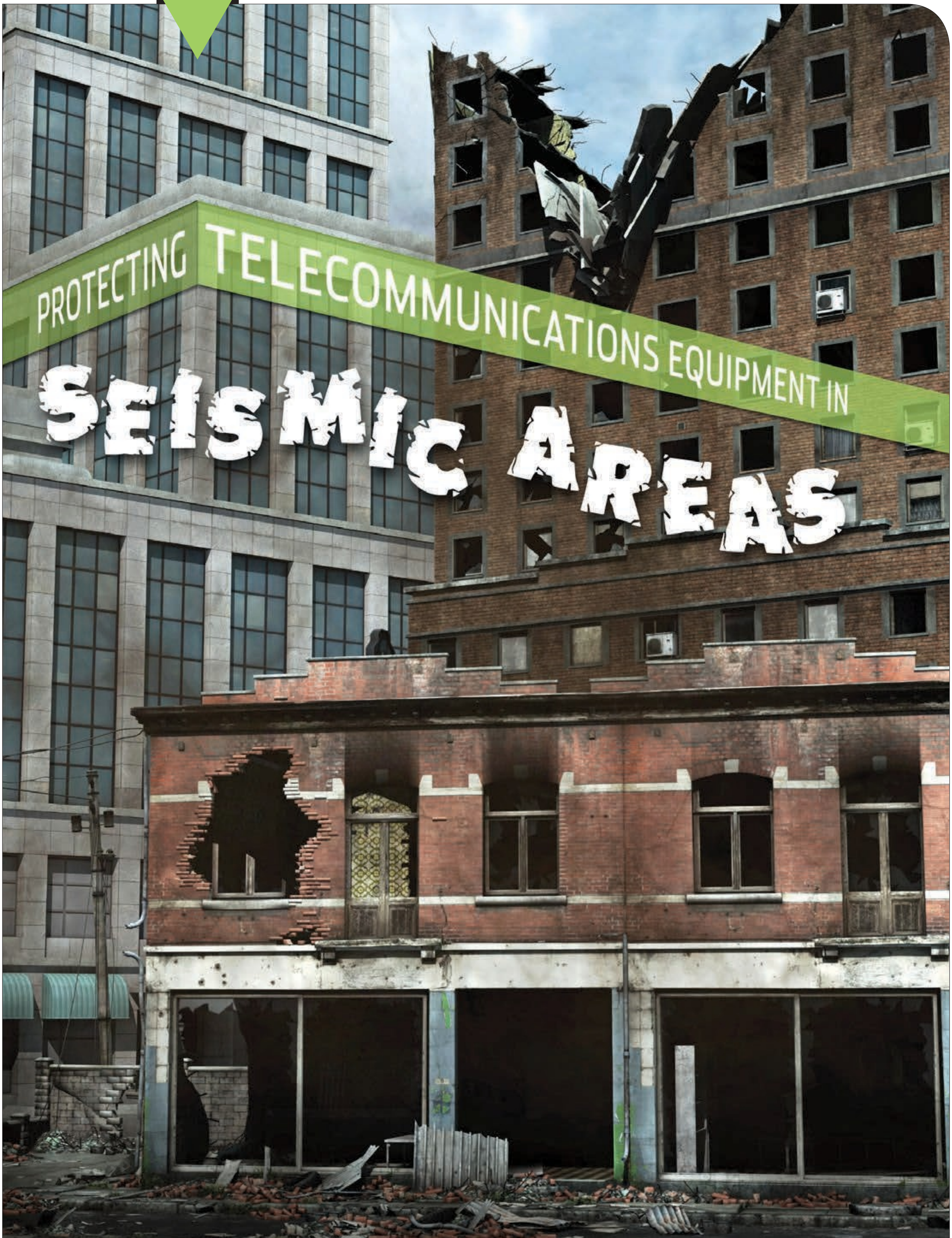
PROTECTING TELECOMMUNICATIONS EQUIPMENT IN SEISMIC AREAS



By Sam Rodriguez, RCDD

An enclosure's seismic load capacity indicates how much weight a cabinet or rack can hold and protect equipment during a seismic event. The higher the seismic load rating, the more equipment and weight it can support.

Seismic events are not uncommon, nor are they limited to the state of California. In fact, earthquakes take place every day throughout the world. According to the Incorporated Research Institutions for Seismology, a consortium of universities dedicated to researching seismological data, minor earthquakes (magnitude 2 and smaller) can occur hundreds of times a day worldwide, while major earthquakes with magnitudes greater than 7 happen more than once a month. Severe earthquakes, with a magnitude of 8 and higher, occur about once a year. The U.S. Geological Survey monitors and reports earthquake events and publishes hazard maps to help understand the risks. You can see a history of events and download hazard maps at www.earthquake.usgs.gov.

For information technology managers, it is easier to prepare for the next earthquake than to predict when it will happen. To reduce risk of injury and minimize damage to telecommunications equipment during an earthquake, proper seismic protection is essential. This is especially important in telecommunications and equipment rooms, as well as data centers that cannot afford to be offline or are not backed up at a secondary location.

Selecting the right infrastructure products for a data center is the key to getting the most protection for servers, switches and cables. Equipment and accessories such as racks, cabinets and bracing help minimize excessive motion that may cause undue strain on cable and network connections.

There are two crucial questions to ask when preparing a data center, hospital or other facility for a seismic event:

- How important is the network or server rack to the facility's seismic strategy?
- Will it endure high ground acceleration levels and keep the network operational during and after a seismic event?

Seismic Threats Defined

Earthquake is a term used to describe both a sudden slip on a fault, resulting in the ground shaking; and radiated seismic energy caused by the slip or any other sudden stress changes in the earth.

Seismic threats can be measured according to hazards and risks. Earthquake hazards are anything associated with an earthquake that may affect the normal activity of people. This includes surface faulting, ground shaking, landslides, tectonic deformation and tsunamis. Earthquake risks are the damage or losses that result from exposure to seismic hazards. They are measured in terms of expected casualties, financial losses and disaster planning.

Seismic zones in the United States are based on a statistical compilation of the number and magnitude of past earthquakes. There are six zones—Zone 0, 1, 2a, 2b, 3 and 4. Zone 0 has the least seismic activity and includes many areas

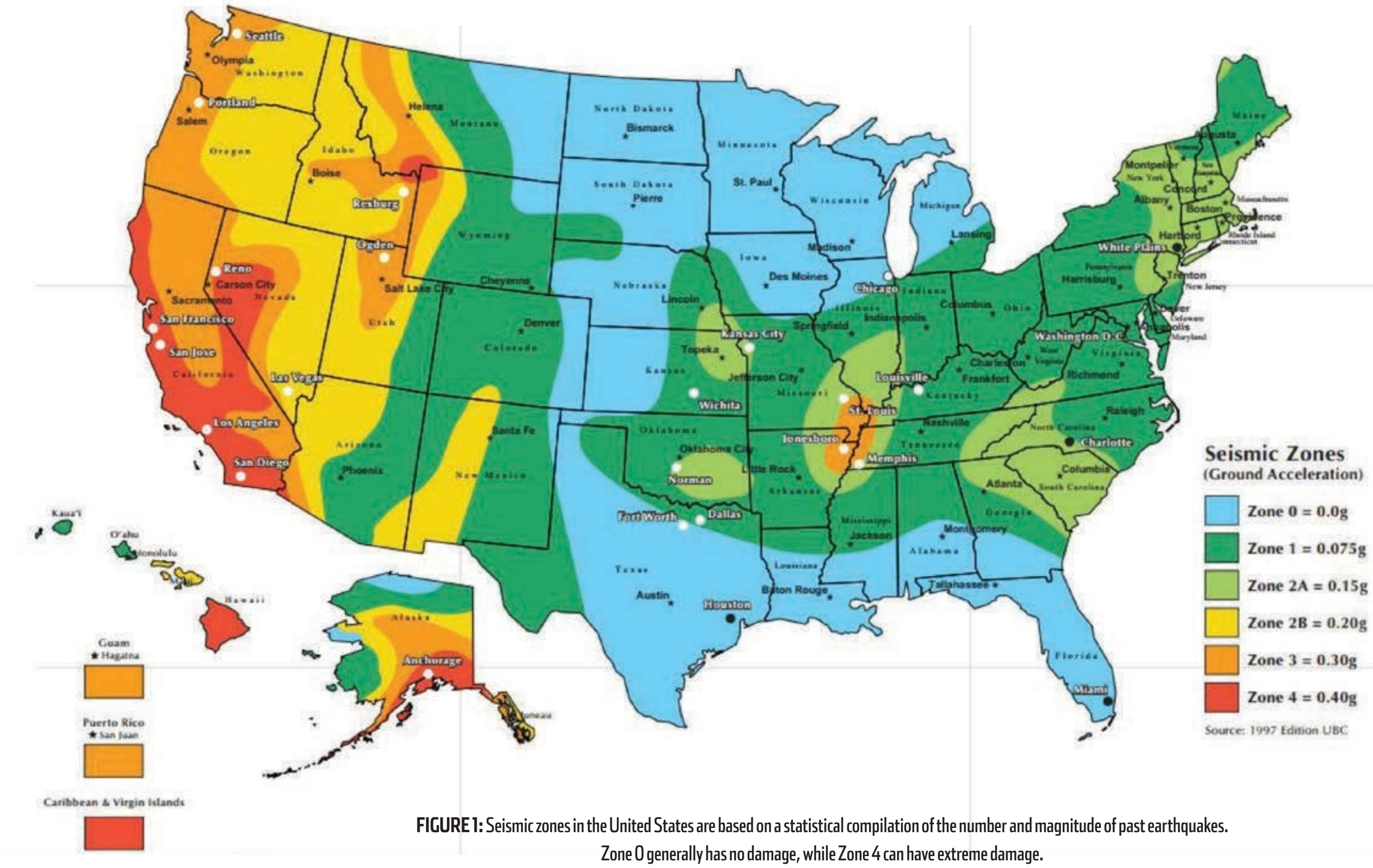


FIGURE 1: Seismic zones in the United States are based on a statistical compilation of the number and magnitude of past earthquakes. Zone 0 generally has no damage, while Zone 4 can have extreme damage.

of the Midwest, as well as Florida. Zone 1 includes most of the East Coast, as well as parts of the Midwest, including Oklahoma and Missouri. Zone 2a is sporadic across the country and includes New England, South Carolina and parts of North Carolina and Tennessee. Zone 3 includes some of the Western states and Alaska, as well as a small area in the Midwest. Zone 4 is only in the West, primarily in California, Nevada and Hawaii (Figure 1).

How Building Codes Affect Seismic Rating of Products

Building codes define construction and installation requirements for public buildings to ensure the safety of people and equipment. Seismic areas require specific codes. For example, structures designed according to the International Building Code (IBC) are expected to have a very low to no likelihood of collapsing during a seismic event.

The IBC also incorporates the ASCE 7, Minimum Design Loads for Buildings and Other Structures, developed by the American Society of Civil Engineers (ASCE), which provides guidelines and specific calculations to prevent nonstructural components from sliding or overturning during an earthquake. (California has its own codes, the California Building Code [CBC], which incorporates IBC's criteria and requirements but with some adjustments to accommodate the state's laws.)

Some facilities are considered essential and are required to continue operation even after an earthquake. According to the IBC, buildings can be ranked under four risk categories, as shown in Table 1.

Components and nonstructural elements that are going to be installed in the facility also get a grade—the component importance factor (Ip), which tells the engineer if there is a need for a special floor design or installation practice. Depending on the Ip (either a 1 or

Risk Category	Nature of Occupancy	What it Means
I	Agricultural facilities, storage facilities	No real threat if equipment and systems stop functioning
II	Buildings that don't fall in Category I, III or IV	No real threat but possible
III	Education facilities, public utility facilities, telecoms, jails	Represent a substantial hazard risk to human life
IV	Hospitals, fire and police stations, emergency shelters, aviation control towers, national defense buildings, facilities containing highly toxic materials	Designed to be essential facilities and required to maintain functionality in the case of an earthquake

TABLE 1: Seismic risk categories for buildings, as ranked by the IBC. Table 1604.5. Excerpted from the 2012 International Building Code; Copyright 2011. Washington DC; International Code Council.

FIGURE 2: Hospital data centers rate an Ip of 1.5 because they cannot be offline following a seismic event.

1.5), building design anchorage, bracing requirements and design robustness are either stricter or can be more flexible to meet codes.

For example, an essential component that is required to function even after an earthquake (e.g., fire protection sprinklers, hospital networking) would get an Ip of 1.5 (Figure 2). Likewise, components that contain hazardous substances or that will be attached to a Risk Category IV building and are required to keep operating in such a building also would get a 1.5 Ip and must have a special seismic qualification from an accredited institution.

Some components are expected to remain in place, sustain limited damage and, when necessary, function after an earthquake. These are given an Ip of 1.25 and are required to include seismic bracing to meet IBC. In all other scenarios, the Ip would be a 1.

Why Seismic Qualification Matters

There are three different ways manufacturers can show their products are qualified to perform in seismic areas:

- Analysis and design calculations that take into consideration the Ip of the component, among other variables.
- Shake-table testing, which tests products on a physical level with stringent conditions, simulating a severe earthquake and ensuring the product will perform before, during and after an earthquake.
- Experience data, which requires that manufacturers submit evidence that the product has performed under severe earthquake.

Installers and contractors must evaluate the type of seismic rating a manufacturer is providing, as there are different methods to achieve a seismic rating for a product.

FIGURE 3: A shake-table test ensures that an enclosure will function properly during seismic events. The shake table simulates an earthquake (up to 8.3 on the Richter scale) and shakes the enclosure front-back, side-side and up-down at different levels of intensity.

IBC compliance certification considers the products and their interaction with the entire building. Approval is achieved either through a mathematical equation that compares and extrapolates potential seismic effects to the components installed in a building or by providing sufficient experience data showing a component's performance during a strong earthquake. Using experience data requires the manufacturer to design the new component with the same specifications. Either way, many variables play into achieving IBC compliance.

Another common and widely sought-after seismic certification is the Telcordia Technologies GR-63-CORE Network Equipment-Building System (NEBS), which provides a set of directives to ensure the protection of telecommunications equipment. GR-63-CORE requires an enclosure to provide protection for equipment so that it maintains operation during and after a seismic event. Unlike the IBC certification process, which is based on analysis, GR-63-CORE tests products on a physical level with stringent conditions to prevent system downtime. Putting a product through a simulated earthquake is the most realistic way to verify its seismic performance. Because of GR-63-CORE, telephone lines still function after severe earthquakes.

To get a GR-63-CORE certification on an enclosure, for example, the product is loaded to maximum capacity and mounted on a shake table (Figure 3). Anchorage, bracing and accessories required during actual product installation are also addressed in the test. The shake table simulates an earthquake (up to 8.3 on the Richter scale) and shakes the enclosure front-back, side-side and up-down at different levels of intensity. To pass the test, the enclosure must not move more than 75 millimeters (mm [3 inches (in)]) at the top of the enclosure relative to the base in each direction and must maintain operation during and after the shake test. The enclosure also must return to within 61 mm (2.4 in) at the highest point of its original position.

In California, the Office of Statewide Health Planning and Development (OSHPD) also provides special seismic certification of products that will be installed in hospitals and health care facilities. In addition to IBC and NEBS, OSHPD certification is based on requirements from the CBC and ASCE 7-10.

Depending on the type of product, an OSHPD Preapproval of Manufacturer's Certification (OPM) or an OSHPD Special Seismic Certification Preapproval (OSP) may be required (Figure 4). OPM is a pre-approval of manufacturer's certification, a process that allows manufacturers to submit analysis or test data prepared by a registered design professional to support design requirements of the code. If approved, this OPM can be referenced in construction documents. It is intended to speed up the approval process for standard installations but is not required. The submission may be project-specific, requiring separate review. Any alterations must be submitted for review and reapproval. (OPM is correlated with permits under the 2012 code. It is backward-compatible with previous codes. OPA, the program that preceded OPM, applies to older versions of codes and cannot be used with 2012 code submissions.)

OSP is the OSHPD preapproval of designated seismic systems for critical components (Ip of 1.5) with moving parts that must function after an event, such as heating, ventilation and air conditioning, uninterruptible power supply or a cabinet frame with system components and electrical connection included. The manufacturer conducts an evaluation of the product using a shake test to confirm function after the event, and the event is labeled with seismic-application information. OSP reviews the evaluation and labeling and preapproves the application of the component.

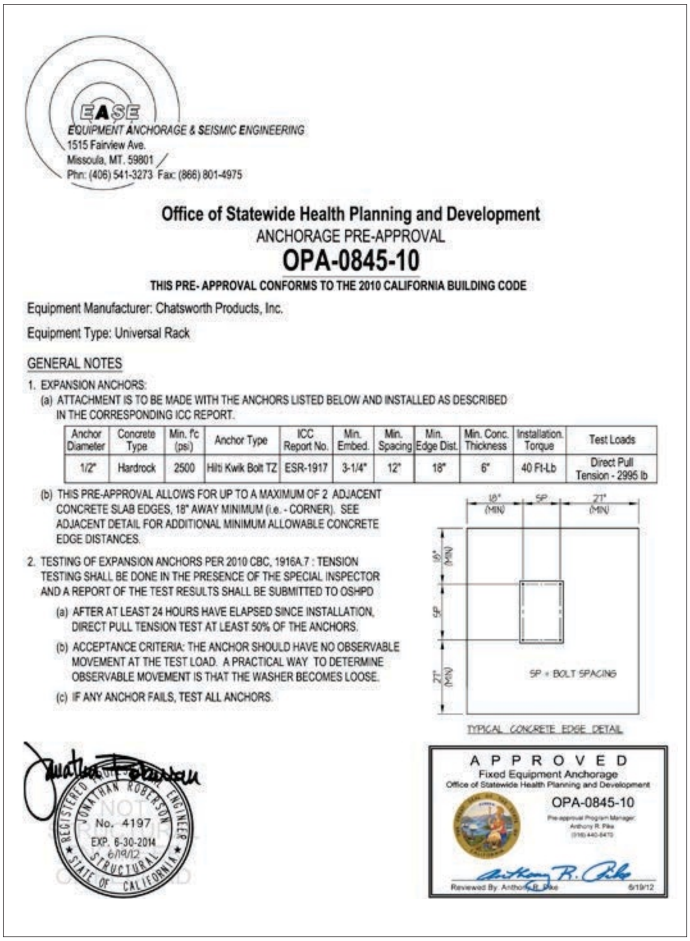
Mounting Considerations

Installers and contractors must also address the way nonstructural components are anchored and braced in a seismic zone or building with Risk Category IV.

Bracing and anchorage must be strong enough to resist seismic activity. Fasteners and anchors with high-shear and high-tensile strength ratings should be used to secure components. When mounting on a concrete floor, it is important to choose seismically rated floor anchors that can support the load of the rack and equipment. A minimum of four floor anchors (one at each corner) is typically required for a two- or four-post equipment rack or cabinet installation.

In addition to complying with building and telecommunications standards and acquiring seismic-rated products, the product design should also be considered carefully. In telecommunications rooms and data centers in seismic areas, it is important to look for certain features when selecting the right enclosures.

Is the enclosure seismic rated? The enclosure should be designed, certified and tested for use in seismic areas (Figure 5). If the enclosure was put under a physical test, such as the one required by NEBS or the International Code Council Evaluation Services Acceptance Criteria 156 (ICC-ES AC156, another recognized testing standard procedure), the manufacturer should be able to provide the lab test report, calculations and a video of the shake-table test. Because shake-table testing provides a defined result of pass or fail without affecting performance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Office of Statewide Health Planning and Development
ANCHORAGE PRE-APPROVAL
OPA-0845-10
THIS PRE- APPROVAL CONFORMS TO THE 2010 CALIFORNIA BUILDING CODE

Equipment Manufacturer: Chatsworth Products, Inc.

Equipment Type: Universal Rack

GENERAL NOTES

1. EXPANSION ANCHORS:
   (a) ATTACHMENT IS TO BE MADE WITH THE ANCHORS LISTED BELOW AND INSTALLED AS DESCRIBED IN THE CORRESPONDING ICC REPORT.

Anchor Diameter	Concrete Type	Min. f'c (psi)	Anchor Type	ICC Report No.	Min. Embed.	Min. Spacing	Min. Edge Dist.	Min. Conc. Thickness	Installation. Torque	Test Loads
1/2"	Hardrock	2500	Hilti Kwik Bolt TZ	ESR-1917	3-1/4"	12"	18"	6"	40 Ft-Lb	Direct Pull Tension - 2995 lb

   (b) THIS PRE-APPROVAL ALLOWS FOR UP TO A MAXIMUM OF 2 ADJACENT CONCRETE SLAB EDGES, 18" AWAY MINIMUM (i.e. - CORNER). SEE ADJACENT DETAIL FOR ADDITIONAL MINIMUM ALLOWABLE CONCRETE EDGE DISTANCES.

2. TESTING OF EXPANSION ANCHORS PER 2010 CBC, 1916A.7 : TENSION TESTING SHALL BE DONE IN THE PRESENCE OF THE SPECIAL INSPECTOR AND A REPORT OF THE TEST RESULTS SHALL BE SUBMITTED TO OSHPD
   (a) AFTER AT LEAST 24 HOURS HAVE ELAPSED SINCE INSTALLATION, DIRECT PULL TENSION TEST AT LEAST 50% OF THE ANCHORS.
   (b) ACCEPTANCE CRITERIA: THE ANCHOR SHOULD HAVE NO OBSERVABLE MOVEMENT AT THE TEST LOAD. A PRACTICAL WAY TO DETERMINE OBSERVABLE MOVEMENT IS THAT THE WASHER BECOMES LOOSE.
   (c) IF ANY ANCHOR FAILS, TEST ALL ANCHORS.

Courtesy of Chatsworth Products

FIGURE 4: Example of an OSHPD Preapproval of Manufacturer's Certification.

and operability, it is easy to compare products that go through the same type of certification to find the best fit for the requirements.

What is the seismic load rating? An enclosure's seismic load capacity indicates how much weight a cabinet or rack can hold and protect equipment during a seismic event. The higher the seismic load rating, the more equipment and weight it can support. Note that seismic load and static load are different. Seismic load indicates a load that has been tested for dynamic movement in a simulated seismic event; static load is qualified by a standard load test (not a shake-table test) without motion.

Is the enclosure big enough for the equipment? Many seismic cabinets are shallow in depth, which limits the depth of equipment that can be installed. Equipment is now typically more than 762 mm (30 in) deep. Current TIA-569-C standards provide size and clearance requirements for equipment and cabling cabinets to address equipment sizes, cable management and installation of power distribution units (PDUs). To ensure these standards are met, cabinets at least 1067 mm (42 in) deep are recommended.

How will cable management and power products be attached? Seismic-rated enclosures often have frames with limited cable management space. Look for products that leave adequate room for cable management and PDUs.

What about airflow? Do not sacrifice proper airflow over seismic stability. Servers still need to remain cool to function properly, even within seismic areas. Thermal management strategies and legislation enacted to reduce energy consumption do not provide exemptions to these products if they are installed in seismic areas. At a minimum, the enclosure's seismic bracing should not block the flow of cool air into the servers.

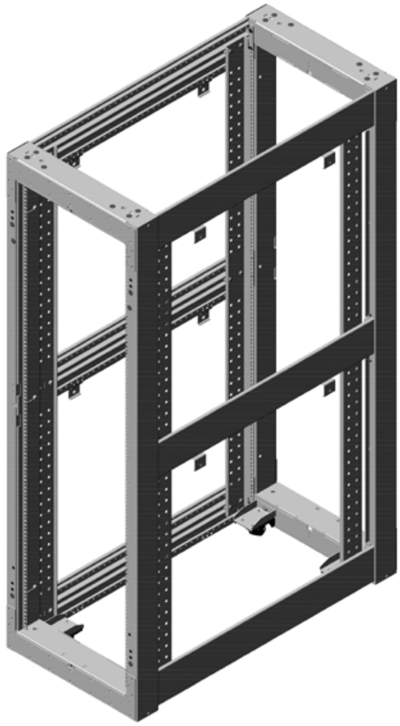

FIGURE 5: The enclosure should be designed, certified and tested for use in seismic areas. If the enclosure is NEBS compliant, the manufacturer should be able to provide the lab test report.

How difficult is it to install? Enclosures are generally heavy and difficult to move on a work site. Seismic cabinets can be almost two times the weight of nonseismic cabinets. Some enclosures feature transport casters and recessed leveler feet to ease installation. The cabinet should be anchored directly to the floor using approved anchors. Designs that allow approved alternate mounting locations reduce the impact of site-specific constraints.

Is the equipment inside the cabinet secure? Equally important to bracing, the cabinet should secure the equipment. Slide-out drawers should have mechanical latches to keep the drawers closed when not in use. Be sure to secure shelf-mounted equipment to the shelf. The rack manufacturer may offer specific accessories that secure equipment to the shelf or provide additional bracing to the equipment mounting rails

Conclusion

Seismic events continue to draw attention on a global scale, acting as a catalyst for ever-increasing building codes and certifications. Be sure to check all codes, rules and regulations in the area. Consult a structural engineer when necessary.

Besides complying with building codes, understanding what goes into deeming a product seismic-ready is also important because different approaches are used to make this determination. Physical shake-table tests, such as those required by GR-63-CORE NEBS or ICC-ES AC156, qualify the performance and endurance of a product during an earthquake. Performance analyses, such as the one required in the IBC and CBC, do not test the product physically. Their advantage is that they account for all variables that are involved in an installation and a building that could potentially affect a product's ability to protect equipment from an earthquake.

The only way to prevent downtime and equipment damage during a seismic event is to plan accordingly. ◂

AUTHOR'S BIOGRAPHY: Sam Rodriguez, RCDD, has over 22 years of experience in the telecommunications industry. He has been employed at Chatsworth Products (CPI) for 16 years and has held technical roles including Technical Support, Technical Services Supervisor, and now Product Manager of Cabinet & Thermal Solutions. Sam is a BICSI member and an RCDD. He is also a member of CPI's product development organization and contributes to the design and development of new product solution.