

6.4 Mechanical, Electrical, and Plumbing Components

6.4.7 Electrical and Communications Equipment

6.4.7.4 Batteries and Battery Racks

This category covers batteries and battery racks, often used as part of the emergency generation system. These may be mounted on a concrete floor, raised floor, wall or roof.

Provisions

BUILDING CODE PROVISIONS

Seismic loads for batteries and battery racks are determined using ASCE/SEI 7-10, *Minimum Design Loads for Buildings and Other Structures*, (ASCE, 2010), Chapter 13. The principal objective is to prevent the component from sliding or overturning.

- If the batteries are required to function for life safety purposes, ASCE/SEI 7-10 classifies them as *Designated Seismic Systems*, with an Importance Factor $I_p = 1.5$. This may require additional analysis, testing, and special inspections.
- ASCE/SEI 7-10 requires anchorage design for all equipment in Seismic Design Categories D, E, and F if the equipment weighs over 400 pounds. Lighter components may be exempt if the component Importance Factor $I_p = 1.0$.
- Items that are exempt from the anchorage design requirements must still be positively anchored to the structure. The anchorage need not be designed or detailed on the construction documents. Exempt items must also be provided with flexible connections between the equipment and associated raceways, bus ducts, or conduits if there is a potential for damaging differential movement between the equipment and connected components.
- Batteries on racks must have wraparound restraints to ensure that the batteries will not fall from the rack. Spacers should be used between restraints and cells to prevent damage to cases.
- All elements of battery racks must be evaluated for sufficient lateral load capacity, including braces, frames, legs, pedestals, restraints, and snubbers.

RETROFIT STANDARD PROVISIONS

ASCE/SEI 41-06, *Seismic Rehabilitation of Existing Buildings*, (ASCE, 2007) classifies electrical equipment, including batteries and battery racks, as force controlled. These components are

subject to the provisions of the standard when the performance level is Immediate Occupancy. The requirements also apply when the performance level is Life Safety in high and moderate seismicity areas, and the equipment is over 6 feet in height and weighs more than 20 pounds. When applicable, batteries and battery racks meeting any of the following criteria must comply with the requirements of ASCE/SEI 41–06:

- The item weighs more than 400 pounds.
- The item is unanchored, weighs over 100 pounds and is subject to overturning. These items may be exempt if they have a factor of safety greater than 1.5 when design loads are applied.
- The item weighs over 20 pounds and is mounted over 4 feet above the floor.

Acceptance criteria for batteries and battery racks focus on providing adequate anchorage for seismic forces.

Typical Causes of Damage

- The racks may slide or overturn and batteries may slip or fall from the rack. Failure of the batteries may compromise the emergency power generation system or other functions that rely on backup battery power.

DAMAGE EXAMPLES

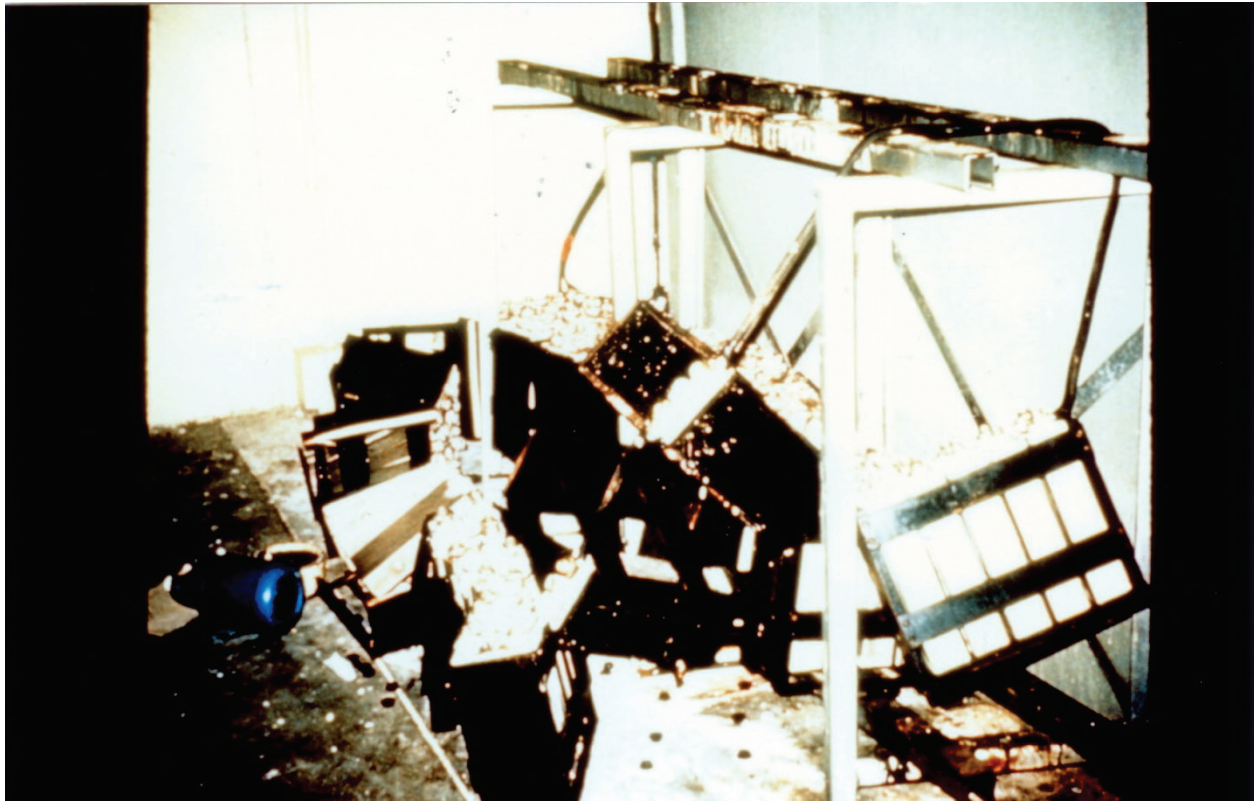


Figure 6.4.7.4-1 Earthquake Damage in the 1971 magnitude-6.6 San Fernando Earthquake (Photo courtesy of John F. Meehan).

Seismic Mitigation Considerations

- Seismic resistant battery racks are available from a number of vendors; these may be directly bolted to the floor or wall. Check the internet for available products.
- For existing battery racks, check that the batteries are secured to the rack and that the rack is properly braced and anchored.

MITIGATION EXAMPLES



Figure 6.4.7.4-2 Anchored battery racks (Photo courtesy of Eduardo Fierro, BFP Engineers).



Figure 6.4.7.4-3 Batteries anchored with equipment skid (Photo courtesy of Eduardo Fierro, BFP Engineers).



Figure 6.4.7.4-4 Battery rack that performed well in the 2010 magnitude-8.8 Chile Earthquake (Photo courtesy of Rodrigo Retamales, Rubén Boroschek & Associates).

MITIGATION DETAILS

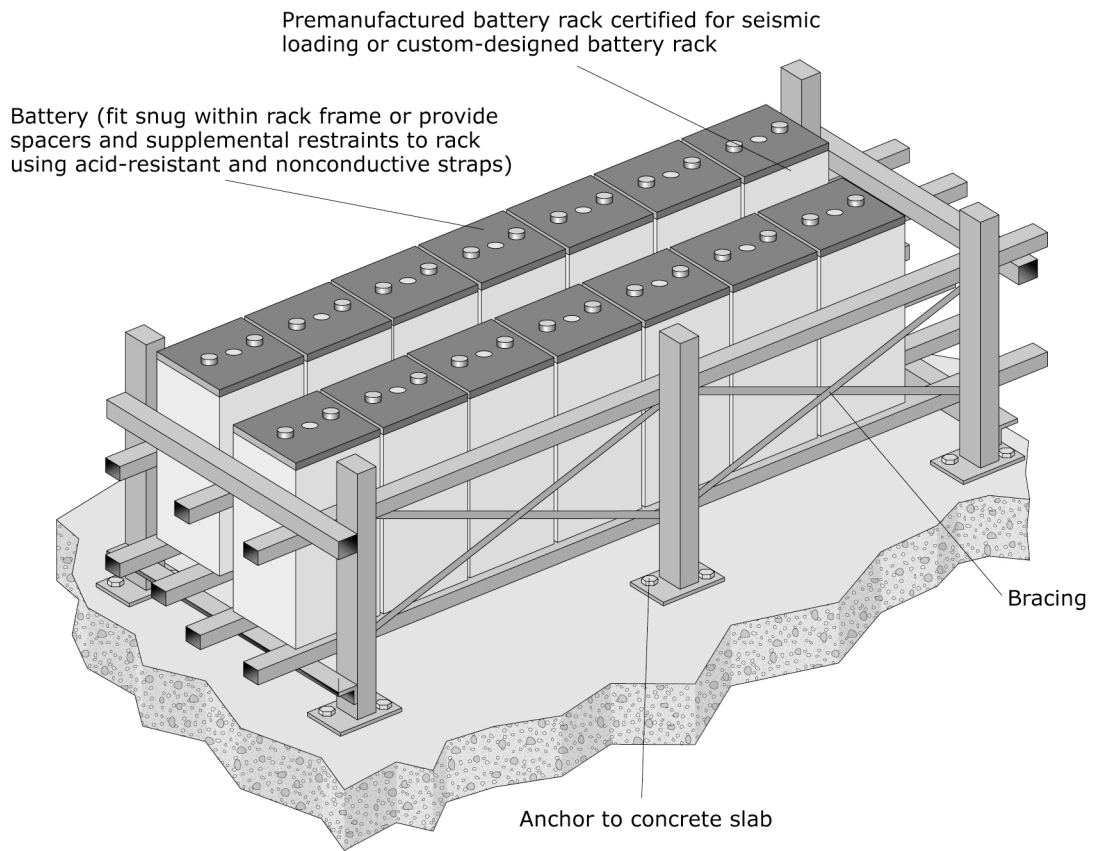


Figure 6.4.7.4-5 Batteries and rack (ER).