

6.5 Furniture, Fixtures, Equipment and Contents

6.5.1 Storage Racks

6.5.1.1 Light Duty Shelving

This category includes light duty shelving units and sheet metal storage cabinets. These items are typically tall and narrow and may be heavily loaded.

Provisions

BUILDING CODE PROVISIONS

The seismic design requirements of ASCE/SEI 7-10, *Minimum Design Loads for Buildings and Other Structures*, (ASCE, 2010) Chapter 13 are intended to apply only to permanently attached components, not to furnishings, temporary items, or mobile units. Storage cabinets and shelving units of significant mass are not considered to be exempt and should be anchored or braced,

Permanent floor-supported shelving or storage cabinets over 6 feet tall must be designed as architectural components per ASCE/SEI 7-10. Bracing and anchorage for these units should be designed considering the weight of the unit and weight of shelved contents.

RETROFIT STANDARD PROVISIONS

ASCE/SEI 41-06, *Seismic Rehabilitation of Existing Buildings*, (ASCE, 2007) classifies light-duty shelving as force controlled, and the principal objective of the code provisions is to prevent the component from sliding or overturning. ASCE/SEI 41-06 requires compliance with the anchorage provisions of the standard for storage racks over 4 feet in height when the performance level is Life Safety or higher. Storage racks in unoccupied spaces are exempt.

Typical Causes of Damage

- Shelving units may slide or overturn and the contents may become dislodged or fall. Where there are rows of freestanding or poorly anchored shelves, the failure of a few may result in progressive collapse of many. Broken bottles, spilled chemicals, mixed or damaged inventory are often the result of the failure of storage or display units.
- Mobile storage carts may roll, overturn, or impact other items. Stored contents may become dislodged or fall.

- Damage to contents or inventory that has fallen from shelving can be costly to repair or replace and may result in substantial business interruption.

DAMAGE EXAMPLES



Figure 6.5.1.1-1 Collapse of row of unanchored freestanding shelving units containing spare parts at an electric power plant in Port-au-Prince in the 2010 magnitude-7 Haiti Earthquake (Photo courtesy of Eduardo Fierro, BFP Engineers).

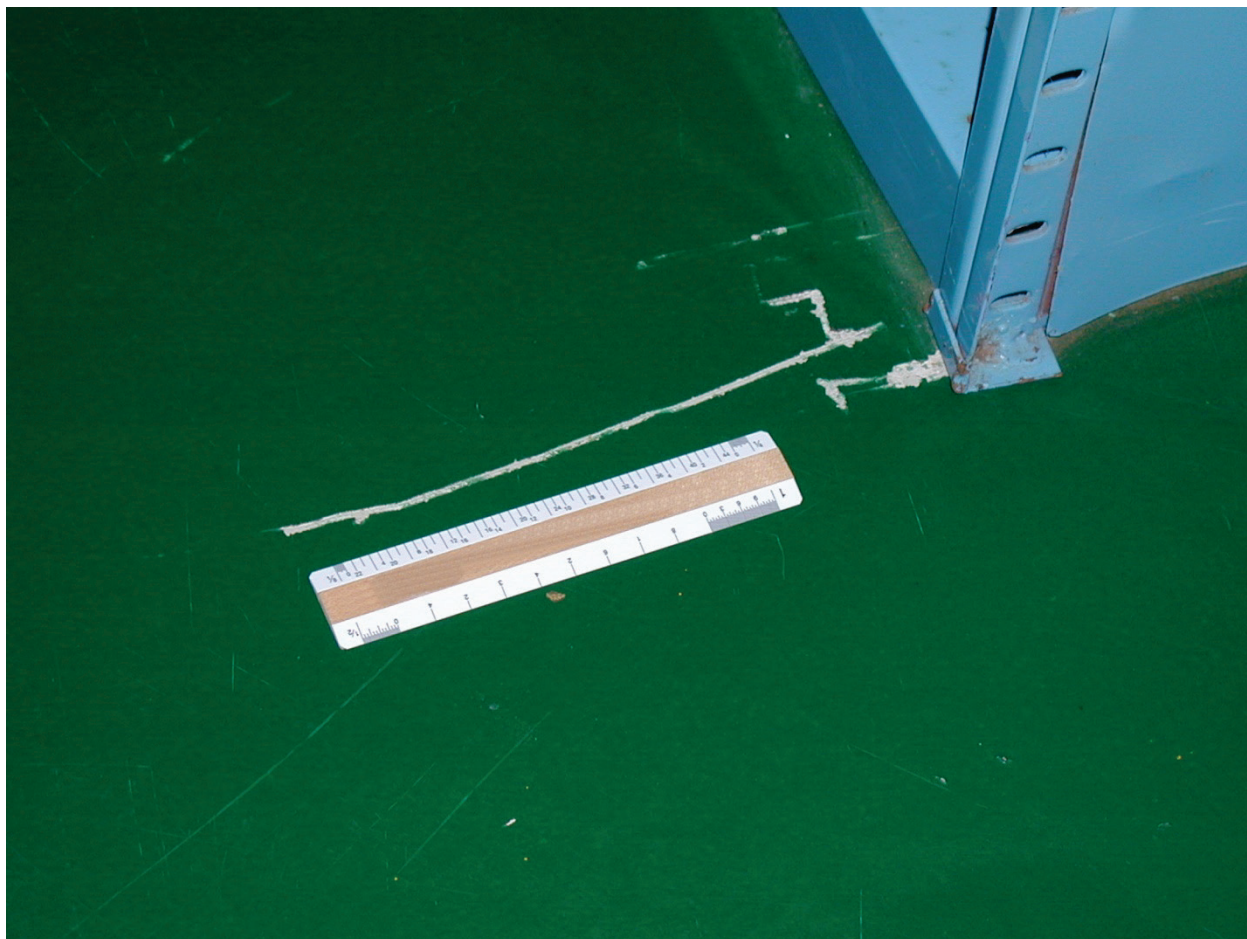


Figure 6.5.1.1-2 Unanchored storage shelving slid nine inches without falling but contents scattered in the 2001 magnitude-8.4 Peru earthquake; unit lifted to original position prior to photo (Photo courtesy of Eduardo Fierro, BFP Engineers).

Seismic Mitigation Considerations

- For sheet metal cabinets or shelving, anchor units to floor, tie back-to-back units together, strap rows of units together across the top, or anchor units to an adjacent wall. Light duty steel storage racks may additionally require cross bracing.
- See Section 6.5.6.1 for recommendations regarding edge restraints and arrangement of shelf-mounted items. Do not locate cabinets or racks adjacent to doors or exits if their failure would block the exit.
- Any connections to stud walls must engage the structural studs. Stud walls and partitions may not have adequate lateral capacity to support many shelving units; engineering may be required. Where items are anchored to heavy partitions, the bracing or anchorage of these partitions to the structure above must also be checked for adequacy considering the seismic loads imposed by all anchored items.

- The details shown are intended for light duty units; heavy duty units with large loads may require engineering. See FEMA 460, *Seismic Considerations for Steel Storage Racks Located in Areas Accessible to the Public* (2005), for additional information on the performance of industrial storage racks. Some racks are available with enhanced seismic performance; check other resources, such as the internet for additional options.

MITIGATION EXAMPLES



Figure 6.5.1.1-3 Mobile carts restrained at base with clip angles anchored to the floor and removable eyebolts attached from each cart to the angles (Photo courtesy of Maryann Phipps, Estructure).



Figure 6.5.1.1-4 Alternate restraint at base of mobile shelving unit (Photo courtesy of Maryann Phipps, Estructure).



Figure 6.5.1.1-5 Fixed base shelving units anchored with optional seismic base plate offered by manufacturer (Photo courtesy of Maryann Phipps, Estructure).



Figure 6.5.1.1-6 Mobile cart restrained at base with removable angles and eyebolts. Back-to-back units are interconnected (Photo courtesy of Maryann Phipps, Estructure).



Figure 6.5.1.1-7 Fixed base shelving units anchored directly to concrete slab through base plate
(Photo courtesy of Maryann Phipps, Estructure).



Figure 6.5.1.1-8 Mobile shelving unit restrained by connection to strut fastened to full height metal studs (Photo courtesy of Maryann Phipps, Estructure).

MITIGATION DETAILS

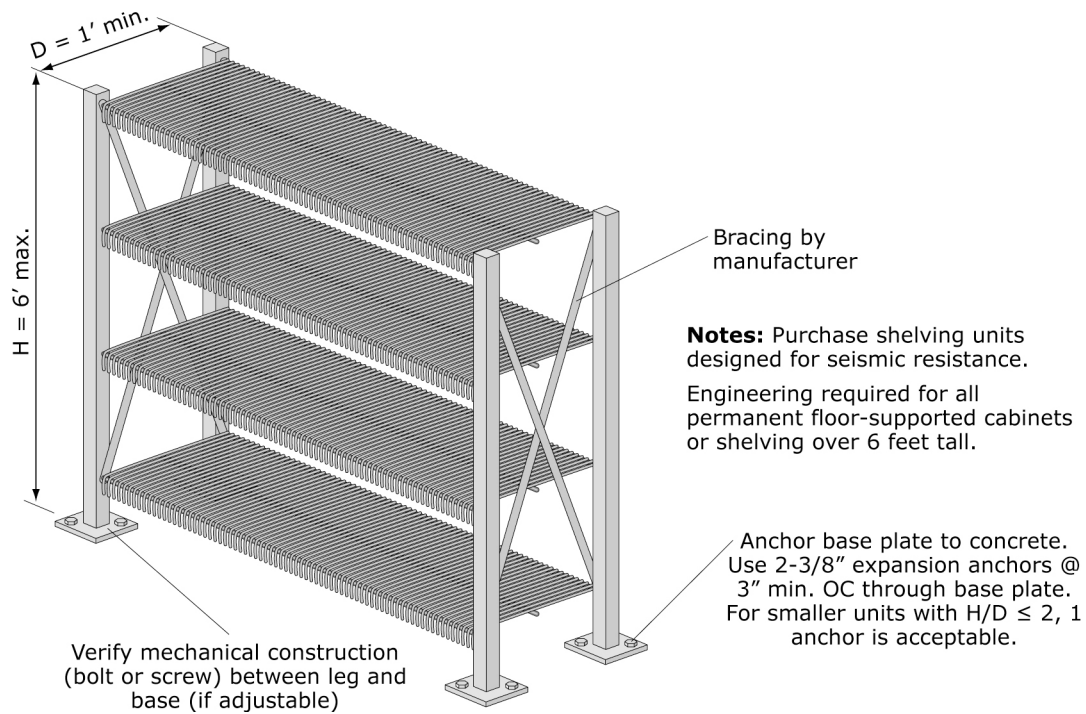


Figure 6.5.1.1-9 Light duty shelving (NE, ER).