6.4 Mechanical, Electrical, and Plumbing Components

6.4.7 Electrical and Communications Equipment

6.4.7.6 Communications Antennae

This category covers communications antennae, often referred to as satellite dishes, which may be mounted in a variety of ways. Circular antennae used for residential or small commercial applications are typically supported by a single mast that may be mounted on a wall, roof, chimney, eaves, balcony, or freestanding at the ground. Non-penetrating roof mounts that typically rely on ballast are also available.

Provisions

BUILDING CODE PROVISIONS

Communications antennae are designed using the provisions of ASCE/SEI 7-10, *Minimum Design Loads for Buildings and Other Structures*, (ASCE, 2010), Chapter 13 when supported by a structure, and Chapter 15, Nonbuilding Structures, if the antennae is supported at grade. The principal objective is to prevent the component from sliding or toppling.

- 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.
- Electrical component supports and their attachment to the component must be designed for the appropriate forces and displacements. Design of dish antennae should consider the effects of both wind and seismic loading.
- The design of the antenna depends on whether it is braced above or below its' center of gravity.

RETROFIT STANDARD PROVISIONS

ASCE/SEI 41-06, *Seismic Rehabilitation of Existing Buildings*, (ASCE, 2007) classifies communications equipment as force-controlled. There are no specific provisions for antennas. Communications equipment is 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, electrical equipment 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.
- Building operation equipment.

Acceptance criteria for communication equipment focus on providing adequate anchorage for seismic forces. Prescriptive anchorage and bracing provisions may be used for smaller components.

Typical Causes of Damage

- While TV antennae have been mounted on roofs for many decades, the appearance of circular antennae on U.S. rooftops is relatively new, and to date, earthquake damage has not been documented. This is in part due to the fact that since antennae tend to be very light, the most severe design loading for circular antennae is typically wind. Nevertheless, if antennae have not been mounted to meet seismic loading, they could become dislodged and either the dish or the mast or both could fall.
- Damage to the antennae could disable critical communications systems or television access that may be needed following an earthquake.

DAMAGE EXAMPLES

Figure 6.4.7.6-1 Most antenna are designed for wind and able to resist seismic loading. In spite of the collapse of the first story of this residential building complex, the roof-mounted antennae appear intact in the 2010 magnitude-8.8 Chile Earthquake (Photo courtesy of Eduardo Fierro, BFP Engineers).

Figure 6.4.7.6-2 Antennae retrieved from roof of adjacent collapsed wing of the Hôpital Saint-François de Sales in the 2010 magnitude-7 Haiti Earthquake (not known if antenna suffered earthquake damage; photo courtesy of Ayhan Irfanoglu, Purdue University). Hospital communications depend on the functionality of antennae such as this.

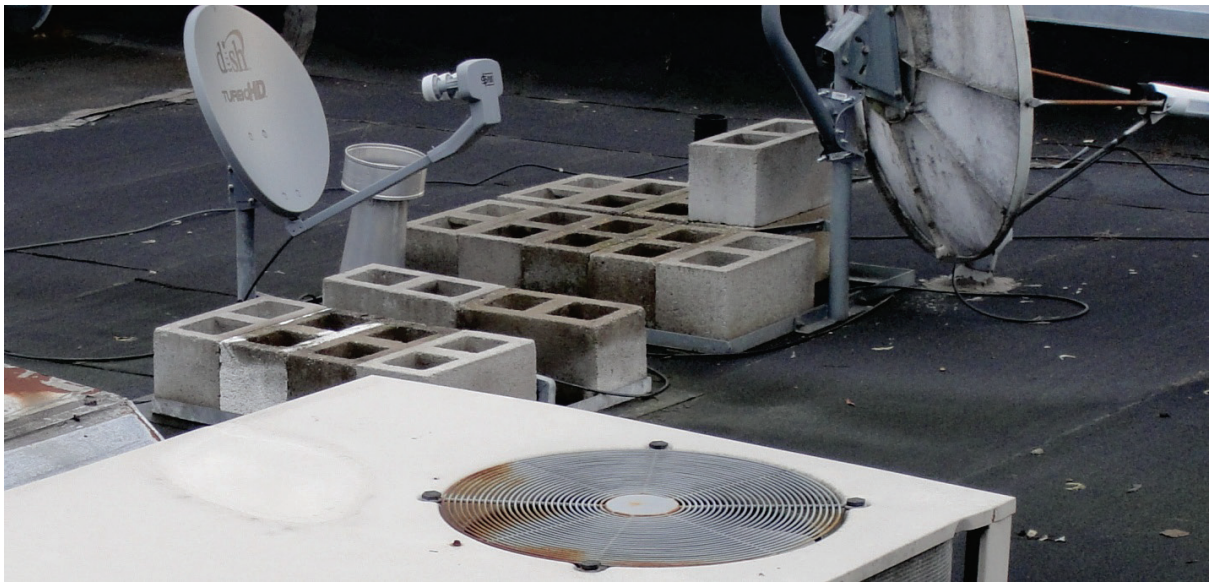

Figure 6.4.7.6-3 Damage or movement of ballasted antennae was not observed on this rooftop in the 2010 magnitude-6.5 Eureka Earthquake (Photo courtesy of Maryann Phipps, Estructure).

Figure 6.4.7.6-4 The antenna with guy wires remained upright atop a collapsed building in the 2010 Haiti Earthquake (Photo courtesy of Eduardo Fierro, BFP Engineers). Even though some of the guy wires went slack, the antenna did not fall into the street.

Seismic Mitigation Considerations

- The Federal Communications Commission (FCC) issues regulations for Over-the-Air Reception Devices to preempt restrictions on the size, mast height, or location of direct-to-home satellite dishes. For instance, Title 47 (Section 1.200) of Code of Federal Regulations which codifies the FCC regulations covers dishes less than 1 meter in diameter with a mast height less than 12 feet above the roofline. In addition, tenant or homeowner association agreements may have restrictions on the size or placement of antennae; check for local code or association requirements.
- The antenna mast may be mounted in a variety of ways, for example to wood or metal stud walls, concrete or solid masonry walls (cells filled with concrete), hollow masonry block walls, freestanding poles, or to roof rafters or a concrete roof slab. Schematic details for installing the mast mounting bracket to a stud or concrete walls are shown in Figure 6.4.7.6-5.
- Some mounting kits available on the internet provide hardware for strapping the antenna to a residential chimney. As unreinforced masonry chimneys are highly prone to earthquake damage as described in Section 6.3.7.1, antenna should not be mounted to unreinforced masonry chimneys. If the chimney is adequately reinforced, chimney mount details may be used for lightweight antennae.
- Hardware and kits for non-penetrating ballasted mounts are also available for purchase. These kits often use standard sized concrete blocks for ballast. Use of multiple concrete blocks for ballast may be heavy enough to trigger the requirement for the equipment to have engineered anchorage. While these ballasted systems can reasonably be used in areas of low seismicity, they could potentially slide and damage roofing or wiring in areas of high seismicity.
- Large or tall antennae need to be properly engineered for both wind and seismic loading. Tower antennae may be anchored with guy wires, or mounted to a specially designed frame. Positive attachments from the antenna to the supporting structure should be provided and one should check with the manufacturer to see if the antenna itself has been designed or tested for seismic loading since seismic forces at the roof elevation are typically much higher than at ground level.
- Communications equipment used for essential facilities may need to be shake table tested and certified. Shake tables operated by the Pacific Earthquake Engineering Research Center (PEER) at UC Berkeley, MCEER at SUNY Buffalo, and others both perform testing of telecommunications network equipment in accordance with *NEBS Requirements: Physical Protection* (NEBS, 2006), protocol to certify that the internal parts and electronic components can withstand seismic shaking.

- As with any items mounted with exterior exposure, components and connectors should be corrosion resistant and roof or wall penetrations should receive flashing and sealant as appropriate.
- Extreme caution must be exercised when working in the proximity of any satellite dish antenna used to uplink internet, broadcast or other communications services. Because the dish is used to greatly focus the beam of microwave radio frequency energy a serious radio frequency (RF) exposure hazard may be present. Never position yourself in front of an uplink dish unless the transmitter has all sources of power removed and the appropriate lock out procedures are in practice.
- Always consult a qualified communications expert knowledgeable about the RF exposure hazard present in the vicinity of all antennas used for all form of radio transmission and obtain a detailed description of what the RF exposure guidelines are for each. For more information refer to FCC OET Bulletin 65 (FCC, 1997).

MITIGATION EXAMPLES

Figure 6.4.7.6-5 Antenna mast mounted to concrete wall surface at top floor of building (Photo courtesy of (Photo courtesy of Maryann Phipps, Estructure). Note that two wall brackets are used to resist moments produced by wind or seismic forces. This antenna is larger than most standard residential versions.

Figure 6.4.7.6-6 Antenna mast mounted to wood stud wall using blocking to clear eves (Photo courtesy of Cynthia Perry, BFP Engineers).

MITIGATION DETAILS

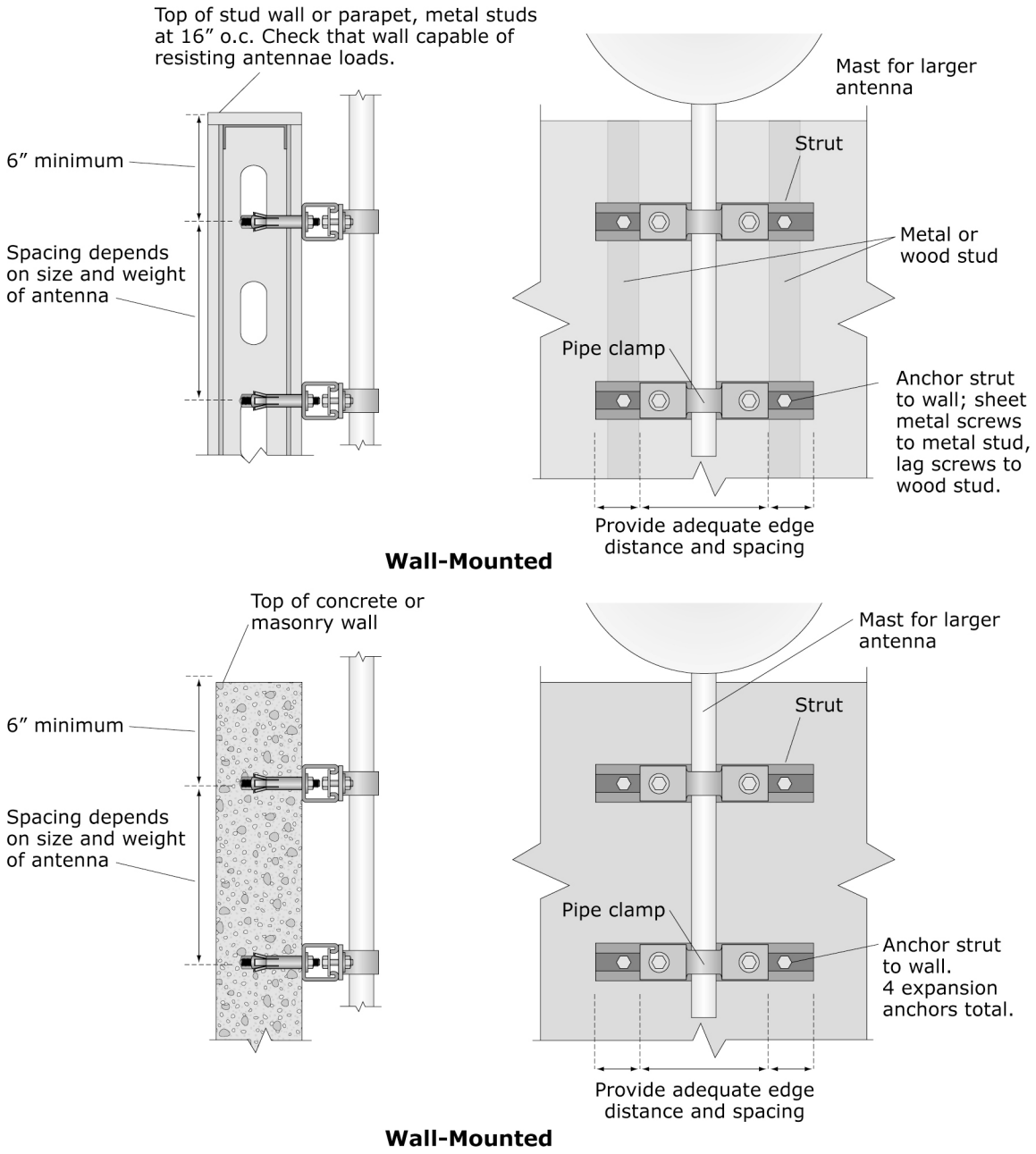

Figure 6.4.7.6-7 Details for wall-mounted communications antenna (ER).

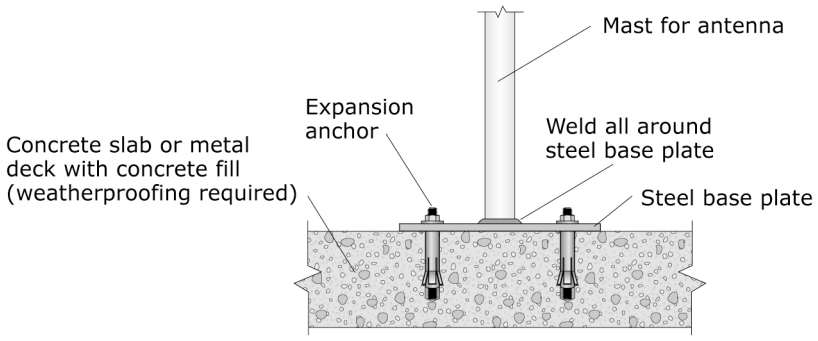

Figure 6.4.7.6-8 Details for roof/slab mounted communications antenna (ER).