6.4 Mechanical, Electrical, and Plumbing Components

6.4.9 Light Fixtures

6.4.9.2 Surface-Mounted lighting

This category covers surface-mounted light fixtures that are overhead in a finished ceiling. The term surface-mounted refers to a range of conditions; in some cases the fixture and housing are entirely below the ceiling surface, in other cases part of the housing is recessed above the bottom of the ceiling. Overhead fixtures may also be surface-mounted on a wall. Damage to overhead lighting has occurred frequently in past earthquakes; the fixtures become dislodged from the ceiling or ceiling grid and fall unless they are tied to the grid or have independent support to the structure above.

Provisions

BUILDING CODE PROVISIONS

ASCE/SEI 7-10, *Minimum Design Loads for Buildings and Other Structures*, (ASCE, 2010) does not have specific seismic requirements for surface mounted light fixtures. For the purposes of design, the same design procedures used for suspended ceilings may be used.

ASCE/SEI 7-10 specifies that systems required for life-safety purposes after an earthquake be classified as designated seismic systems and designed using a component importance factor, I_p, of 1.5. Ceiling systems and light fixtures classified a designated seismic systems may require engineering calculations, or special inspection.

When supported by ceiling systems other than suspended lay-in types, surface-mounted light fixtures must conform to the anchorage requirements of ASCE/SEI 7-10. The anchorage of surface mounted light fixtures weighing less than 20 pounds need not be designed, provided that the importance factor for the fixtures is equal to 1.0 (not part of an essential system), the fixture is positively attached to the structure, and that flexible connections are provided between the fixture and conduit if there is a potential for damaging differential movement.

When surface-mounted fixtures are supported by suspended lay-in ceilings, the provisions of ASTM E580, *Standard Practice for Installation of Ceiling Suspension Systems for Acoustical Tile and Lay-in Panels in Areas Subject to Earthquake Ground Motions* (ASTM, 2010) apply. The requirements for support of the fixtures depend on the Seismic Design Category of the structure.

- In Seismic Design Category C:
  - Lighting fixtures that weigh less than 56 pounds must be positively attached to the ceiling grid as specified in the electrical code, with a minimum of two attachment devices. The attachment devices must be capable of resisting 100% of the fixture weight in any direction.
  - Lighting fixtures weighing less than 10 pounds that are supported by the ceiling grid must have a safety wire attached to the fixture and the structure above.
  - Lighting fixtures weighing between10 and 56 pounds that are supported by the ceiling grid must have two safety wires attached to the fixture and the structure above.
  - Lighting fixtures that weigh more than 56 pounds must be supported directly from the structure.

- In Seismic Design Categories D, E, and F:
  - Light fixture attachments and safety wires must conform to the requirements for Seismic Design Category C.
  - An intermediate duty or heavy duty ceiling grid is required for ceilings carrying light fixtures.
  - Where the load carrying capacity of the cross runners is less than 16 lb/ft, supplementary hanger wires may be required for the ceiling grid.
  - Lighting fixtures weighing less than 10 pounds require one safety wire connected from the fixture housing to the structure above. The wire may be slack.
  - Lighting fixtures weighing 10 to 56 pounds require two safety wires at diagonally opposite corners connected from the fixture housing (not the detachable end plates) to the structure above. The wires may be slack.
  - Fixtures weighing more than 56 pounds must be supported directly from the structure above by approved hangers. If the ceiling bracing can provide lateral restraint for such fixtures, they should be positively attached to the ceiling grid but must still be supported with not less than four taut #12 wires.

- ASTM E580 Section 5.3 contains prescriptive requirements for attachment of surface-mounted light fixtures:
  - Surface-mounted lighting fixtures must be attached to the ceiling system with a positive clamping device that completely surrounds the supporting members. Safety wires have to be attached between the clamping device and the adjacent ceiling hanger or to the structure above.

RETROFIT STANDARD PROVISIONS

ASCE/SEI 41-06, *Seismic Rehabilitation of Existing Buildings*, (ASCE, 2007) classifies light fixtures into one of four types. Surface-mounted light fixtures are classified as "Category 2" or "Category 3," depending on the type of ceiling they are installed in. ASCE/SEI 41-06 provides prescriptive acceptance criteria for the life safety and immediate occupancy nonstructural performance levels. Fixtures not meeting the criteria must be retrofitted.

Evaluation for the presence of adequate attachment is required for all performance levels and in high, moderate, and low seismicity areas.

Typical Causes of Damage

- Surface lighting that is not equipped with independent safety wires may fall to the floor. Lighting with proper safety wires may fall from the ceiling and dangle from the safety wires but will not pose a safety risk to occupants.
- Unless secured to a properly braced ceiling grid, relative movement between the light fixture and the ceiling may damage the ceiling finishes, ceiling grid, wiring, or the light fixture.
- Unsecured lenses and bulbs may become dislodged and fall to the floor even where the fixture is restrained. This may occur with both ceiling and wall mounted surface lighting.
- Most observed damage to light fixtures in the U.S. has involved fixtures in suspended acoustic tile ceilings which do not have much inherent in-plane stiffness; damage to fixtures mounted in or on gypsum board ceilings has been less common.

DAMAGE EXAMPLES

Figure 6.4.9.2-1 Numerous failures of ceilings and lights were observed at the Concepción airport in the 2010 magnitude-8.8 Chile Earthquake. Photo shows surface-mounted fixture on wall that remained in place but the lens fell and the bulbs were dislodged (Photo courtesy of Rodrigo Retamales, Rubén Boroschek & Associates).

Figure 6.4.9.2-2 Overhead surface-mounted fixture anchored to underside of concrete slab damaged in the 2010 Chile Earthquake. Back of fixture housing remained anchored to the concrete slab above and the bulbs remained in place but the lens and sides of housing fell indicating that internal connections in the fixture were inadequate (Photos courtesy of Rodrigo Retamales, Rubén Boroschek & Associates).

Seismic Mitigation Considerations

- Retrofit of surface-mounted light fixtures is generally performed by following the prescriptive requirements for new construction. The key considerations include attachment to the ceiling suspension system with positive clamping devices that completely surround the supporting members. Safety wires are required between the clamping device and the adjacent ceiling hanger or to the structure above. The weight of the fixture shall not exceed the design carrying capacity of the supporting members. One, two, or four safety wires are required from the fixture housing to the structure above.
- For suspended acoustic ceilings, ASTM E580 has other requirements related to the grid itself. Intermediate or heavy duty ceiling grid is required where lights will be supported and supplementary ceiling framing and supplementary hanger wires may be required adjacent to fixtures. Lateral restraint for lighting is assumed to be provided by the ceiling grid so the design of the grid must account for the overall weight of all the attached lighting and mechanical registers. See Section 6.3.4 for additional information regarding ceilings.
- Per ASCE 7-10, certain types of suspended ceilings with screw-attached gypsum board built at one level do not require special seismic details; these ceilings also do not require safety wires for light fixtures (see Section 6.3.4.3). The weight of surface-mounted fixtures must be supported by main runners, supplementary framing supported by the main runners, or directly by the structure above. Neither the ceiling finish material nor the cross furring should be used to support light fixtures. The fixture should be positively attached with screws or other approved connectors to the ceiling grid. Requirements for California schools are in DSA IR 25-3 *Drywall Ceiling Suspension Conventional Construction-One Layer* (California Department of General Services, 2005b) and read "Surface-mounted fixtures shall be attached to a main runner with a positive clamping device made of material with a minimum of 14 gage. Rotational spring clamps do not comply." For suspended gypsum ceilings built at multiple levels, or other types of heavy ceilings, seismic detailing and safety wires may be required; check applicable code provisions.
- International Code Council Evaluation Service has published Acceptance Criteria AC184 (ICC-ES, 2006) with information on attachments of light fixtures to suspended ceiling grids. The website located at http://www.agi-seismic.com/code/ac184.html provides footage of lighting fixture failures where the lights are attached only with tie wires. A discussion of issues related to the code design provisions and the requirement for positive attachments is also provided. In some instances, where approved seismic

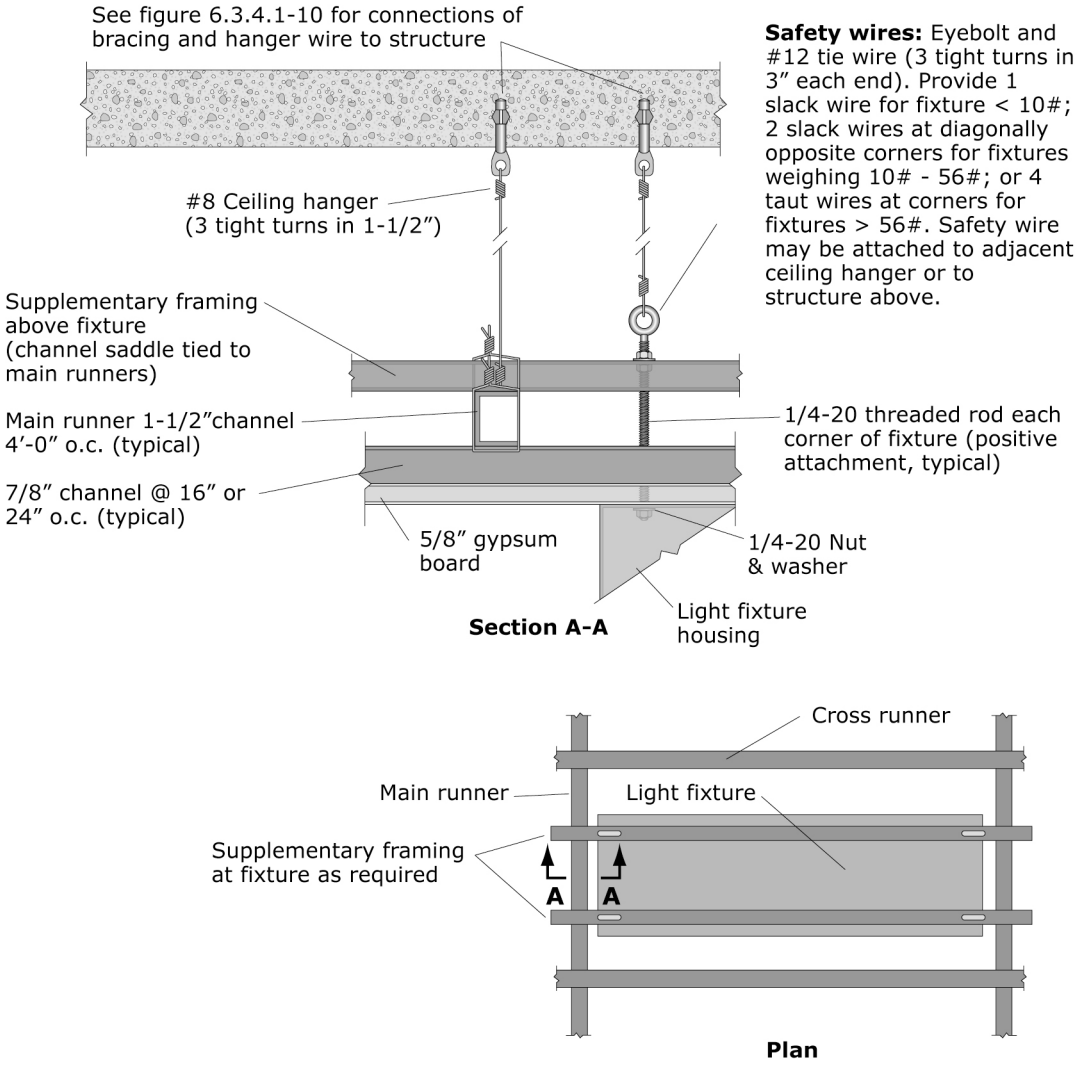
fixture clamps are used to anchor the lighting to a properly braced ceiling grid, independent tie wires are not required. Check for pre-approved details for such devices in the applicable jurisdiction.

- For surface-mounted fixtures in existing buildings where the ceiling grid is unbraced, such fixtures should be retrofit with safety wires at a minimum to prevent them from falling. Providing independent lateral bracing for the fixture may reduce the potential for the light to damage an existing unbraced ceiling.
- For fire rated ceiling assemblies, only fixtures and attachments with an approved fire rating may be used. Check with the manufacturer for approved systems. Some fixtures may require lead shielding or a fire-rated enclosure; check local code provisions.
- Do not attach lights to ducts, piping, or other nonstructural items in the ceiling plenum.

MITIGATION EXAMPLES

Figure 6.4.9.2-3 Independent vertical support for surface-mounted light fixture in suspended gypsum board ceiling located in California hospital. Eye hook and slack wire from fixture is tied to concrete slab above. The rigid bracing in the photos is attached to the ceiling grid, not the light fixture (Photos courtesy of Maryann Phipps, Estructure).

MITIGATION DETAILS



Note: Surface-mounted fixtures shall be attached to ceiling suspension systems with screws or positive clamping devices. Safety wires (1, 2 or 4) are required in suspended acoustic lay-in tile ceilings depending on the size and weight of the fixture; safety wires may be required in other ceiling types as well. Weight of fixture shall not exceed design carrying capacity of the supporting members; supplementary framing and additional hanger wires may be required. Gypsum board ceiling shown in details; although some gypsum ceilings may be exempt from the seismic detailing requirements and may not require the safety wires shown.

Figure 6.4.9.2-4 Surface-mounted fixture below suspended ceiling grid (PR).