

6.4 Mechanical, Electrical, and Plumbing Components

6.4.9 Light Fixtures

6.4.9.1 Recessed Light Fixtures

This category covers recessed light fixtures that are part of a suspended ceiling grid. These may be lay-in fixtures in a suspended acoustic tile ceiling or recessed fixtures in other types of suspended ceilings such as gypsum board, plaster, or metal panels. Overhead light fixtures in a finished ceiling have often been damaged in past earthquakes; the fixtures may become dislodged from the ceiling or ceiling grid and fall unless they are tied to the grid and have independent support to the structure above.

Provisions

BUILDING CODE PROVISIONS

Recessed light fixtures are an integral part of suspend ceiling systems, and their support is covered by the standards for suspended acoustical tile ceilings. Requirements for recessed fixtures in suspended acoustic tile ceilings in ASCE/SEI 7-10, *Minimum Design Loads for Buildings and Other Structures*, (ASCE, 2010), are by reference to 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).

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.

The requirements 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 between 10 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.
 - The requirements for safety wires on fixtures are identical to Seismic Design Category C.
 - Lighting 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 light fixtures: Fixtures must be positively attached to the suspended ceiling system by mechanical means. The attachment device shall have the capacity of supporting 100 % of the lighting fixture weight acting in any direction. A minimum of two attachment devices are required for each fixture.

RETROFIT STANDARD PROVISIONS

ASCE/SEI 41-06, *Seismic Rehabilitation of Existing Buildings*, (ASCE, 2007) classifies light fixtures into one of four types. Recessed light fixtures are classified as “Category 1” 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 seismically retrofit.

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

- Recessed fixtures supported by a suspended ceiling without independent safety wires to the structure above can become dislodged and fall. Fixtures with proper safety wires may fall from the grid and dangle from the safety wire but will not threaten 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. Heavy fixtures that are hung independently but not laterally braced may swing independent of the ceiling and damage the ceiling system.
- Unsecured lenses and bulbs may fall independent of the fixture and cause damage below.
- Most observed damage to recessed 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 in gypsum board ceilings has been less common.

DAMAGE EXAMPLES



Figure 6.4.9.1-1 Numerous fluorescent fixtures dangling from electrical conduit; installed without safety wires in unbraced suspended acoustical ceiling and damaged in the 2010 magnitude-7 Haiti Earthquake. Loose bulbs, lenses, ceiling panels, diffusers and ducts also on the floor (Photo courtesy of Ayhan Irfanoglu, Purdue University).



Figure 6.4.9.1-2 Overhead lights with four vertical hangers to the structure. Unbraced acoustic ceiling system was damaged beyond repair in the 2001 magnitude-8.4 Peru Earthquake but none of the diffusers or lights fell because they had independent supports. Ceiling was demolished prior to photo (Photo courtesy of Eduardo Fierro, BFP Engineers).



Figure 6.4.9.1-3 Light fixture without adequate independent support dangling along one edge from ceiling grid, damaged in the 1994 magnitude-6.7 Northridge Earthquake (Photo courtesy of Degenkolb Engineers).



Figure 6.4.9.1-4 Light fixture without independent support dangling from conduit as a result of the 1994 Northridge Earthquake (Photo courtesy of Degenkolb Engineers).

Seismic Mitigation Considerations

- Requirements for recessed lighting fixtures may vary depending on requirements for the type of ceiling in which they are located. Recessed light fixtures may be found in any type of ceiling system. Requirements for suspended acoustic ceilings and suspended gypsum board ceilings are discussed below.
- For acoustic tile ceilings, California schools require safety wires or independent vertical support for each light fixture, positive attachment from the light fixtures to the ceiling grid, and bracing for the ceiling grid that is adequate to resist the lateral loading from the ceiling, lights, and diffusers. DSA IR 25–5 *Metal Suspension Systems for Lay-in Panel Ceilings* (California Department of General Services, 2009c) provides details for lights in suspended acoustic ceiling grids. The requirements in DSA IR 25–5 differ slightly from ASTM E580: California schools require two safety wires on all fixtures under 56 pounds; require all 4 ft x 4 ft fixtures have a slack #12 safety wire at each corner, even if the fixture weight is less than 56 lb; and for fixtures weighing more than 56 lb, require they be independently supported by not less than four taut #12 wires, and that these wires be capable of supporting four times the weight of the fixture.
- 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 for a discussion of exempt ceilings). The weight of recessed light fixtures in suspended gypsum board ceilings 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). For suspended gypsum ceilings built at multiple levels, or other types of heavy ceilings, seismic detailing and safety wires for lighting may be required; check applicable code provisions.
- International Code Council Evaluation Service has published AC184, *Acceptance Criteria for Attachment Devices for Recessed Lighting Fixtures (Luminaries) in Suspended Ceiling Systems* (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 (SFC) are used to anchor the lighting to a properly braced ceiling grid, the independent tie wires are not required.

- For existing construction where the ceiling grid is not adequately braced or not strong enough to provide lateral restraint for the lighting, splay wire bracing at each corner of the fixture can be used to provide horizontal restraint. Such bracing would also help prevent swinging lights from damaging the surrounding ceiling. At a minimum, such fixtures should be retrofit with independent safety wires to prevent them from falling.
- Lenses and bulbs may require independent restraints to keep them from falling from the fixture.
- 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 6.4.9.1-5 Example of light fixture with only one safety wire attached; the Salt Lake City schools require four wires for a fixture of this size and weight and also require tighter turns on the wire (Photo courtesy of Salt Lake City School District). Investigations in ceiling plenums often reveal missing wires.

MITIGATION DETAILS

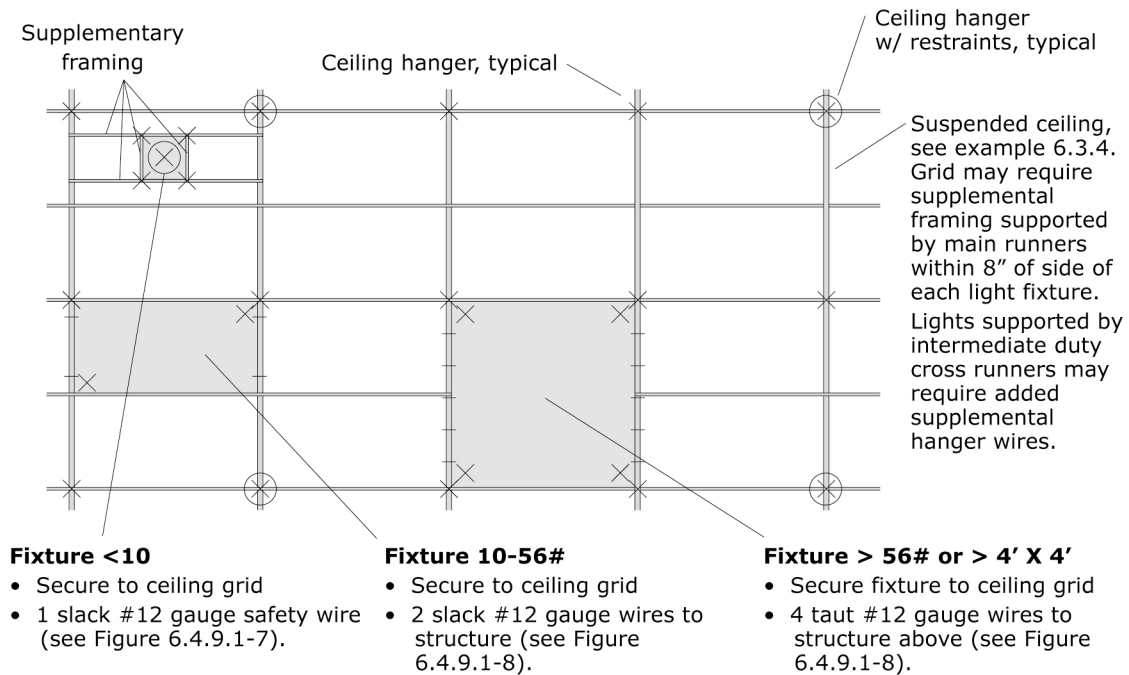


Figure 6.4.9.1-6 Schematic plan of recessed lights in suspended acoustic ceiling (PR).

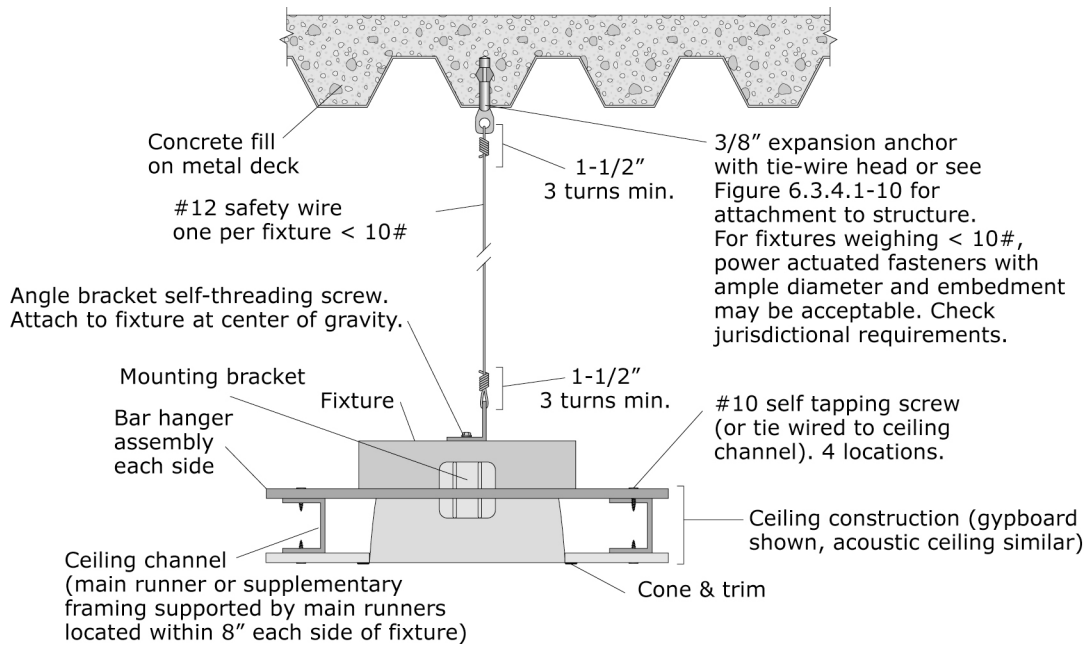


Figure 6.4.9.1-7 Recessed light fixture in suspended ceiling (fixture weight < 10 pounds) (PR).

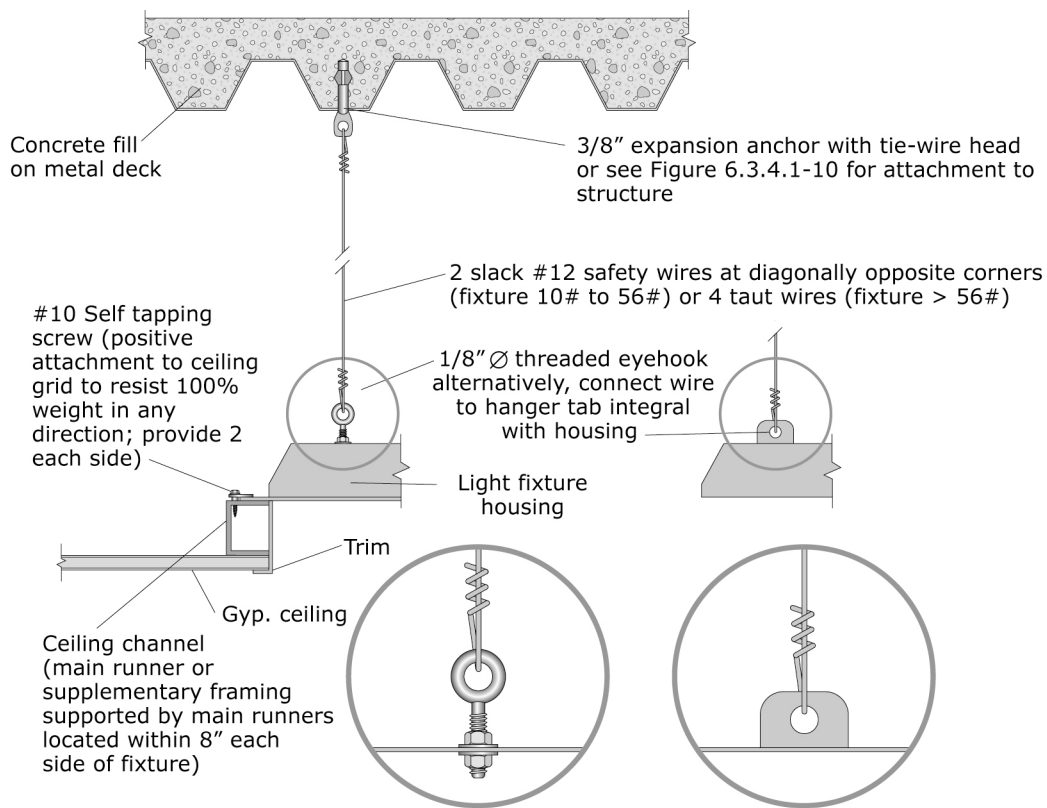


Figure 6.4.9.1-8 Recessed light fixture in suspended ceiling (fixture weight 10 to 56 pounds) (PR).