

## 6.4 Mechanical, Electrical, and Plumbing Components

---

### 6.4.9 Light Fixtures

#### 6.4.9.4 Heavy Light Fixtures

This category covers heavy or special purpose overhead light fixtures that require engineered support details. This includes fixtures such as hospital operating room lights which also have movable arms. Damage to overhead lighting has occurred frequently in past earthquakes; special purpose lighting has additional issues in that the fixture may have internal joints and movable parts which may not have not been designed for seismic loading.

### Provisions

#### BUILDING CODE PROVISIONS

Seismic loads for heavy light fixtures 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 falling. Light fixtures are classified as an electrical component. Unless they are anchored directly to the structure (slab or framing), they require component supports (structural members, frames, braces, anchor plates, etc) that carry gravity and lateral loads to the structure. The design of heavy light fixtures must include the component supports as well as the design of the anchorage of the fixture itself.

- ASCE/SEI 7-10 requires anchorage for items weighing over 20 pounds that are mounted over 4 feet above the floor.
- Heavy light fixtures in essential buildings such as hospitals may be classified as designated seismic systems. Designated seismic systems are designed using a component importance factor,  $I_p$ , of 1.5 and may require engineering calculations, equipment certification, and special inspection.

#### RETROFIT STANDARD PROVISIONS

ASCE/SEI 41-06, *Seismic Rehabilitation of Existing Buildings*, (ASCE, 2007) classifies light fixtures into one of four types. Heavy suspended light fixtures do not fit any of the four types. “Category 4” fixtures are described as “lighting suspended from ceiling or structure by a pendant or chain.” Heavy light fixtures are generally supported by a rigid or braced frame component supports, and so do not fit this category. They rarely rely on the ceiling for vertical or lateral support, and so do not fit the other categories.

Analysis of the fixture anchorage and component supports is required, since the prescriptive acceptance criteria for the life safety and immediate occupancy nonstructural performance levels are not generally applicable.

Given the level of risk posed by these components, evaluation for the presence of adequate attachment and support should be performed for all performance levels in high, moderate, and low seismicity areas.

### Typical Causes of Damage

- Heavy or special purpose lighting can fail at the attachment to the structure above if not adequately designed and the fixture could fall and injure occupants. Overhead braces may buckle and the fixture will be misaligned or fail to function as intended.
- Fixtures with multiple parts or movable arms may fail at the connections or arm joints; bulbs or lenses may fall.
- Bracing for the light fixture and surrounding ceiling should be coordinated to allow for relative movement. If the ceiling surround has not been designed with appropriate clearance around the fixture, the ceiling may be damaged at the interface with the light.

### DAMAGE EXAMPLES



Figure 6.4.9.4-1 Operating room lights undamaged although hospital evacuated due to collapse of adjacent wing in the 2010 magnitude-7 Haiti Earthquake. Fixture anchored to underside of concrete slab (Photo courtesy of Ayhan Irfanoglu, Purdue University).

## Seismic Mitigation Considerations

- Per 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), where the weight of a fixture in a suspended acoustic ceiling is greater than 56 pounds, the fixture must be supported directly from the structure above by approved hangers. Where the fixture is over 56 pounds but light enough so that the lateral restraint for the fixture can be provided by the lateral bracing for the ceiling grid, these fixtures must also be positively attached to the ceiling grid with a minimum of two attachment devices capable of resisting 100% of the fixture weight in any direction. This condition is covered in Sections 6.4.9.1 and 6.4.9.2.
- Lights covered here are those heavier than can be safely supported by the suspended ceiling grid and require independent engineered supports for both vertical and lateral loads. In addition, special purpose lighting with movable parts may require more fixity than provided by the ceiling grid and require independent support and bracing to maintain position and satisfy operational tolerances.
- Note that fixed lighting provides an obstruction for a suspended ceiling system. For suspended acoustic ceilings in Seismic Design Category D, E & F, ASTM E580 requires that the ceiling surrounding such a fixture must be detailed as if it were a perimeter closure that must allow the required clearances by use of suitable closure details; this typically would require a minimum  $\frac{3}{4}$ " clearance around the fixture.
- When purchasing heavy light fixtures that have multiple part or movable arms, check with the manufacturer for seismically qualified fixtures. Certified fixtures are required for hospitals or essential facilities that must remain functional following an earthquake per Section 13.2.2.1 of ASCE 7-10, *Minimum Design Loads for Buildings and Other Structures* (ASCE, 2010).

## MITIGATION EXAMPLES



Figure 6.4.9.4-2 Engineered support and bracing are required for heavy operating room lights. The arms, joints, lenses and bulbs must be capable of resisting seismic forces. Hospital fixtures require certification. Photo also shows surface mounted fluorescent fixtures in a suspended gypsum board ceiling; each of these requires independent safety wires to the structure above; see Section 6.4.9.2 (Photo courtesy of Maryann Phipps, Estructure).



Figure 6.4.9.4-3 Engineered support and bracing for operating room lights located in California hospital. Steel plate has predrilled holes to receive fixture attachments (Photo courtesy of Maryann Phipps, Estructure).

## MITIGATION DETAILS

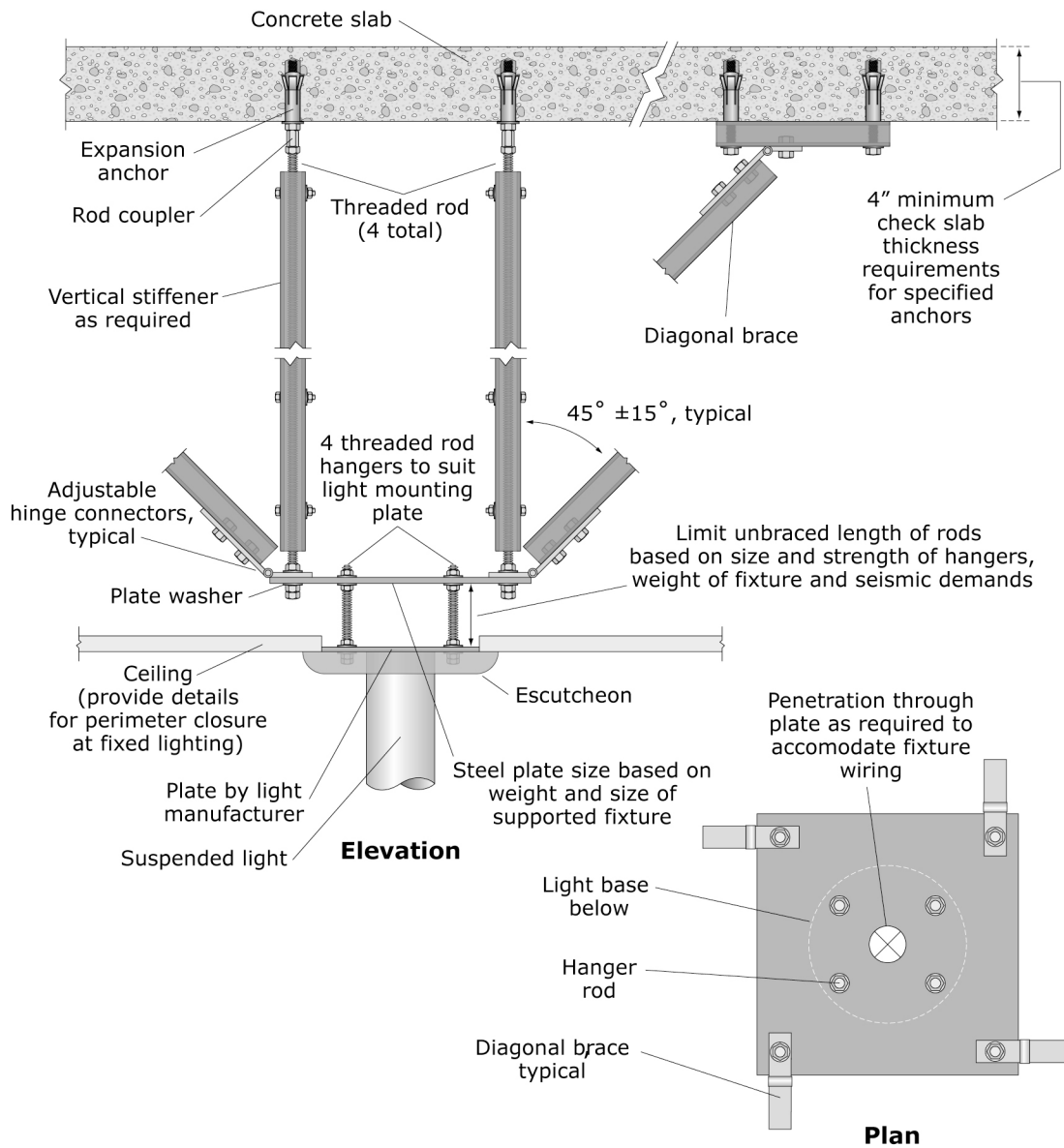


Figure 6.4.9.4-4 Details for supporting heavy light fixture directly from structure (ER).

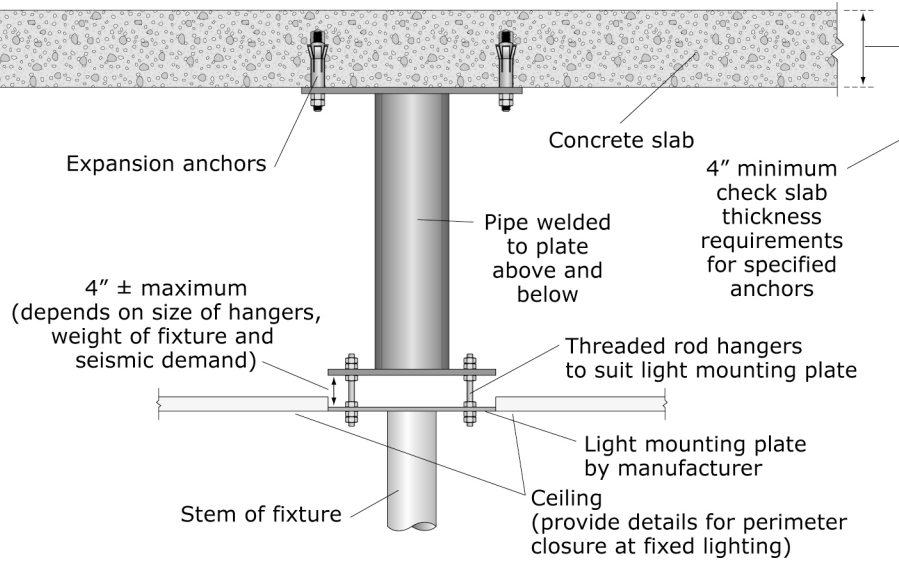


Figure 6.4.9.4-5 Details for supporting heavy light fixture directly from structure (ER).