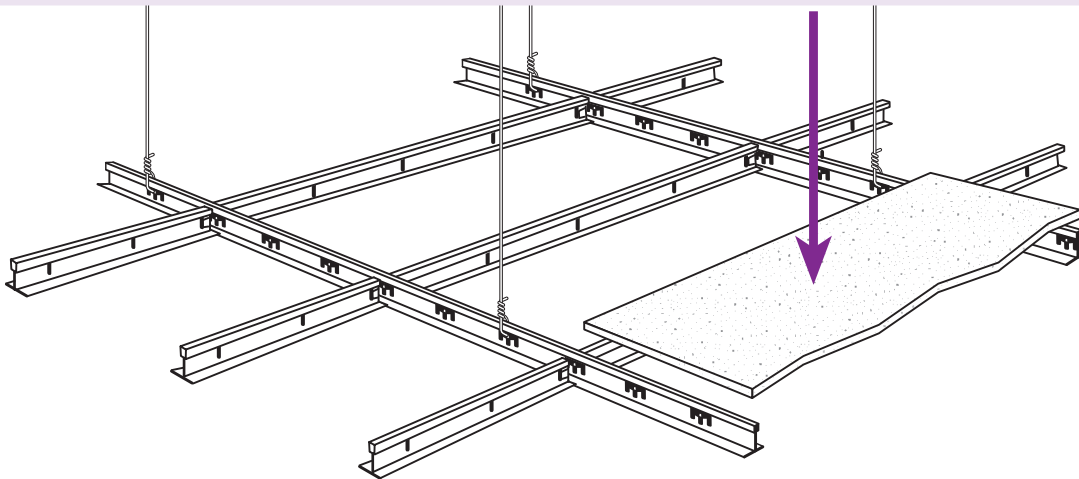


SUSPENDED CEILINGS
401

Suspension Systems for Acoustical Lay-in Ceilings
Seismic Design Categories D, E & F

This document has been revised based on current Building Code standards. In all buildings, other than structures classified as essential facilities, **suspended ceilings installed in accordance with the prescriptive provisions of this document are deemed to comply with the current building code interpretation.**

This document provides the IBC-2015 referenced standards for the installation of suspension systems for acoustical lay-in ceilings. Incorporation of this document will provide a more uniform standard for installation and inspection. This document is designed to accomplish the intent of the International Building Code (IBC) with regard to the requirements for seismic design category D, E and F for suspended ceilings and related items. Unless supported by engineering, the suspension system shall be installed per these requirements and those of the referenced documents. Manufacturers' recommendations should be followed where applicable.



General Recommendations

- Referenced sources per hierarchy: 2015 International Building Code (IBC), American Society of Civil Engineers (ASCE 7-16), American Society of Testing Materials (ASTM C 635, ASTM C 636, ASTM E 580/E 580M), and Ceilings and Interior Systems Construction Association (CISCA).
- Partitions that are tied to the ceiling and all partitions greater than 6 ft in height shall be laterally braced to the structure. Bracing shall be independent of the ceiling splay bracing system. *Source: ASCE 7-16 Section 13.5.8.1*
- For further information on bracing of non-load bearing partitions, refer to NWCB Technical Document #200-501.
- All main beams are to be Heavy Duty (HD). *Source: ASTM E580 Section 5.1.1*
- Ceilings less than or equal to 144 ft² and surrounded by walls connected to the structure above are exempt from the seismic design requirements. *Source ASTM E580 Section 1.4*
- These recommendations are intended for suspended ceilings and related components in areas that require resistance to the effects of earthquake motions. *Source: ASTM E580 Section 3.2*
- All wire ties are to be three tight turns around themselves within three inches. Twelve-gauge hanger wire spaced 4 ft on center (Figure 1). *Source: ASTM C636 Section 2.3.4*
- Changes in ceiling planes will require positive bracing. *Source: ASTM E580 Section 5.2.8.6*

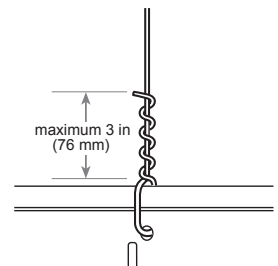


Figure 1

Figure 2
Lateral-Force Bracing

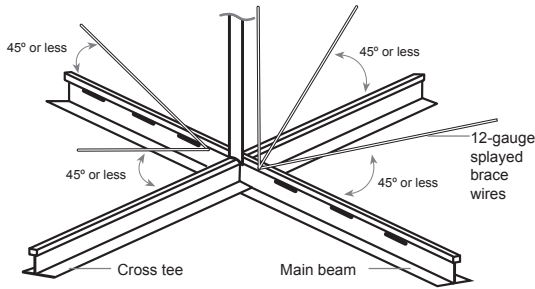


Figure 3
Maximum Recommended Lengths for Vertical Struts

EMT CONDUIT	
½" EMT conduit	up to 5' 10"
¾" EMT conduit	up to 7' 8"
1" EMT conduit	up to 9' 9"
METAL STUDS	
Single 1½" metal stud (20-gauge)	up to 12' 0"
Back-to-back 1½" metal stud (20 gauge)	up to 15' 0"
Single 2½" metal stud (20-gauge)	up to 13' 6"
Back-to-back 2½" metal stud (25-gauge)	up to 15' 0"

Source: Portland Building Department

Note: Plenum areas greater than 15'0" will require engineering calculations.

Figure 4a
Attached Wall Molding Requirements

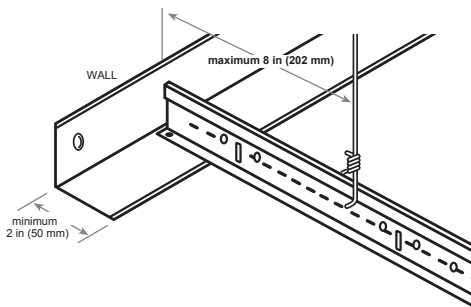
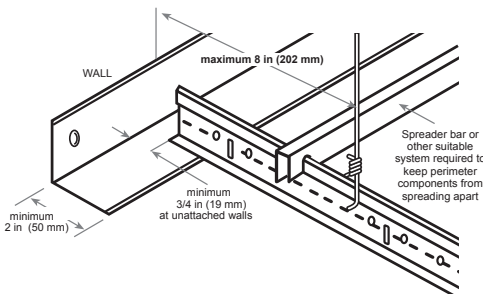


Figure 4b
Unattached Wall Molding Requirements



Lateral-Force Bracing (Figures 2 and 3)

- Ceilings constructed of screw- or nail-attached gypsum board on one level that are surrounded by and connected to walls or soffits that are laterally braced to the structure above are exempt from seismic design requirements. *Source: ASCE 7-16 Section 13.5.6, ASTM E580 Section 1.7*
- Ceiling areas of 1000 ft² or less shall be exempt from lateral-force bracing requirements. *Source: ASTM E580 Section 1.6*
- Lateral-force bracing is the use of vertical struts (compression posts) and splay wires (see Figure 2).
- Lateral-force bracing shall be 12 ft on center (maximum) and begin no farther than 6 ft from walls. *Source: ASTM E580 Section 5.2.8.2*
- Seismic splay wires are to be four 12-gauge wires attached to the main beam. Wires are arrayed 90° from each other and at an angle not exceeding 45° from the plane of the ceiling. *Source: ASTM E580 Section 5.2.8.2*
- Seismic splay wires shall be attached to the grid and to the structure in such a manner that they can support a minimum design load of 200 lb or the actual design load, with a safety factor of 2, whichever is greater (Figure 6b). *Source: CISCA zones 3-4*
- Power-actuated fasteners in concrete or steel shall not be used for sustained tension loads or for brace applications in Seismic Design Categories D, E, or F unless approved for seismic loading. Power-actuated fasteners in masonry are not permitted unless approved for seismic loading.

Exceptions:

- Power-actuated fasteners in concrete, used for support of acoustical tile or lay-in panel suspended ceiling applications and distributed systems where the service load on any individual fastener does not exceed 90 lb.
 - Power-actuated fasteners in steel where the service load on any individual fastener does not exceed 250 lb (1.112N). *Source: ASCE 7-16 13.4.5*
- Splay wires are to be within 2 inches of the connection of the vertical strut to suspended ceiling. *Source: ASTM E580 Section 5.2.8.2*
 - Rigid bracing may be used in lieu of splay wires. *Source: ASTM E580 Section 5.2.8.4*
 - Ceilings with plenums less than 12 inches to structure are not required to have lateral-force bracing. *Source: Portland Building Department*
 - Vertical struts must be positively attached to the suspension systems and the structure above. *Source: ASTM E580 Section 5.2.8.2*
 - The vertical strut may be EMT conduit, metal studs or a proprietary compression post (see Figure 3).

Wall Moldings (Figures 4a and 4b)

- Wall moldings (perimeter closure angles) are required to have a horizontal flange 2 inches wide. One end of the ceiling grid shall be attached to the wall molding, and the other end shall have a 3/4-in clearance from the wall and free to slide. *Source: ASTM E580 Section 5.2.2, Section 5.2.3*
- Where substantiating documentation has been provided to the local jurisdiction, perimeter clips may be used to satisfy the requirements for the 2-in closure angle. *Source: State of Oregon, Building Codes Division*

Figure 5a

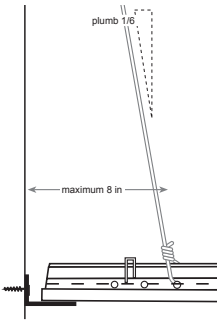


Figure 5b • Countersloping

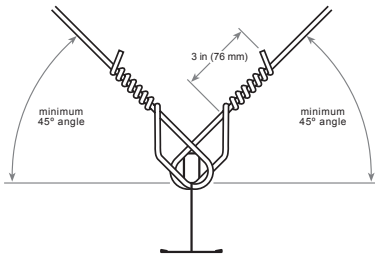


Figure 6a

Vertical hanger wire attachment

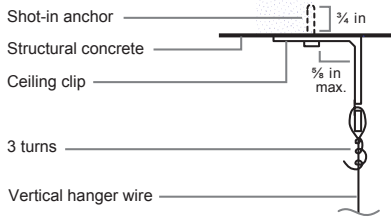
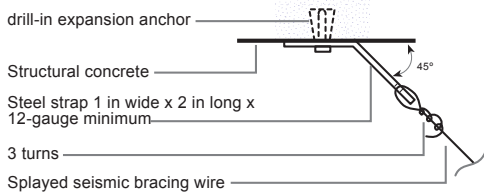


Figure 6b

Splayed seismic bracing wire attachment



- Perimeter supporting clips shall be attached to the supporting closure angle or channel with a minimum of two screws per clip and shall be installed around the entire ceiling perimeter. *Source: ASCE 7-16, Section 13.5.6.2.2a*
- The grid shall be attached at two adjacent walls (pop rivets or approved method). Soffits extending to a point at least level with the bottom plane of the grid and independently supported and laterally braced to the structure above are deemed to be equivalent to walls. *Source: State of Oregon, Building Codes Division, ASTM E580 Section 5.2.3, Section 5.2.9.1*

Spreader Bars (Figure 4b)

- Terminal ends of main runners and cross members shall be tied together or have some other approved means to prevent their spreading. *Source: ASTM E580 Section 5.2.4*
- Spreader bars are not required at perimeters where runners are attached directly to closure angles.
- Spreader bars are not required if a 90° intersecting cross or main is within 8 inches of the perimeter wall.
- Where substantiating documentation has been provided to the local jurisdiction, perimeter clips may be used to satisfy the requirements for spreader bars. *Source: State of Oregon, Building Codes Division*

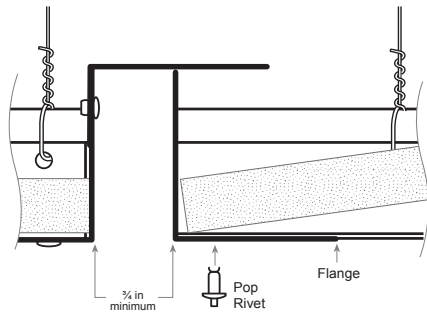
Hanger (Suspension) Wires (Figures 5a and 5b)

- Hanger and perimeter wires must be plumb within 1:6 unless (Figure 5a) counter sloping wires are provided (Figure 5b). *Source: ASTM C636 Section 2.1.4*
- Hanger wires shall be 12-gauge and spaced 4 ft on center. *Source: ASTM C636 Section 2.1.6, ASTM E580 Section 5.2.7.1*
- Any connection device at the supporting construction shall be capable of carrying not less than 100 lb. *Source: CISCAs zones 3-4*
- Powder Actuated Fasteners (PAFs) are an approved method of attachment for hanger wires. *Source: ASCE 7-16 13.4.5 Exception 1 & 2, State of Oregon, Building Codes Division*
- Terminal ends of each main beam and cross tee must be supported within 8 inches of each wall with a perimeter wire or approved wall support (see Figures 4a & 5a). *Source: ASTM E580 Section 5.2.6*
- Wires shall not attach to or bend around interfering material or equipment. A trapeze or equivalent device shall be used where obstructions preclude direct suspension. Trapeze suspensions shall be sized to resist the dead load and lateral forces appropriate for the seismic category. *Source: ASTM E580 Section 5.2.7.4*

Electrical Fixtures

- Light fixtures weighing less than 10 lb shall have one 12-gauge hanger wire connected from the fixture to the structure above. This wire may be slack. *Source: ASTM E580 Section 5.3.4*
- Light fixtures weighing more than 10 lb and less than 56 lb shall have two 12-gauge wires attached at opposing corners of the light fixture to the structure above. These wires may be slack. *Source: ASTM E580 Section 5.3.5*
- Light fixtures weighing more than 56 lb shall be supported directly from the structure above by approved hangers. *Source: ASTM E580 Section 5.3.6*
- Pendant-hung fixtures shall be directly supported from the structure above using a 9-gauge wire or an approved alternate support without using the ceiling suspension system for direct support. *Source: ASTM E580 Section 5.3.7*

Figure 7



supported directly from the structure above by approved hangers. *Source: ASTM E580 Section 5.4.3*

Seismic Separation Joints (Figure 7)

- All continuous ceiling areas exceeding 2500 ft² (232 m²), shall have a seismic separation joint, bulkhead braced to the structure or full-height partition that breaks the ceiling into areas of no more than 2500 ft² (232 m²) and a ratio of the long to short dimension less than or equal to four. Each area shall be capable of allowing + or – 3/4 in (19 mm) axial movement. Areas surrounded by bulkheads or full height partitions shall be provided with closure angles. Each area with a seismic separation joint, bulkhead or full-height partition shall have horizontal bracing or restraints. *Source: ASCE 7-16 Section 13.5.6.2.2 b, ASTM E580 Section 5.2.9.1*

Sprinklers

- For ceilings without rigid bracing, sprinkler head penetrations shall have a 2-in oversize ring, sleeve or adapter through the ceiling tile to allow free movement of at least one inch in all horizontal directions. Flexible head design that can accommodate 1 inch free movement shall be permitted as an alternate. *Source: ASTM E580 Section 5.2.8.5*

Mechanical Services

- Terminals or services weighing less than 20 lb shall be positively attached to the ceiling suspension main runners or to cross runners that have the same carrying capacity as the main runners. *Source: ASTM E580 Section 5.4.1*
- Terminals or services weighing 20 lb but not more than 56 lb shall have, in addition to 5.4.1, two 12-gauge wires connecting them to the ceiling system hangers or the structure above. These wires may be slack. *Source: ASTM E580 Section 5.4.2*
- Terminals or services weighing more than 56 lb shall be

Glossary for this Document (regional terminology may vary)

CROSS TEE The cross member that interlocks with the main beams, also known as a cross runner or cross T-bar.

DIFFUSER A circular or rectangular metal grill used for the passage of air from a ducted system.

ESSENTIAL SERVICE BUILDING Any building designed to be used by public agencies as a fire station, police station, emergency operations center, State Patrol office, sheriff's office, or emergency communication dispatch center.

GRID The main beams and cross tees of the suspension system.

HANGER WIRE 10- or 12-gauge soft annealed wire used as primary support for the grid system. Also called a suspension wire.

LATERAL-FORCE BRACING The bracing method used to prevent ceiling uplift or restrict lateral movement during a seismic event. Lateral-force bracing consists of vertical struts and splay wires.

MAIN BEAM The primary suspension member supported by hanger wires, also known as the main runner or carrying tee, carrying runner or mains.

MOLDING/CLOSURE ANGLE A light-gauge metal angle or channel fastened to the perimeter wall or partition to support the perimeter ends of an accoustical ceiling grid.

PERIMETER CLIP A proprietary angle bracket attached directly to the wall molding/closure angle which allows for 3/4 in movement in the event of seismic activity and interlocks properly with ends of grid system.

PERIMETER WIRE A hanger wire placed within 8 in of the surrounding walls.

PLENUM The space above a suspended ceiling.

SLACK WIRE A 12-gauge wire that is not tight or taut.

SPREADER or SPACER BAR A bar with notches to prevent the suspension system from separating, also called a stabilizer bar.

SPLAY WIRE A wire installed at an angle rather than perpendicular to the grid.

VERTICAL STRUT The rigid vertical member used in lateral-force bracing of the suspension system. Also known as compression post, seismic pod or seismic strut. Common materials are electrical conduit (EMT), metal studs or proprietary products.

The NWCB has been serving the construction industry since 1950. It is recognized as a technical authority, educational body and spokesperson for the wall and ceiling industry. It provides services to architects and the construction community on all matters relating to the diversified wall and ceiling industry. As the industry's development and coordination organization, the NWCB saw the need to establish this document to provide clarification and the intent of NEHRP (National Earthquake Hazards Reduction Program) an agency of FEMA (Federal Emergency Management Agency). It is meant to serve as a set of recommendations and is not intended for any specific construction project. NWCB makes no express or implied warranty or guarantee of the techniques, construction methods or materials identified herein.