

NWCB Technical Document

SUSPENDED CEILING
401Suspension Systems for Acoustical Lay-in Ceilings
Seismic Design Categories D, E & F

This document provides the 2021 IBC referenced standards for the prescriptive design and 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 intended to accomplish the intent of the International Building Code (IBC), including the Oregon Structural Specialty Code and Washington State Building Code, with regard to the requirements for seismic design category D, E and F for suspended ceilings and related items. Prescriptive suspension systems shall be installed per these requirements and those of the referenced documents. Engineered design of suspension systems are outside the scope of this document. Manufacturers' recommendations shall be followed where applicable.

The following are outside the scope of this technical document:

- Suspension systems for acoustical lay-in ceilings in Risk Category IV structures. *Source: ASCE 7 Section 13.1.3, ASTM E580 Section 5.7*
- Suspension systems for acoustical lay-in ceilings assigned a component importance factor of 1.5 in accordance with ASCE 7 Section 13.1.3 by the registered design professional. *Source: ASCE 7 Section 13.1.3, ASTM E580 Section 5.7*
- Suspension systems for acoustical lay-in ceiling designed in accordance with accepted engineering practice by a registered design professional. *Source: ASCE 7 Section 13.5.6.2*
- Suspension systems consisting 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 the requirements of ASCE-7 Section 13.5.6.

Source ASCE-7 Section 13.5.6 Exception 2

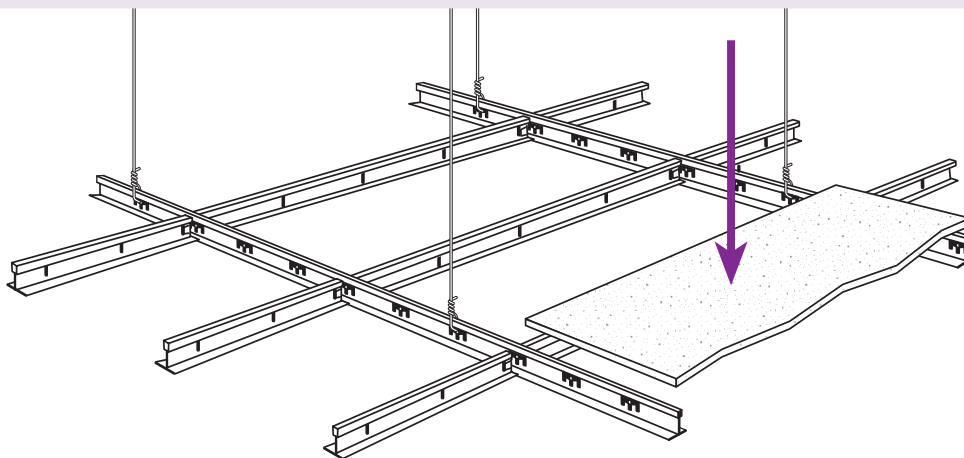
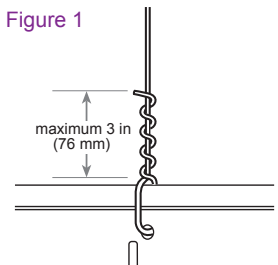


Figure 1



General Requirements

- Referenced sources per hierarchy: 2021 International Building Code (IBC), American Society of Civil Engineers (ASCE-7-16), American Society of Testing Materials (ASTM C635, ASTM C636, ASTM E580).
- 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 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 as defined in ASTM C635). *Source: ASTM E580 Section 5.1.1*
- Ceilings less than or equal to 144 ft² and surrounded by walls or soffits that are laterally braced to the structure above are exempt from the seismic design requirements of ASCE 7 and ASTM E580. *Source ASCE 7 Section 13.5.6 Exception 1*
- All wire ties shall be tightly wrapped around themselves a minimum of three turns within three inches (Figure 1). *Source: ASTM C636 Section 2.3.4*
- Main beams shall be level to within 1/4 in. in 10-ft. *Source: ASTM C636 Section 2.3.1*
- Cross tees shall be level to within 1/8 in. in 12-ft. *Source: ASTM C636 Section 2.2.1*

Figure 2
Lateral-Force Bracing *Source: ASTM E580 Figure 5*

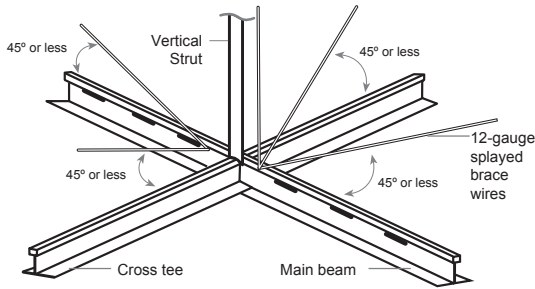


Figure 3
Maximum Recommended Lengths for Vertical Struts

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: Northwest Wall and Ceiling Bureau

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

Figure 4a
Attached Wall Molding Requirements

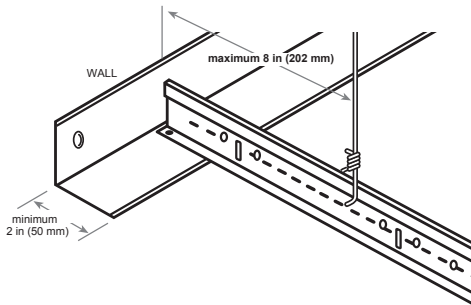
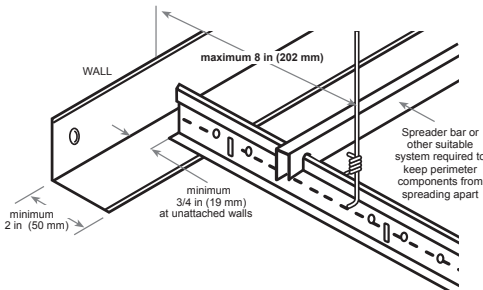


Figure 4b
Unattached Wall Molding Requirements



Lateral-Force Bracing (Figures 2 and 3)

- Lateral-force bracing, which is the use of vertical struts (compression posts) and splay wires, is required for all ceiling areas greater than 1000 ft² (see Figure 2). *Source: ASTM E580 Section 5.2.8.1, Section 5.2.8.2*
- 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*
- Lateral-force bracing splay wires shall consist of four 12-gauge wires attached to the main beam, 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*
- Lateral-force bracing splay wires shall be attached to the grid and to the structure in such a manner that they can support a load of not less than 250 lb when tested per ASTM E3090 (Figure 6b). *Source: ASTM E580 Section 5.2.8.3*
- Power-actuated fasteners in concrete or masonry shall not be used for the attachment of lateral-force bracing splay wires unless tested and approved for seismic loading. *Source: ASCE 7 Section 13.4.5, Oregon Building Codes Division Statewide Code Interpretation No. 11-01 (oregon.gov/bcd/codes-stand/Documents/interp-11-01-pafceilings.pdf)*
- Power-actuated fasteners in steel shall be permitted for the attachment of lateral-force bracing splay wires. *Source: ASCE 7 Section 13.4.5 Exception 2*
- 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*
- 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).
- Changes in ceiling plane elevation requires independent lateral force-bracing for each ceiling plane. *Source: ASTM E580 Section 5.2.8.6*

Wall Moldings (Figures 4a and 4b)

- Wall moldings (perimeter closure angles) are required to have a horizontal flange not less than 2" wide. Two adjacent ends of the ceiling grid shall be positively attached to the wall molding (pop rivets or approved method), and the opposite ends shall have a ¾-in clearance from the wall and be free to slide. *Source: ASTM E580 Section 5.2.2, Section 5.2.3*
- Where substantiating documentation has been provided to the local jurisdiction, proprietary perimeter clips may be used in tandem with 7/8" closure angle to satisfy the requirements for the 2" closure angle.
- 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 Section 13.5.6.2.2a*

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*

Figure 5a

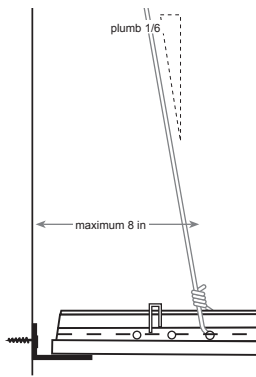


Figure 5b • Countersloping

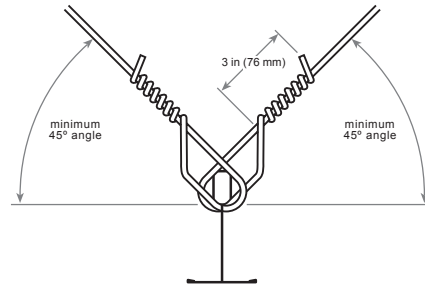


Figure 6a

Vertical hanger wire attachment

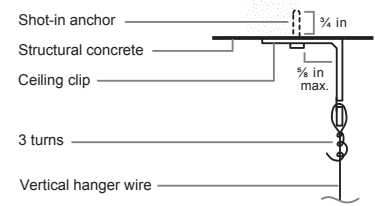


Figure 6b

Spplayed seismic bracing wire attachment

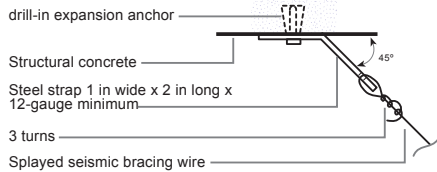
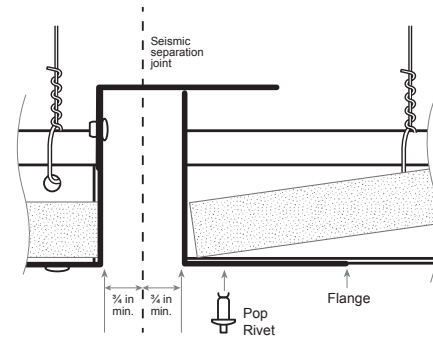


Figure 7



- Spreader bars are not required at perimeters where runners are attached directly to closure angles.
- Where substantiating documentation has been provided to the local jurisdiction for review and approval, proprietary perimeter clips may be used to satisfy the requirements for spreader bars.

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 spaced 4 ft on center, maximum. *Source: ASTM C636 Section 2.1.3*
- Hanger wires shall be No. 12-gauge. *Source: ASTM C636 Section 2.1.6, ASTM E580 Section 5.2.7.1*
- Hanger wires shall not press against ducts or pipes. *Source: ASTM C636 Section 2.1.4*
- Hanger wires shall not have local kinks or bends as a means of leveling main beams or cross tees. *Source: ASTM C636 Section 2.2.3, Section 2.3.3*
- Any connection device at the supporting construction shall be capable of carrying not less than 90 lb. *Source: ASTM E580 Section 5.2.7.2*

- Power Actuated Fasteners (PAFs) are an approved method of attachment for hanger wires where the service load on any individual fastener does not exceed 90 lb in concrete or 250 lb in steel. *Source: ASCE Section 7-16 13.4.5 Exception 1 & 2, Oregon Building Codes Division Statewide Code Interpretation No. 11-01 (oregon.gov/bcd/codes-stand/Documents/interp-11-01-pafcellings.pdf)*
- 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

- All lighting fixtures shall be positively attached to the suspended ceiling system by mechanical means as specified in the National Electrical Code (NEC), unless independently supported. *Source: ASTM E580 Section 5.3.1*
- Light fixtures weighing less than 10 lb shall have one 12-gauge safety wire connected from the fixture housing 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 or equal to 56 lb shall be supported directly from the structure above by approved hangers. 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 minimum wire or an approved alternate support without using the ceiling suspension system for direct support. *Source: ASTM E580 Section 5.3.7*

Mechanical Services

- Terminals or services weighing less than or equal to 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 more than 20 lb but less than or equal to 56 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, and shall have two 12-gauge safety 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 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 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 and a ratio of the long to short dimension less than or equal to four. Each 2500 ft² maximum area shall be capable of allowing + or - 3/4 in (1 1/2 in total) at the joints horizontal movement in the plane of the ceiling. 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 Lateral-Force Bracing as prescribed on page 2. *Source: ASCE-7 Section 13.5.6.2.2b, 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*

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.

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.

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