Hanger Wire Attachment

Code Requirements[1]

The International Building Code (IBC) defines the requirement for hanger wire and their supports and attachment methods. However, there are exceptions and the application of hanger wires in a seismic design category can meet code requirements in different ways.

USG® recommends that the design team, consulting engineers and code officials work together to analyze these factors and determine the appropriate construction and application of hanger wire attachment. Because codes continue to evolve, check with local officials prior to designing and installing a suspension system.

Guidelines

- 12-gauge, galvanized, soft-annealed steel wire
- Manufactured in accordance with ASTM A641
- Meets or Exceeds Federal Specification QQ-W-461H

Note: 12-gauge hanger wire produced by USG meets these requirements.

Performance Data

12-Gauge Wire	Wire Tie Failure / Pullout Load
Typical 3 wrap tie[1]	270 lbs.
Tight 3 wrap tie	358 lbs.
Yields	424 lbs.
Ultimate load	+550 lbs.
Tensile Strength (Ksi)	80 max.

[1] Per ASTM C636

Note: Tight wrap typically consists of three complete wraps within 1 in. Some jurisdictions may require four complete wraps for bracing wires. These requirements may vary by jurisdiction.

Splice Options

Hanger wire splices are typical when the ceiling drop is greater than the length of the wire available and are allowed in seismic ceiling construction. The industry standard is to loop and tie the wire ends with three tight turns, or use a square knot. The square knot is the stronger of the two options at 550 lbs. versus 350 lbs. for the loop and tie option.

12-Gauge Wire Splice	Wire Tie Failure
Loop and Tie	350 lbs.
Square Knot	550 lbs.

Note: Accessories by others for securing hanger wire splices should be evaluated for pullout and strength.

[1] See last page for Seismic Code Reference Standards

Application

Hanger Wire Splices

Loop and Tie Application

Step 1 Connect the hanger wire ends together through two loops.

Step 2 Wrap the hanger wire ends securely around itself with three complete turns within 1 in.

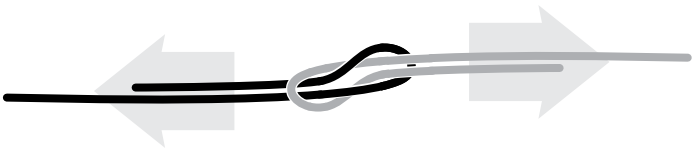
Square Knot Application

Step 1 Create an approximate 5 in. bend in the end of each hanger wire

Step 2 With the short ends opposed, bring the right-hand end over the left-hand and loop the short end under and around the left-hand end, as shown.

Step 3 Loop the left-hand short end back up and around the right-hand loop, with the left-hand end over the right-hand end and bring the left-hand end under the loop of the right-hand end, as shown.

Step 4 Draw the knot tight.



Step 5 Wrap the hanger wire ends securely around itself with three complete turns within 1 in.

Note: In the symmetry of the knot, the wire piece on the left emerges parallel from below the other loop, while the wire piece on the right emerges parallel from above the other loop. This appearance confirms you have tied the square knot correctly.

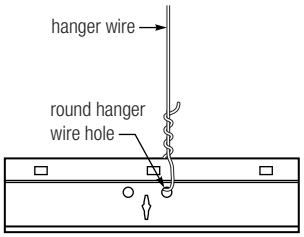
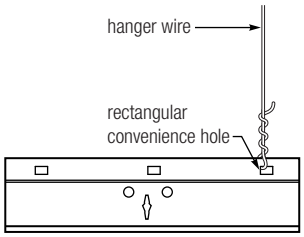
Application

Attachment to Tee

Insert the hanger wire ends through a wire hole in the tee and wrap the wire end securely around itself with three complete turns within 3 in. Ensure the remaining wire end is secured so that it does not interfere with the placement of ceiling panels.

USG DONN® main tees are produced with round hanger wire holes in the tee web at regular intervals. There are also rectangular (convenience) holes located in the tee bulb at regular intervals. The typical location for the hanger and bracing (splay) wires is in the round holes, but the rectangular (convenience) holes may also be used when needed. We have load tested the rectangular (convenience) holes located in the tee bulb with 12 ga. hanger wire on a 45° angle. The failure load is in excess of 400 lbs. This far exceeds the 250 lb. minimum prescribed by the code for the connections of the bracing (splay) wires.

Note: USG has qualified the use of the rectangular (convenience) holes located in the tee bulb through comparison testing by seismic shake-table analysis. In these tests the rectangular (convenience) holes located in the tee bulb were used for all hanger wire attachments to the tee.

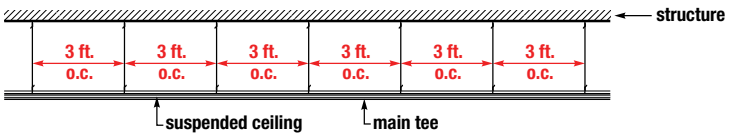
Round Hanger Wire Hole Attachment	Rectangular (Convenience) Hole Attachment
	

Alternative Hanger Wire Spacing

ASTM C635 addresses the load carrying capability of main tees, categorizing them as Light, Intermediate or Heavy Duty. This is also known as deflection criteria. The associated load ratings are:

Light Duty	Intermediate Duty	Heavy Duty
5 lbs./LF (7.4 kg/m)	12 lbs./LF (17.9 kg/m)	16 lbs./LF (23.8 kg/m)

Hanger wires are typically spaced 4 ft. o.c. along the main tee. Reducing the hanger wire spacing on Intermediate Duty main tees from 4 ft. o.c. to 3 ft. o.c. can achieve Heavy Duty load carrying capacity values.



Notes:

- Reducing the hanger wire spacing on Intermediate Duty main tees can achieve Heavy Duty load carrying capacity values but does not change the duty classification of the main tee.
- The performance of Donn suspension systems is based on the specific combination of superior components, and the design and installation methods shown. Components from other manufacturers were not evaluated, and their use or any mixed use is not recommended.
- Many jurisdictions accept the installation of Intermediate Duty main tees with additional supports to achieve Heavy Duty load carrying capacity values, however, some jurisdictions will not accept this application. Check with a local official prior to designing and installing a suspended ceiling system.

Anchorage

The International Building Code (IBC), through references to *ASCE/SEI 7 Minimum Design Loads for Buildings and Other Structures*, American Society of Civil Engineers/Structural Engineering Institute (ASCE/SEI), defines the requirements for component anchorage. The requirements are as follows: "Component attachments shall be bolted, welded, or otherwise positively fastened without consideration of frictional resistance produced by the effects of gravity. A continuous load path of sufficient strength and stiffness between the component and the supporting structure shall be provided. Local elements of the structure including connections shall be designed and constructed for the component forces where they control the design of the elements or their connections.

Anchors in Concrete or Masonry

Anchors in concrete shall be designed in accordance with Appendix D of ACI 318.

Anchors in masonry shall be designed in accordance with ACI 530. Anchors shall be designed to be governed by the tensile or shear strength of a ductile steel element.

Exception:

Anchors shall be permitted to be designed so that the attachment that the anchor is connecting to the structure undergoes ductile yielding at a load level corresponding to anchor forces not greater than their design strength, or the minimum design strength of the anchors shall be at least 2.5 times the factored forces transmitted by the component.

Post-installed Anchors in Concrete and Masonry

Post-installed anchors in concrete shall be pre-qualified for seismic applications in accordance with ACI 355.2 or other approved qualification procedures. Post-installed anchors in masonry shall be pre-qualified for seismic applications in accordance with approved qualification procedures.

Multiple Attachments

Determination of force distribution of multiple attachments at one location shall take into account the stiffness and ductility of the component, component supports, attachments, and structure and the ability to redistribute loads to other attachments in the group. Designs of anchorage in concrete in accordance with Appendix D of ACI 318 shall be considered to satisfy this requirement.

Anchorage

Power Actuated Fasteners

Power actuated fasteners in concrete or steel shall not be used for sustained tension loads exceeding 100 lb (445 N) or for brace applications in Seismic Design Categories D, E, or F unless approved for seismic loading. Power actuated fasteners in steel are permitted in Seismic Design Category D, E or F if the gravity tension load on any fastener does not exceed 250 lbs (1123 N) unless approved for seismic loading. Power actuated fasteners in masonry are not permitted unless approved for seismic loading.

Exception:

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 (400 N). Power actuated fasteners in steel where the service load on any individual fastener does not exceed 250 lb (1,112 N).

Power Actuated Fasteners for Acoustical Tile or Lay-In Panel Suspended Ceiling Applications
Seismic Design Category D, E or F

Concrete	Steel
Allowed for sustained tension loads exceeding 90 lb (400 N)	Allowed where gravity tension load on any fastener does not exceed 250 lbs (1123 N)

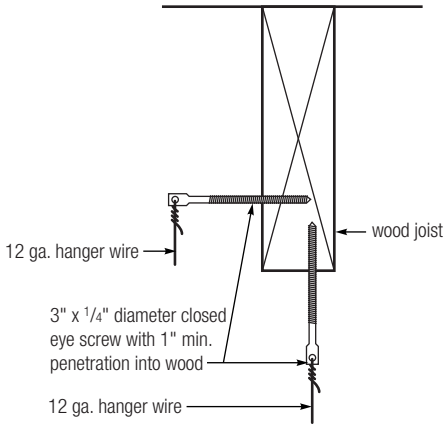
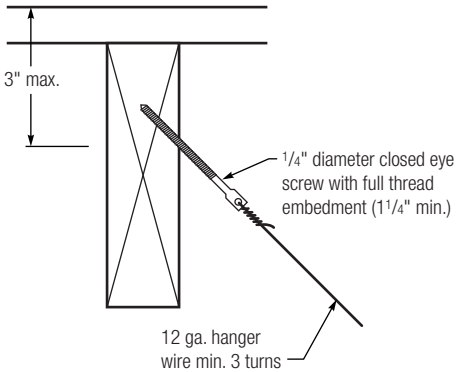
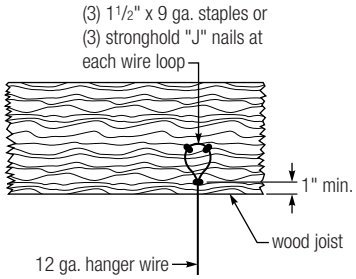
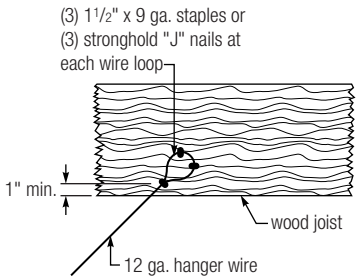
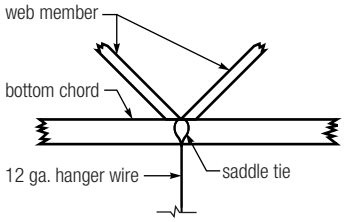
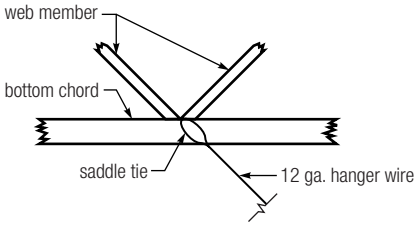
Note: The load for suspension system hanger wires will not exceed 64 lbs. based on hanger wires spaced 4 ft. o.c. along heavy duty main tees designed to carry 16 lbs/l.f. Also ASCE7-10 contains an exception allowing power actuated fasteners for support of acoustical tile or lay-in panel suspended ceiling applications. ASCE7-02 and ASCE7-05 does not contain this exception. Please check with the authority having jurisdiction as interpretation and enforcement of this may vary.

Friction Clips

Friction clips in Seismic Design Categories D, E or F shall not be used for supporting sustained loads in addition to resisting seismic forces. C-type beam and large flange clamps are permitted for hangers provided they are equipped with restraining straps equivalent to those specified in NFPA 13 Section 9.3.7. Lock nuts or equivalent shall be provided to prevent loosening of threaded connections.

Attachment to Structure

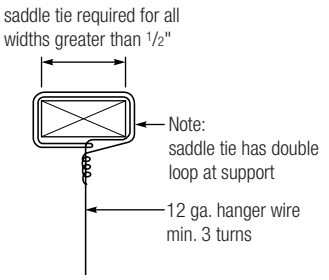
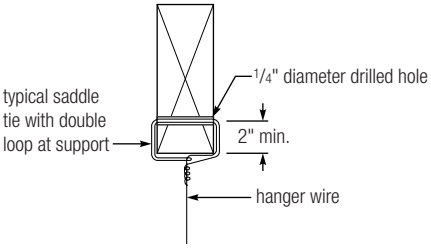
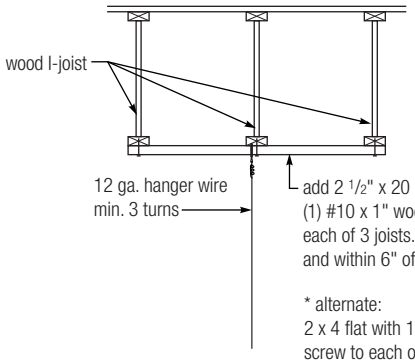
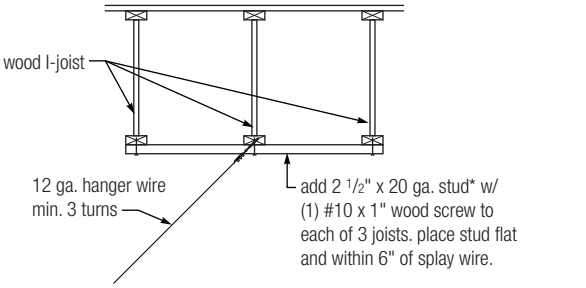
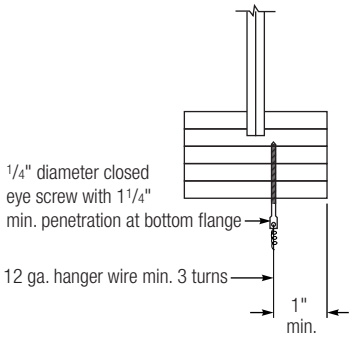
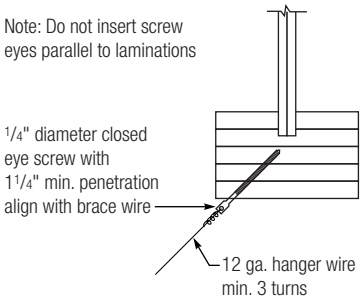
Wood

	Vertical	Splay
Wood Joist of Rafter		
		
Wood Truss		

Note: Hanger or bracing wire anchors to the structure should be installed in such a manner that the direction of the anchor aligns as closely as possible with the direction of the wire.

Attachment to Structure

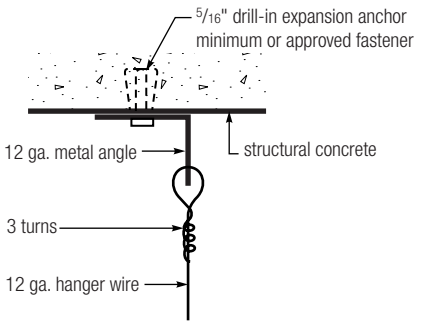
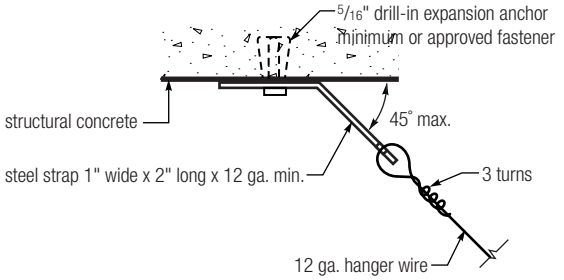
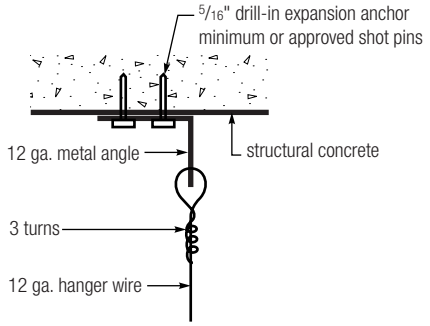
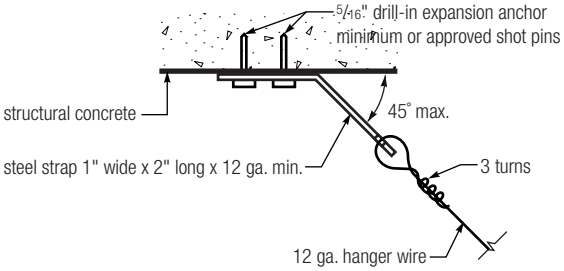
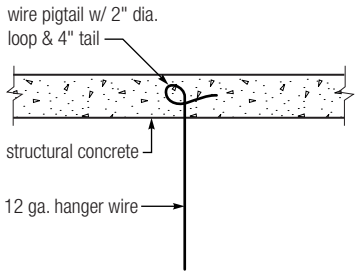
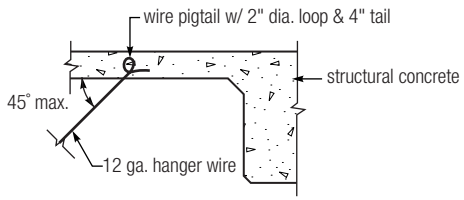
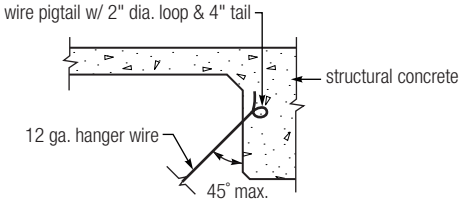
Wood

	Vertical	Splay
Bottom of Wood Joist		Not Applicable
		
Wood I-Joist		
Wood I-Joist Bottom Flange		

Note: Hanger or bracing wire anchors to the structure should be installed in such a manner that the direction of the anchor aligns as closely as possible with the direction of the wire.

Attachment to Structure

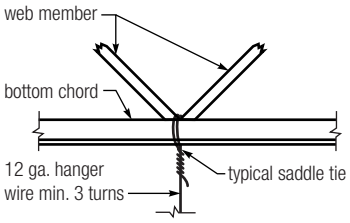
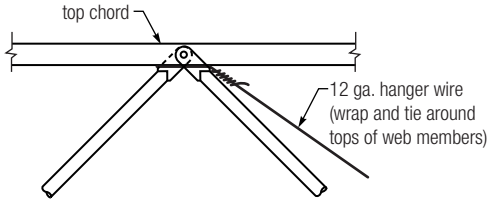
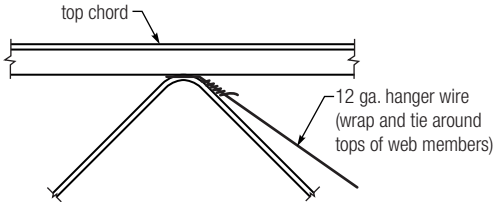
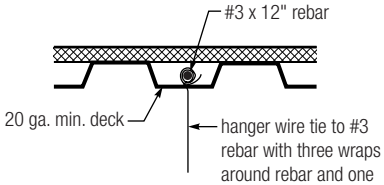
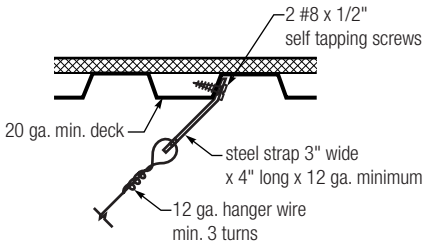
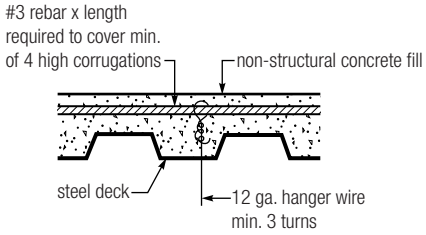
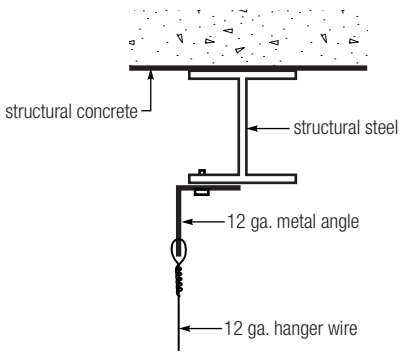
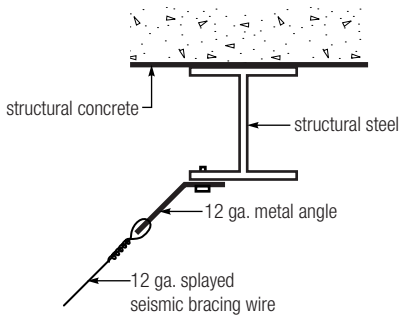
Concrete

	Vertical	Splay
Clip Attachment		
		
Cast In Place Concrete		
		

Note: Hanger or bracing wire anchors to the structure should be installed in such a manner that the direction of the anchor aligns as closely as possible with the direction of the wire.

Attachment to Structure

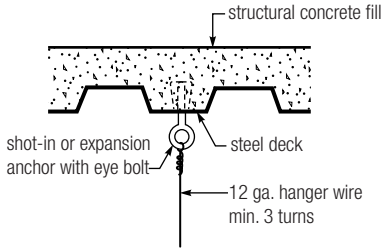
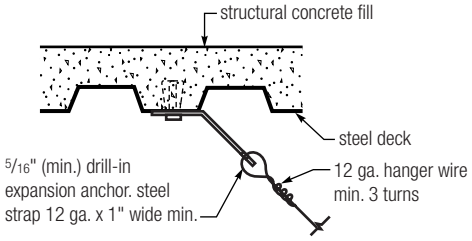
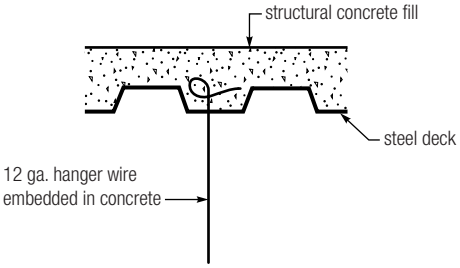
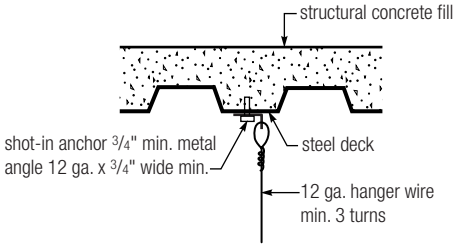
Steel

	Vertical	Splay
Open-Web Steel Joist	 Attach hanger wire to bottom chord only when designed to carry the vertical load of the suspended ceiling system.	 
Steel Roof Deck		
Steel Deck With Insulation Fill		Not Applicable
Steel Beam		

Note: Hanger or bracing wire anchors to the structure should be installed in such a manner that the direction of the anchor aligns as closely as possible with the direction of the wire.

Attachment to Structure

Steel

	Vertical	Splay
Steel Deck With Concrete Fill		
		
		

Note: Hanger or bracing wire anchors to the structure should be installed in such a manner that the direction of the anchor aligns as closely as possible with the direction of the wire.

Testing and Inspection

Post-installed anchors shall be tested when deemed necessary by the authority having jurisdiction. Testing shall be performed by an accepted testing facility, unless approval of an alternative is obtained in advance from the engineer of record (EOR) for the project. If any anchor fails testing, test all anchors of the same type, not previously tested until twenty (20) consecutive anchors pass, then resume the initial test frequency. The anchors tested shall be only those anchors installed by the same trade. The authority having jurisdiction shall define acceptance/failure criteria. The test values and all appropriate criteria shall be shown on the contract documents.

The test load may be applied by any method that will effectively measure the tension in the anchor, such as direct pull with a hydraulic jack, calibrated spring loaded devices, or a calibrated torque wrench except that displacement-controlled anchors such as drop-ins shall not be tested using a torque wrench.

When field testing of component anchorage is required by the authority having jurisdiction, the following criteria shall apply unless otherwise specified:

Anchor Type	Test Value	Percent Tested
Support (Vertical)	200 lbs. in tension	10%
Bracing (Splay)	440 lbs. in tension	50%

Note: Drilled-in or shot-in anchors typically require special approval prior to use in pre-stressed concrete.
Note: Shot-in anchors in concrete are not permitted for bracing wires.

	Installation Guidelines for Suspended Ceilings			
International Building Code (IBC)	2003 IBC	2006 IBC	2009 IBC	2012 IBC
American Society of Civil Engineers (ASCE)	ASCE7-02	ASCE7-05	ASCE7-05	ASCE7-10
Ceilings Interior Systems Construction Association (CISCA) or **ASTM International (ASTM)**	CISCA Zones 0-2 CISCA Zones 3-4	CISCA Zones 0-2 CISCA Zones 3-4	CISCA Zones 0-2 CISCA Zones 3-4	ASTM E580

International Building Code (IBC) defines Seismic Design Categories A, B, C, D, E, and F.
www.iccsafe.org

ASCE/SEI 7 Minimum Design Loads for Buildings and Other Structures
American Society of Civil Engineers/Structural Engineer Institute (ASCE/SEI)
www.asce.org

Guidelines for Seismic Restraint for Direct-hung Suspended Ceiling Assemblies (Zones 3-4)
Recommendations for Direct-hung Acoustical Tile and Lay-in Panel Ceilings (Zones 0-2)
CISCA Ceilings & Interior Systems Construction Association (CISCA)
www.cisca.org

ASTM Internationl E580/E580M Standard Practice for Installation of Ceiling Suspension Systems for Acoustical TIle and Lay-in Panels in Areas Subject to Earthquate Ground Motions.
ASTM International (formerly American Society for Testing and Materials)
www.astm.org

Further References

USG Seismic Ceiling Resource Center
Seismic Technical Guides
seismicceilings.com

Product Information
See usg.com for the most up-to-date product information.

Installation
Must be installed in compliance with ASTM C636, ASTM E580, CISCA, and standard industry practices.

Code Compliance
The information presented is correct to the best of our knowledge at the date of issuance. Because codes continue to evolve, check with a local official prior to designing and installing a ceiling system. Other restrictions and exemptions may apply. This is only intended as a quick reference.

Purpose
This seismic technical guide (STG) is intended as a resource for design professionals, to promote more uniform criteria for plan review and jobsite inspection of projects. This STG indicates an acceptable method for achieving compliance with applicable codes and regulations, although other methods proposed by design professionals may be considered and adopted.

ICC Evaluation Service, Inc., Report Compliance
Suspension systems manufactured by USG Interiors, Inc., have been reviewed and are approved by listing in ICC-ES Evaluation Report 1222. Evaluation Reports are subject to reexamination, revision and possible cancellation. Please refer to usgdesignstudio.com or usg.com for current reports.

L.A. Research Report Compliance
DONN brand suspension systems manufactured by USG Interiors, Inc., have been reviewed and are approved by listing in the following L.A. Research Report number: 25764.

Notice
We shall not be liable for incidental and consequential damages, directly or indirectly sustained, nor for any loss caused by application of these goods not in accordance with current printed instructions or for other than the intended use. Our liability is expressly limited to replacement of defective goods. Any claim shall be deemed waived unless made in writing to us within thirty (30) days from date it was or reasonably should have been discovered.

Safety First!
Follow good safety/industrial hygiene practices during installation. Wear appropriate personal protective equipment. Read MSDS and literature before specification and installation.

USG

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