

SCHOOL FACILITIES MANUAL
Nonstructural Protection Guide

SECTION C

**DETAILS FOR PROTECTING NONSTRUCTURAL
ELEMENTS FROM EARTHQUAKE-INDUCED DAMAGE**

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NONSTRUCTURAL PROTECTION DETAILS

Installation Notes For The Details In Section C

Most of the details and methods shown in this manual are general in nature and lack many of the specifics usually found in construction details. The reason for this is simply that the enormous variety of field conditions found in our schools requires a generalized approach, since specific details to fit every situation would lead to additional complexity in the document without necessarily clarifying the issue for users.

Because of the generalized approach taken in the document, it is necessary for users to apply common sense in the application and supply suggestions noted in each detail. The sizes and methods given should be sufficient for the vast majority of cases found in the field, provided care is taken in the selection of material lengths and in the substitution of materials.

The key parameter to bear in mind when completing the installation of most of the details in this guide, is that, when connecting a nonstructural element to a support system, it is important to maintain a direct load path between the nonstructural element and the surrounding structural or nonstructural system which will act as support. The most obvious instance is securing bookshelves or racks to a wood stud wall. Here, it is very important to make sure that the lag bolts or wood screws connecting the brackets to the wall itself are securely embedded in the wood studs. The plaster or gypsum wallboard is not a part of the structure and cannot be relied upon to provide an adequate resistance to seismic forces generated in the nonstructural element as they try to traverse the bracket and enter the wall. Another way of thinking of this problem is to make sure that when attaching any nonstructural element to a support, the support must be stronger than either the nonstructural element or the bracket.

When choosing supplies for which a diameter, but not a length is specified (for instance, wood screws), select a length such that at least three times the diameter of the screw will find purchase in the underlying structure. For instance, a 3/8" lag bolt designed to be attached to a wood stud should penetrate the stud at least 1-1/8". Adding to this length the thickness of intervening materials and the bracket itself will give the required length of the screw. When connecting an expansion bolt to concrete, select a bolt length based on the diameter given in the document so that the minimum embedment in concrete will be as specified by the manufacturer. In many cases, manufacturers mark their bolts to show minimum embedment. If such a designation is not present on the bolt, assume an embedment of five times the bolt diameter.

Care must also be taken, in the installation of any screw or bolt to maintain a minimum edge distance between the edge of support material and the centerline of the bolt or screw. Spacing of elements is usually not critical in these details. Edge distance in wood should be at least 1-1/2 times the diameter of the connector, and in concrete, an edge distance of 6 times the diameter should be maintained.

For those details where professional engineering consultation is recommended, installers should not attempt to install the detail based on the information provided in this manual. Consultation is recommended when either the circumstances are likely to vary widely or where the life safety hazard posed by the element is higher than for most nonstructural elements. The services of a professional structural engineer are necessary to determine the specific and technical requirements of each situation.

DETAILS FOR PROTECTING NONSTRUCTURAL ELEMENTS

Nonstructural Components

Nonstructural components are typically located in the architectural, mechanical, and electrical systems of a building. They include such items as:

- Partitions
- Ceiling and light systems
- Parapets and chimneys
- Mechanical and electrical equipment
- Piping
- Ducts

Other nonstructural components are building contents and furnishings such as:

- Shelving and their contents
- Computer equipment
- File cabinets

Nonstructural Component Evaluation

For nonstructural component evaluation, the key issue is generally whether the component or item is anchored or braced. Visual inspection can usually identify these components.

Nonstructural components become hazards to life safety when they slide, break, or fall during an earthquake. They may injure occupants or block exits from the room or building.

Communications / 1.0

Purpose

To secure communication equipment racks.

Caution
<ul style="list-style-type: none"> ■ The weight of the rack and equipment should not exceed 250 pounds. ■ When anchoring to post-tensioned slab, locate and avoid reinforcing.

Note
<p>This detail assumes the following:</p> <ul style="list-style-type: none"> ■ The rack meets the ANSI C 83.9-1972 and EIA RS-310-B Standard. ■ The rack strength is equivalent to Harris Corp., Dreacorp Division brand rack.

Recommendation

Racks Less Than 6 Feet Bolt to the floor in all four corners.

Racks More Than 6 Feet Bolt to the floor in all four corners and add a brace to the top of the rack.

Supplies Required

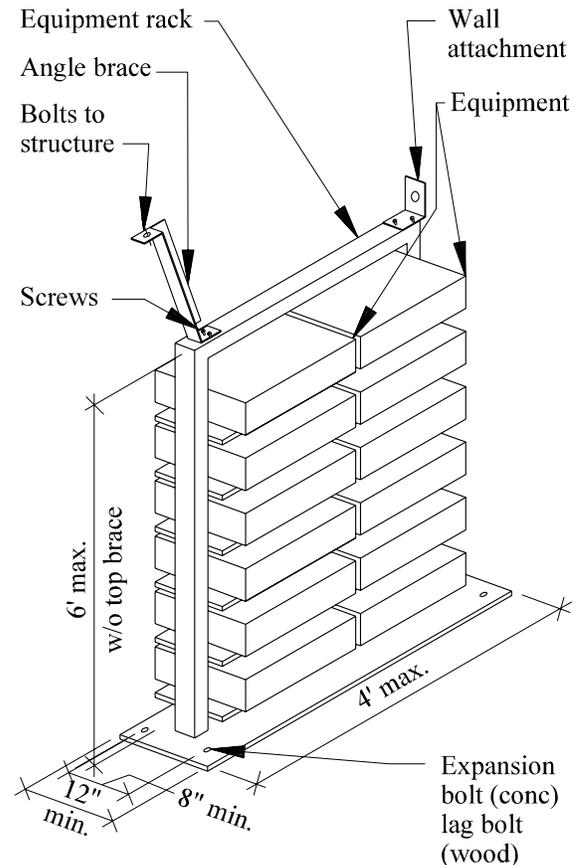
- Expansion bolts—1/2" diameter (concrete)
- Lab bolts—1/2" diameter (wood)
- Sheet metal screws—No. 12
- Angle—2" x 2" x 1/4"

Installation

1. Anchor the rack to the floor in each of the four corners.
2. Install an angle brace at each end of the top of the rack to the adjacent wall or the structure above.
3. Attach the angle brace to the rack using sheet metal screws.
4. Attach the angle to the structure with lag bolts for wood and embed them into studs at least 2". (Do not attach to gypsum wallboard only.)

OR

Secure the angle to concrete with expansion bolts.



Standard Equipment Rack

Data Processing / 2.0

Purpose

To secure access floors.

Recommendation

Install braces and anchor the existing pedestals. When floor height exceeds 12", install a steel brace to every third pedestal 8' on center.

Supplies Required

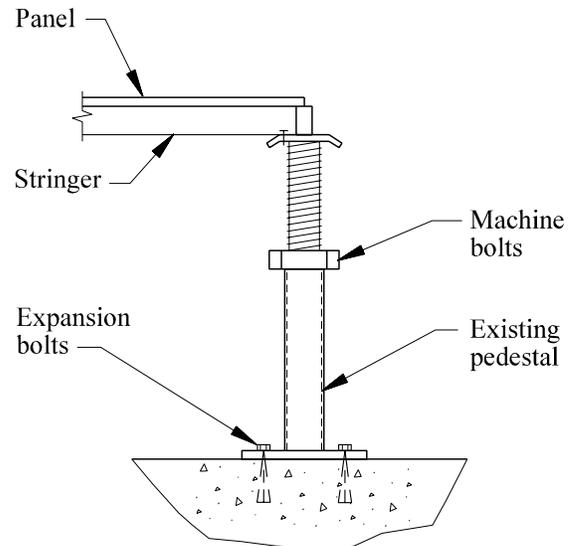
- Expansion bolts—3/8" diameter
- Machine bolt—3/8" diameter
- Angle—1-1/2" × 1-1/2" × 1/4"

Installation

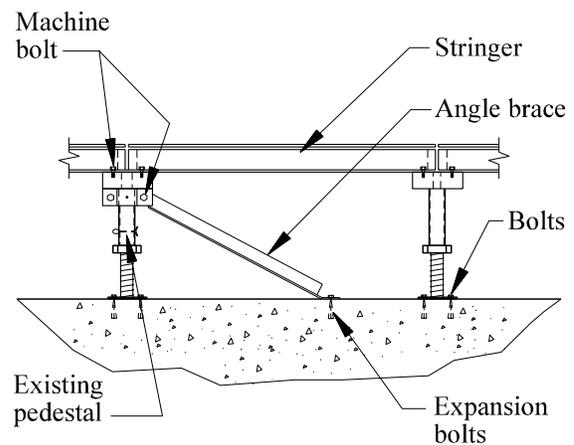
1. Install four expansion bolts through each pedestal base to the floor below (concrete floors).
2. Install a steel brace with a machine bolt or weld between the diagonal steel brace and the pedestal head with expansion bolts to the floor below.
3. Locate braces at 8' on center. At each location, install two braces in perpendicular directions.
4. Secure pedestal head to the stringer or to each floor panel corner with one machine bolt.

Caution

When anchoring to post-tensioned slab, locate and avoid penetrating reinforcing.



Short Pedestal System



Braced Pedestal System

Purpose

To secure computer equipment and other furniture and equipment located on the raised access floors.

Note

Typical equipment to anchor or brace:

- Main frame
 - Processors
 - Power distribution unit
 - Coolant distribution unit
 - Control console
- Large storage facilities
- Telecommunications equipment and modern _____
- Cabinets
- Air handling units

Caution

Verify that internal components have low vulnerability to vibrating motion. If internal components require vibration isolation, provide motion isolators in accordance with the manufacturer's requirements.

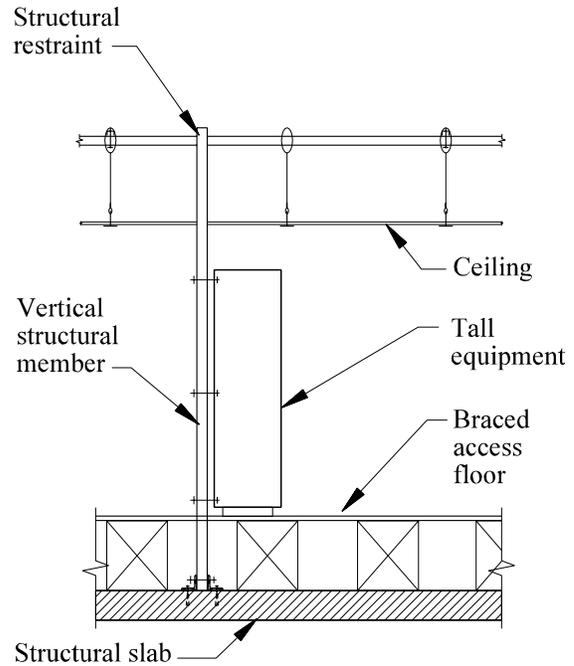
Recommendation

Install seismic bracing or anchors for computer equipment with the following characteristics:

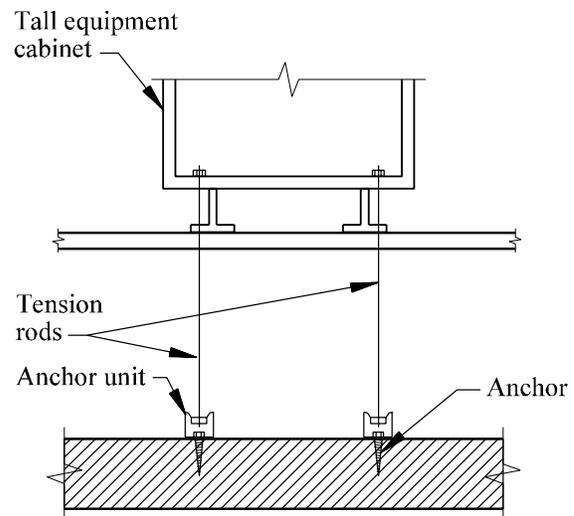
Height Height is greater than 2-1/2 times the base width.

Spacing Closely spaced or less than 18" apart on ground floor.

Consult a structural engineer for design of bracing or anchors.



Vertical Seismic bracing



Through-Floor Anchor System

Purpose

To secure computer equipment on an access floor.

Caution

Verify that internal components have low vulnerability to vibrating motion. If internal components require vibration isolation, provide motion isolators in accordance with Section 2.4.

Recommendation

Install high friction, rubber-based leveling pads for computer equipment with the following characteristics:

Height Height is less than 1/2 the base width.

Spacing Adequate spacing* between equipment to prevent impact.

Cabinet Strong, stiff cabinet.

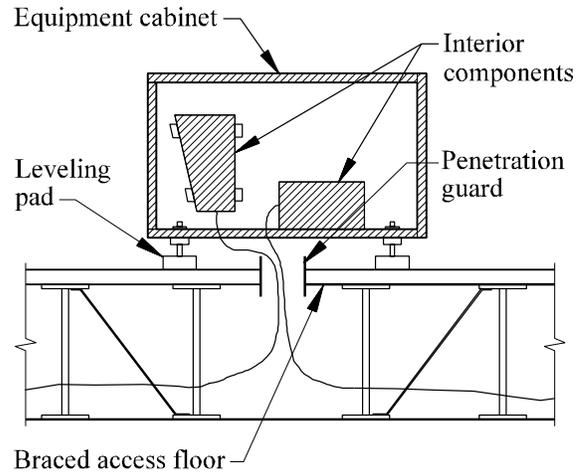
*Adequate spacing is either equipment that is spaced 3' or more apart or equipment that is tied together.

Supplies Required

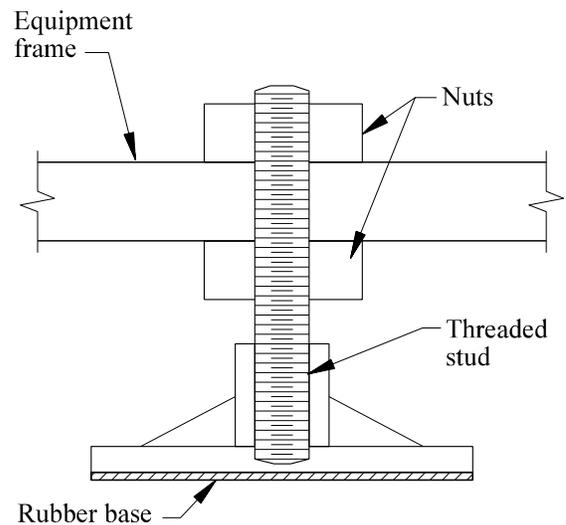
- Seismic leveling pads (with rubber base)
- Floor penetration guard

Installation

1. Provide leveling pad below each corner of equipment.
2. Provide penetration guard around opening in access floor.



Secured Equipment



Leveling Pad

Purpose

To secure computer equipment on an access floor.

Note

Seek engineering assistance for the design of the tether spring. Typical equipment to tether:

- Disk drive controllers
- Disk drives
- High speed printers
- Magnetic tape drives
- Printer controllers
- Tape drive controllers

Recommendation

Provide horizontal motion isolators for computer equipment with the following characteristics:

Height Height less than 1-1/2 times the base width.

Spacing Moderate spacing (1-1/2 to 3') between equipment.

Cabinet Flexible equipment cabinet that cannot be adequately strengthened or stiffened.

Internal Components Internal components with HIGH vulnerability to vibrating motion.

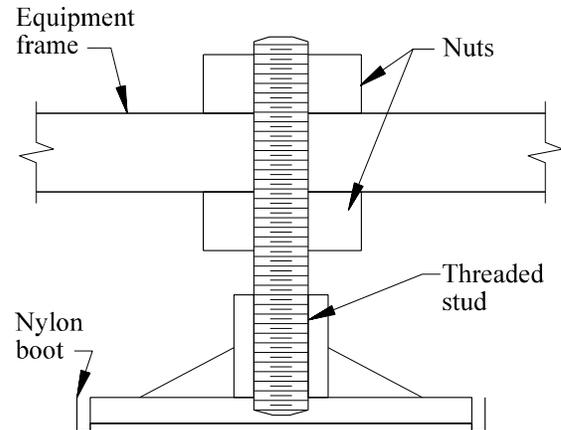
Supplies Required

- Seismic level pads (with nylon boot)
- Floor penetration guard
- Steel cable tether (with springs)
- Eyebolt with expansion insert—1/2" diameter
- Machine bolt—1/2" diameter

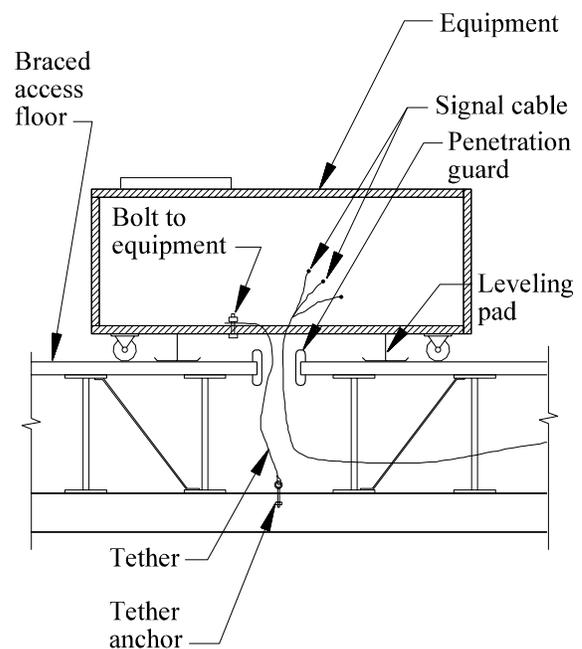
Installation

1. Provide a leveling pad below each corner of the equipment.
2. Provide a penetration guard around access floor opening.

3. Provide more slack in signal cables than in tether.
4. Provide a steel tether between equipment and floor structure.



Leveling Pad



Isolated Equipment

Electrical Systems / 3.0

Purpose

To secure cable trays.

Recommendation

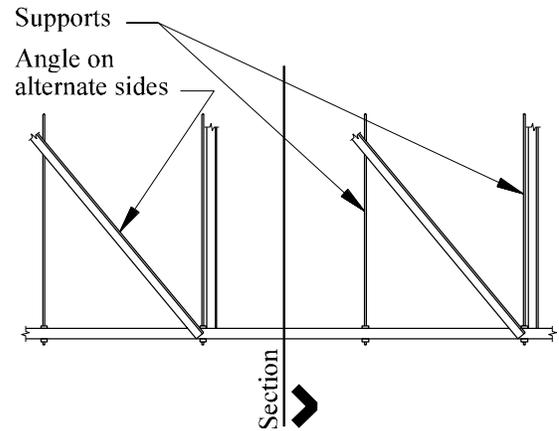
Strengthen existing supports with angles that are welded and braced.

Supplies Required

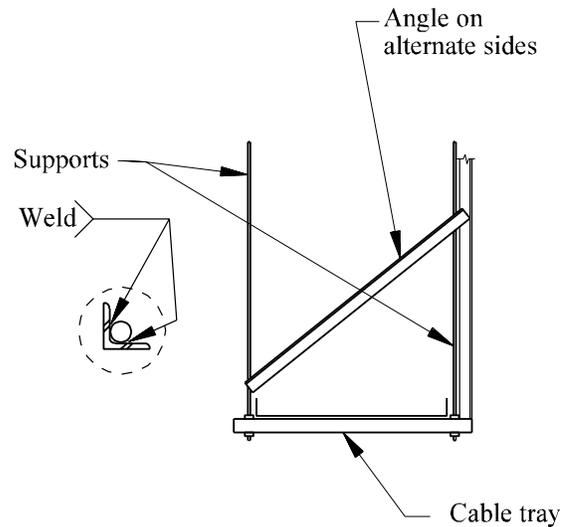
- Angle—1-1/2" × 1-1/2" × 1/4"
- Sheet metal screws—No. 10 × 3/4"

Installation

1. Brace cable tray with angles in two directions, installed diagonally at every other or alternate sides.
2. Weld angles to the supports or screw the top and bottom of the angles to the support with sheet metal screws.



**Side View Of Cable Tray
With Screws And Attached Braces**



**Section Through Cable Tray
With Welded Brace**

Purpose

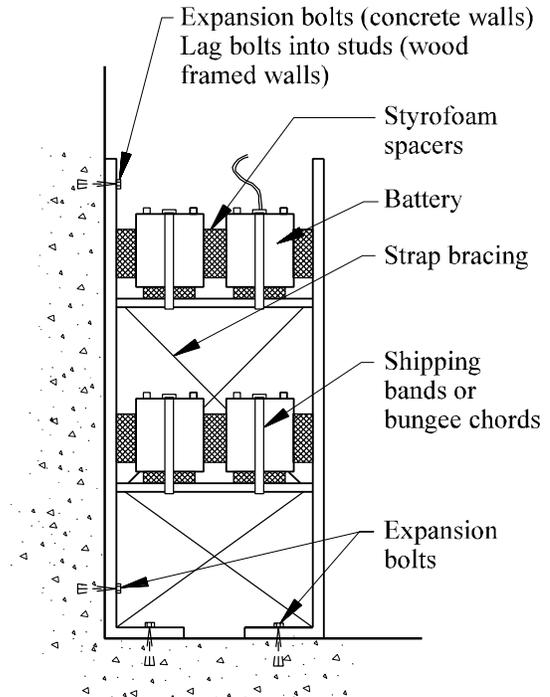
To anchor battery sets in the emergency power system.

Recommendation

Anchor battery sets to the building with bolts.

Supplies Required

- Angle—3" × 3" × 3/8"
- Angle—5" × 3" × 3/8"
- Expansion bolts—1/2" diameter
- Machine bolts—1/2" diameter
- Lag bolts—3/8" diameter × 4" (for wood)
- Styrofoam spacers
- Unistrut frames
- Velcro, nylon, or metal shipping bands
- Strap bracing—16 gage × 1"
- Sheet metal screws—No. 10
- Shipping bands or bungee chords



Wall-Mounted Battery Rack

Installation

Free-Standing Battery Racks

1. Install angle (5" × 3" × 3/8") at each leg of the battery rack.
2. Bolt to the floor with expansion bolts and bolt to the rack with machine bolts.
3. Strap each battery to the rack with shipping bands.

Wall-Mounted Battery Racks

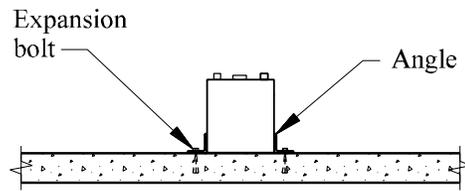
1. Bolt battery rack to wall and floor with expansion bolts. At wood-framed walls, secure to wall with lag bolts into studs. (Do not attached to gypsum wallboard only.)
2. Brace full height with X-bracing where wall support is unavailable. Provide two screws at each end of the X-bracing.
3. Strap each battery to the rack with shipping bands.



(Continued)

Single Battery On Floor

1. Install angle (3" × 3" × 3/8") on each side of battery rack.
2. Bolt each angle to the floor with two expansion bolts.



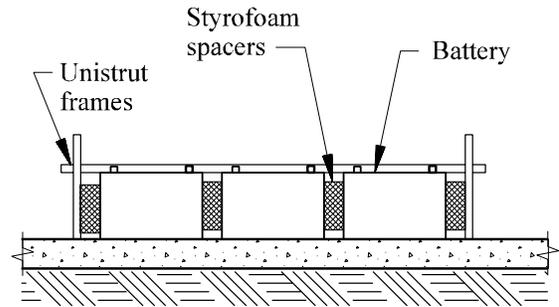
Single Battery On Floor

Multiple Batteries on Floor

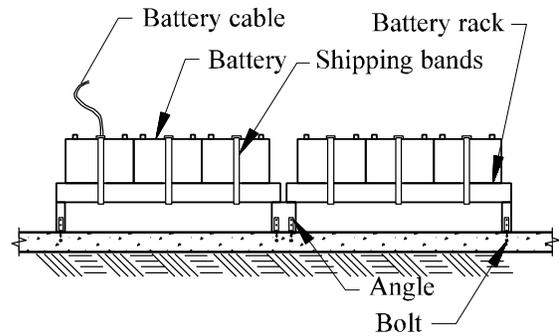
Provide unistrut frame secured to the floor.

Caution
When anchoring to post-tensioned slab, locate and avoid reinforcing.

Note
<ul style="list-style-type: none"> ■ Provide slack in battery cables. ■ Place styrofoam spacers between batteries.



Multiple Batteries On Floor



Free Standing Battery Rack

Purpose

To secure emergency power system.

The emergency power system can include the following elements:

- Motor generator set
- Battery set
- Fuel supply tank
- Muffler
- Electric cable
- Power transfer unit

Recommendation

Install seismic snubbers to secure motor generator set.

Supplies Required

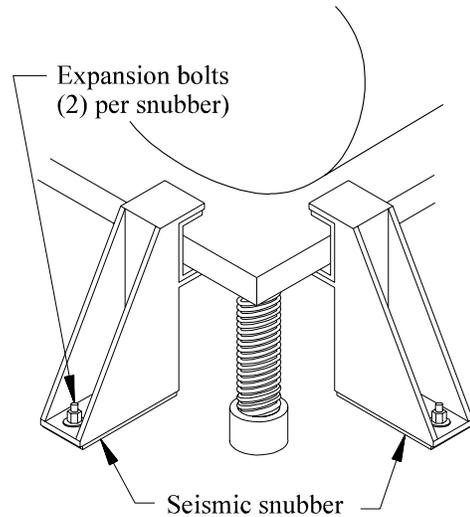
- Eight steel Z snubbers (or other type of seismic snubber)
 - Eight expansion bolts—1/2" diameter (for concrete)
- OR**
- Eight expansion bolts—1/2" diameter (for wood)

Installation

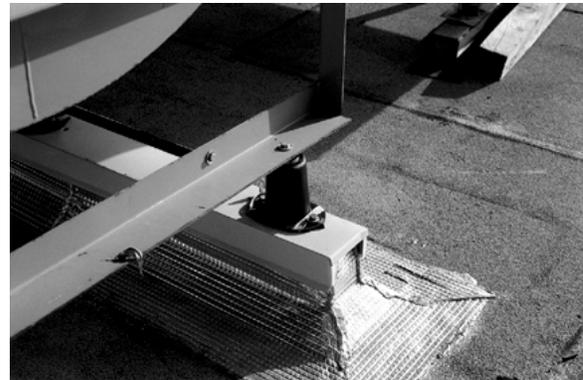
1. Place snubbers at two sides near the corners.
2. Bolt to the concrete or wood, allowing 1" free play between the generator and snubber.

Note

- Due to size or complex design, motor generator sets and power transfer units may require more extensive mitigation design by a structural engineer.
- Equipment may already be anchored directly without using isolation springs. Consult with structural engineer to determine if seismic snubbers are necessary.



Seismic Snubber



(Continued)

Recommendation

Install steel braced platforms, metal straps, and slack line to secure fuel supply tank or water day tank.

Caution

When anchoring to post-tensioned slab, locate and avoid reinforcing.

Supplied Required

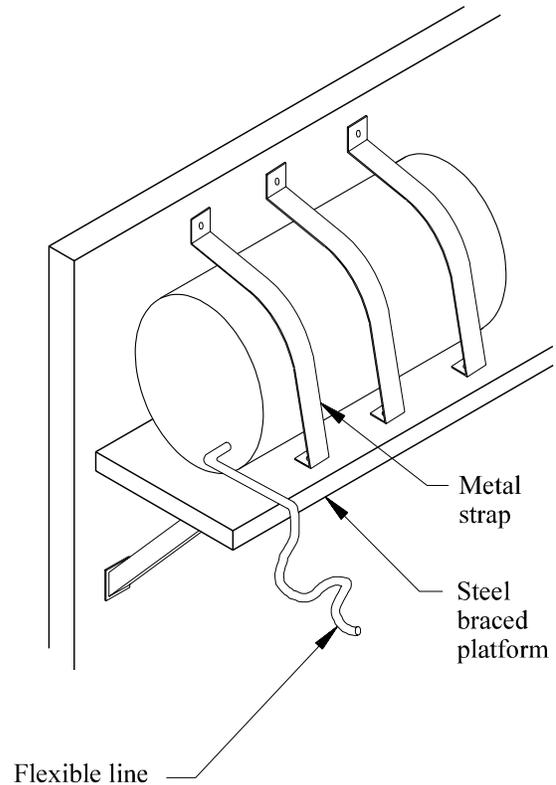
- Steel-braced platform (Consult an engineer for design.)
- Metal straps (18 gage \times 2")
- Sheet metal screws— $3/8$ "
- Flexible line
- Lag bolts or expansion bolts— $3/8$ "

Installation

1. Place a minimum of two straps (one at each end of the tank).
2. Secure straps to the steel-braced platform with sheet metal screws. Attach to supporting structure with lag bolts or expansion bolts.

Note

- Provide slack in electrical cables.
- Anchor each element in the system.



Purpose

To prevent damage or injury from wires.

Caution
Exterior wires that are located overhead pose a hazard to anyone exiting a building during an earthquake.

Recommendations

Exterior Wires

To prevent damage or injury from exterior wires that are located overhead, follow these steps:

- Contact an electrician to replace external wires that are located overhead with underground wires.
- Designate an individual school staff to notify the local power company of downed power lines. (The designated individual will be responsible for providing information about downed power lines.)

Interior Wires

To prevent damage or injury from internal wires, follow these steps:

- Secure elements that could fall on wires.
- Provide slack in the wires where they connect to equipment, cross seismic joints, or extend through openings in the wall.

Note
During an earthquake, falling objects such as lights can disrupt power.

Exiting / 4.0

Purpose

To secure canopies.

Caution
Canopies may fall during an earthquake causing injury or death. Damaged canopies may also block entrances and exits.

Recommendation

Secure the canopy to the building to prevent from detaching.

Consult a structural engineer and architect to implement one of the following options:

- Increase the lateral capacity of the columns
- Add steel bracing at the columns
- Reconstruct the roof system with lightweight material
- Add plywood or concrete shear walls
- Install plywood at the roof
- Install additional anchors at the roof

Purpose

To secure doors and door frames.

Recommendation

Install latches or automatic door closers.

Caution

Free-swinging doors may cause injuries during an earthquake.

Supplies Required

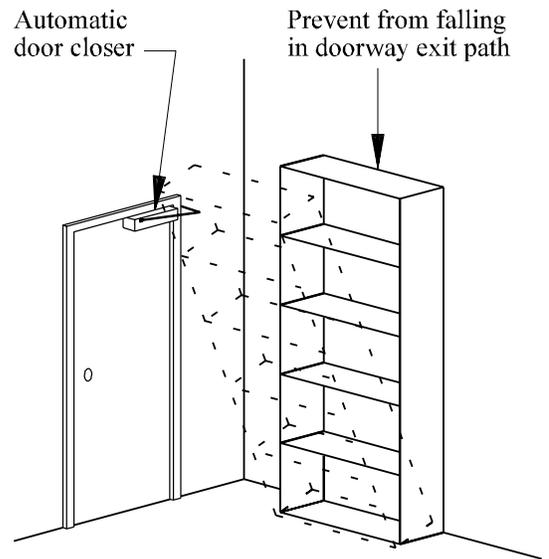
- Mechanical latches
- Automatic door closers

Installation

1. Install mechanical latches on cupboard doors.
2. Replace magnetic latches with mechanical latches.
3. Install automatic door closers, particularly on exit doors.

Note

- Keep doorways clear.
- Secure or remove objects that may block doorways during an earthquake.
- Secure sliding doors in the open position if possible.



Automatic Door Closer

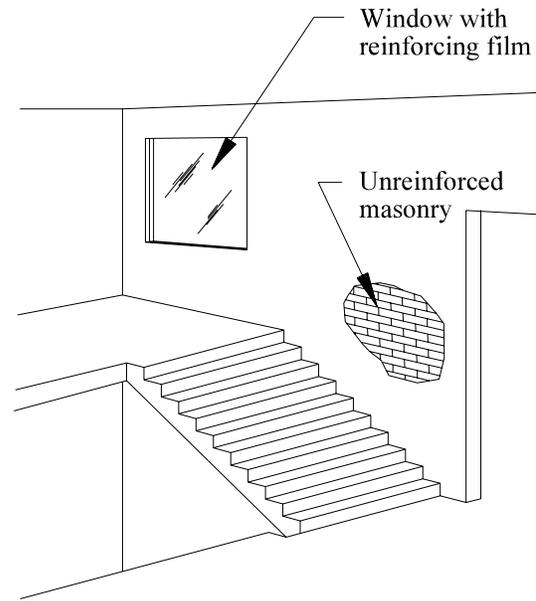
Purpose

To keep stairwells clear for exiting the building.

Recommendation

Consult a structural engineer to implement any of the following options:

- Remove or anchor all materials which may be loosened or fall during an earthquake.
- Reinforce or replace masonry walls and plaster (if not adequately reinforced) in the stairwell. Replace the wall with steel studs and sheetrock.
- Install battery-operated emergency lighting in stairwells.
- Reinforce windows (see Section 7.1).
- Secure ceiling (see Section 10.1).



Stairwell

Exteriors / 5.0

Purpose

To secure chimneys.

Caution

Chimneys that extend above the roof more than twice the least dimension of the chimney tend to crack just above the roof line. Chimneys may then fall through the roof or onto walkways below creating a life-safety hazard.

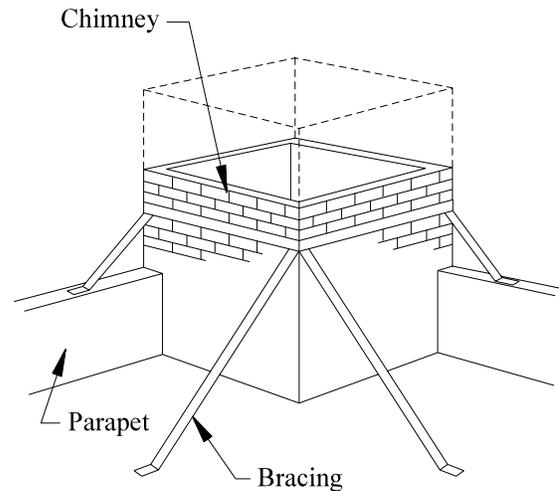
Recommendation

Consult a structural engineer to implement one or more of the following options:

- Remove chimney.
- Reduce chimney height to no more than twice the smallest chimney dimension.
- Brace the chimney.
- Fill the chimney with concrete.
- Install plywood reinforcing on the roof to prevent chimney bricks from falling through the roof to the rooms below.
- Tuckpoint deteriorated mortar in the chimney.

Note

- The mechanical code requires specific heights and locations for the type of chimney used. These code requirements must be considered before selecting any of the options to secure the chimney.
- Exterior walls may require additional strengthening if the wall supports a chimney and large windows.



Braced Chimney



Purpose

To secure parapets and cornices.

Recommendation

Consult a structural engineer to implement any of the options below, where parapet or cornice height is greater than 1.5 times the thickness, some overstrengthening is advisable.

Supplies Required

- Angle—3" × 3" × 1/4"
- Continuous angle and channel
- All-thread rod—3/4" diameter
- Lag bolts—3/4" diameter
- Epoxy grout
- Blocking—4" × 8"
- Clips—Simpson A 35
- Masonry wall anchor—Simpson LTT

Installation

8" Wall Thickness

1. Attach continuous channel to the top of the parapet with all-threads embedded 12" and epoxy at 4' on center.
2. Weld 3" × 3" angle at 8' on center to continuous channel. Provide a lag bolt from the angle to a joist or blocking in the roof.

Caution

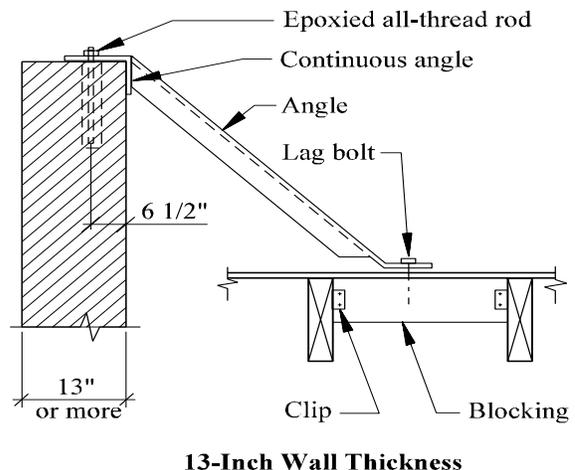
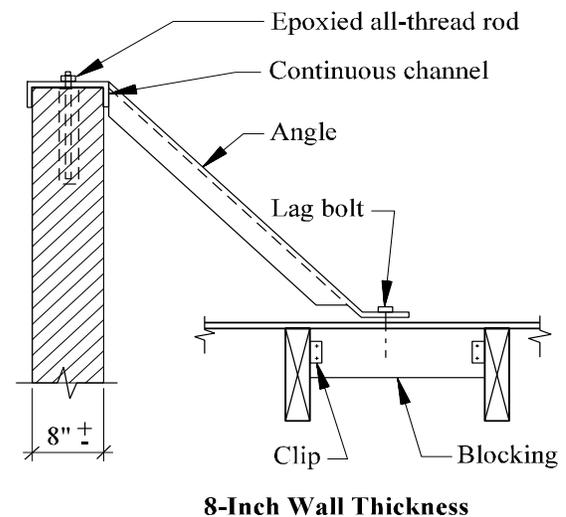
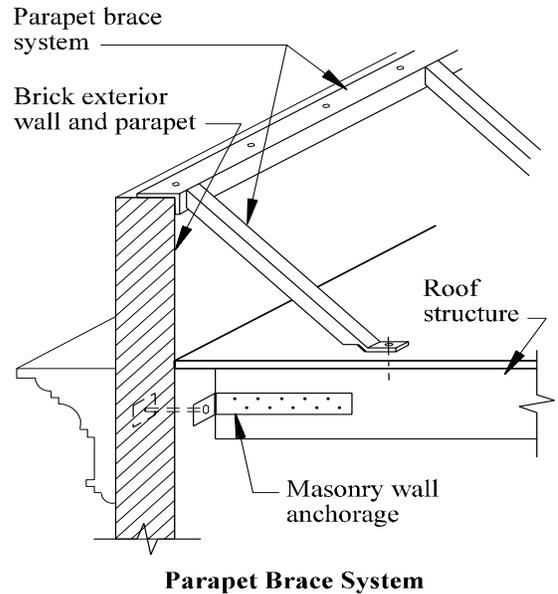
Parapets and cornices can detach during an earthquake, causing injuries and deaths.

13" Wall Thickness

1. Attach continuous channel to the top of the parapet with all-threads embedded 12" and epoxy at 4' on center. Place all thread at least 6-1/2" away from the edge of the parapet.
2. Weld 3" × 3" angle at 8' on center to continuous channel. Provide lag bolt from angle to joist or blocking in roof.

Note

Consult an architect for waterproofing details where structural connections penetrate roofing or flashing.



Purpose

To anchor the walls to the roof/floor.

Recommendation

Install LTT anchors.

Supplies Required

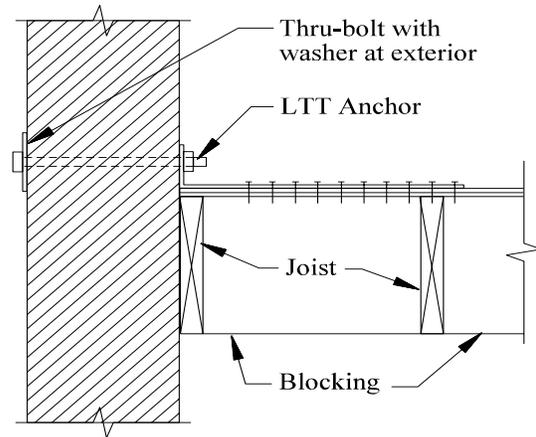
- LTT anchors (manufactured by Simpson or equivalent)
- Thru-bolt—3/4" diameter
- Washer—3/8" × 6" diameter
- 2×___ blocking (depth to match existing joist depth)

Installation

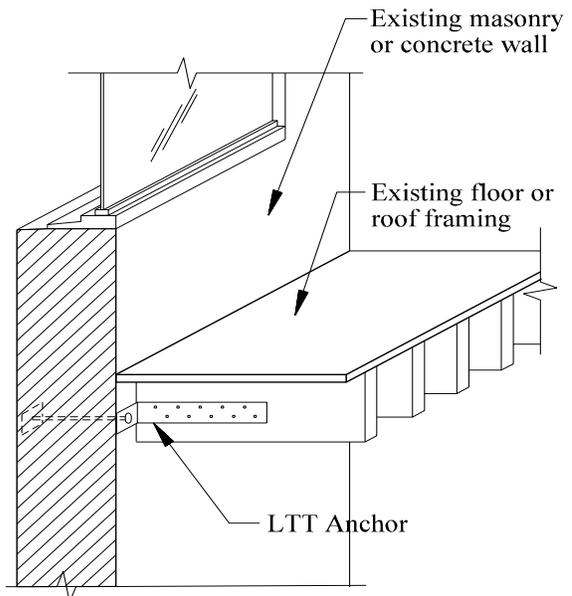
1. Install LTT anchors approximately every 4' on center.
2. Where existing joists are perpendicular to the wall, attached anchors to the sides at the top or bottom of the joists.
3. Where existing joists are parallel to the wall, install blocking to two joist spaces at the LTT anchor locations. Install anchors above or below blocking.

Note

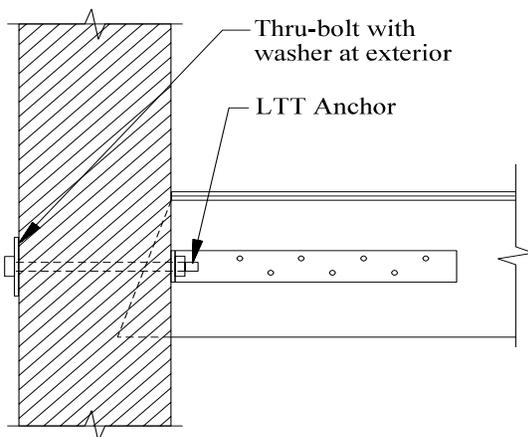
If washers are not desired, as in historic buildings or terra cotta exteriors, epoxy an all-thread rod inserted into the wall a minimum 8".



Joists Parallel To Wall



Wall Section



Joists Perpendicular To Wall



Furnishings and Equipment / 6.0

Purpose

To secure desktop/countertop equipment.

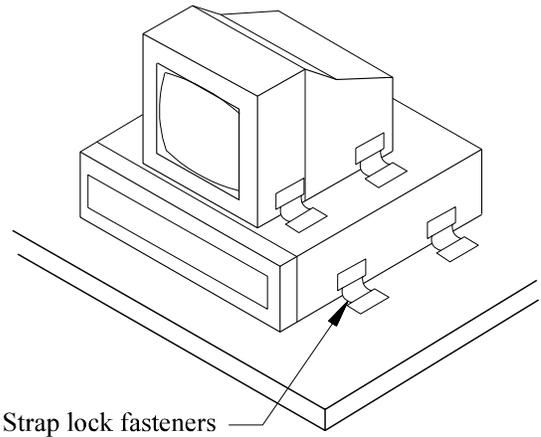
Recommendation

Install one of the following:

- Bungee cord
- Strap/lock fasteners
- Leash locks
- Earthquake pads

Note

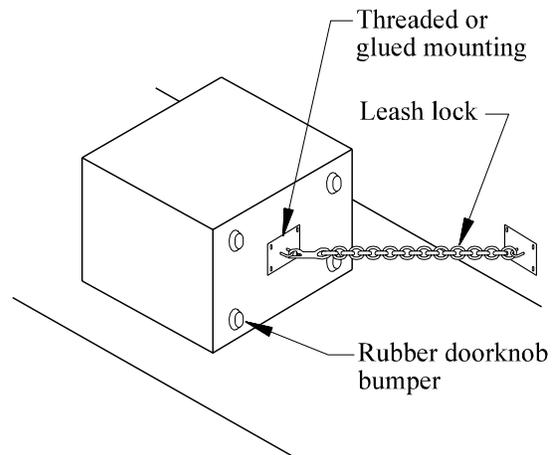
- Use leash locks for equipment that may be moved (for example, telephones, keyboards, laptops.)
- Fasten near the top and near the bottom if equipment is more than two times as tall as it is wide.



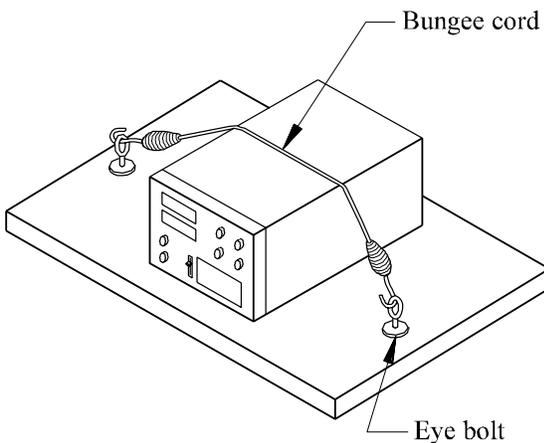
Versa Grip Fasteners

Supplies Required

- Bungee cord
- Eye-bolts—3/16" diameter
- *Versa Grip* fasteners
- Leash locks
- Rubber doorknob bumpers
- Threaded or glued mounting



Leash Locks



Bungee Cord

Purpose

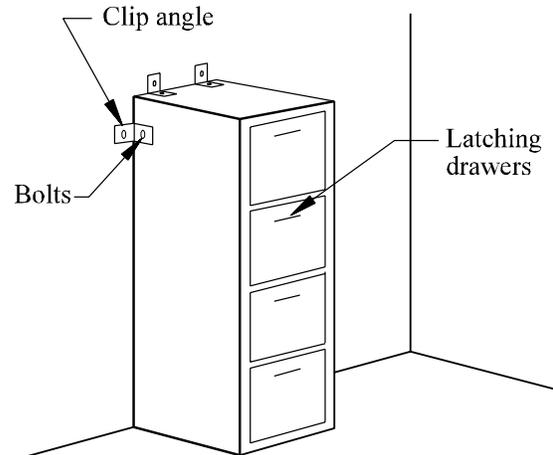
To secure file cabinets.

Recommendation

Anchor the file cabinets with clip angles.

Supplies Required

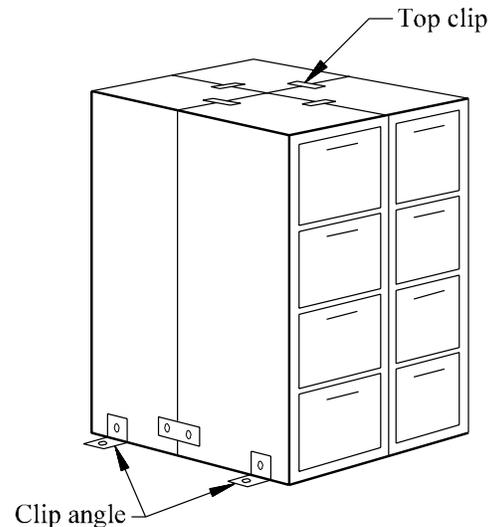
- Clip angles—2" × 2" × 3/16"
 - Lag bolts—1/4" diameter × 3" (for wood walls)
 - Expansion bolts—3/8" diameter × 2" (for concrete walls)
 - Top clips—2" × 3/32"
 - Sheet metal screws—No. 10
 - *Leash Locks* for drawers without latching locks
- OR**
- Thumb Lock latches



File Cabinets With Clip Angle

Installation

1. Anchor file cabinets with four or more drawers to wall stud with clip angles.
2. Use lag bolts for wood walls.
OR
Use expansion bolts for concrete walls.
3. Connect adjacent cabinets with top clips and sheet metal screws. Use clips near the cabinet bases.



File Cabinets With Top Clips

Note

- Fill file cabinets from the bottom up if it is not full.
- Locate cabinets away from exits and hallways.
- Do not place file cabinets so that the drawer opens toward the occupants of the room.
- Keep cabinet drawers shut, locked, or secure with latches.

Purpose

To secure floor-mounted objects that weigh less than 40 pounds.

Recommendation

Install a clip angle or a metal plate.

Caution

When anchoring to post-tensioned slab, locate and avoid reinforcing.

Supplies Required

- Clip angle—3" × 3" × 1/4"
 - Metal plate—1/4" × 3" × 3"
 - Expansion bolts—3/8" or 1/2" diameter × 2" to 4" (for concrete floors)
- OR**
- Lag bolts—1/2" diameter × 4" (for wood floors)

Installation

Clip Angle Installation

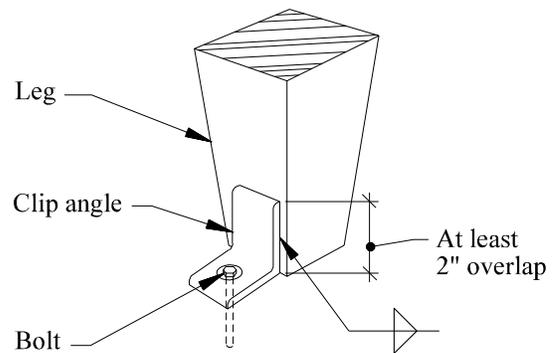
1. Weld a clip angle to leg (4" of 1/8" fillet).
OR
Secure clip angle with a lag bolt for wood legs or a machine bolt or steel legs.
2. Overlap clip angle 2" with the floor-mounted object.
3. Secure horizontal leg of angle with a lag bolt to wood or an expansion bolt to concrete.

Metal Plate Installation

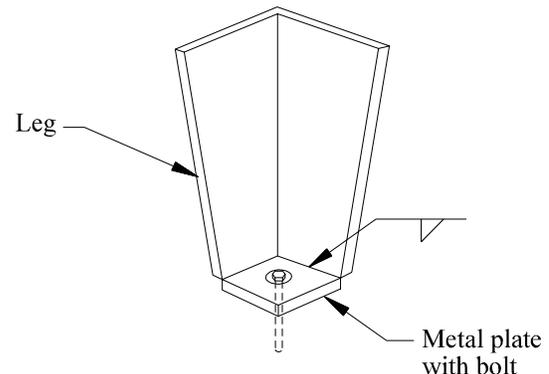
1. Weld the metal plate inside the leg of the object (4" of 1/8" fillet).
2. Secure the metal plate with a lag bolt to wood or an expansion bolt to concrete.

Note

- If object is marked DO NOT BOLT TO FLOOR, locate it away from classrooms and people.



Clip Angle



Metal Plate

Purpose

To anchor lockers and cabinets.

Recommendation

Install a metal angle.

Supplies Required

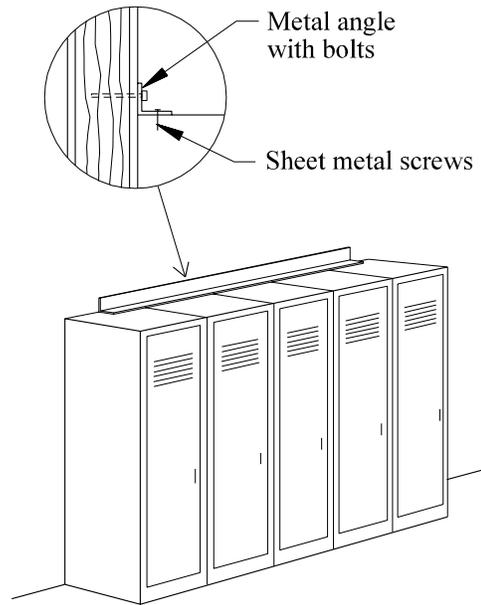
- Metal angle—2" × 2" × 3/16"
- Sheet metal screws—No. 10 × 1-1/2"
- Lag bolts—1/4" diameter × 3" (for wood walls)
OR
 Expansion bolts—3/8" diameter (for concrete walls)

Installation

1. Anchor metal angle to wall stud.
2. Use lag bolt for each stud in wood wall.
OR
 Use expansion bolts at 32" on center for concrete walls.
3. Attach metal angle to each locker section with two sheet metal screws.

Note

- If lockers or cabinets cannot be anchored, place them away from hallways and doors.
- If lockers or cabinets are internally secured to walls, ensure that the attachments are directly to wall studs, masonry, or concrete. Toggle bolts to sheetrock will not prevent the lockers from topping.



Lockers



Purpose

To secure refrigerators.

Recommendation

Install angle brackets or pronged zee clips.

Supplies Required

- Angle bracket—4" × 2" × 1/8"
- Lag bolts—3/8" diameter × 4" (for wood)
- Expansion bolts—1/2" diameter × 4" (for concrete)
- Metal screws—No. 14
- Pronged zee clip

Installation

Angle Bracket Installation

1. Secure the angle bracket to a wood wall with a lag bolt for wood.

OR

Secure to a concrete wall with an expansion bolt for concrete.

2. Use a metal screw to attach bracket to the refrigerator.

Pronged Zee Clip Installation

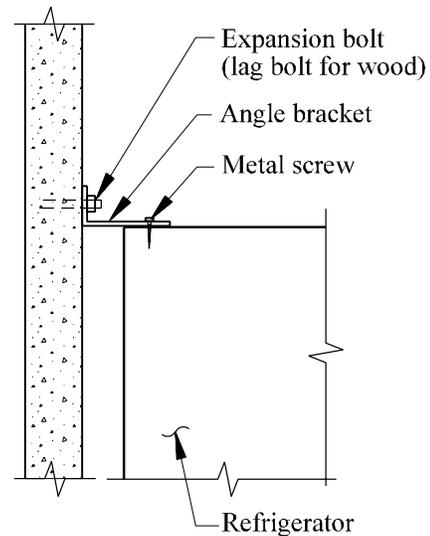
1. Align the angle the clip with the leg of the refrigerator.

Note

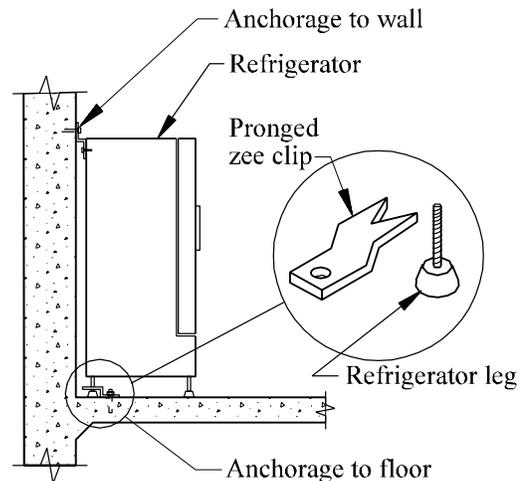
- Place refrigerators and vending machines away from exits and hallways if possible.
- Enclose refrigerators in a confined space (if possible) to prevent the machine(s) from tipping over.

Caution

When anchoring to post-tensioned slab, locate and avoid reinforcing.



Wall Anchorage



Floor Anchorage

Purpose

To secure shelf contents.

Recommendation

Use metal edge angles to secure large items or to secure items stored in high areas. Secure computers or typewriters to tables or shelves without lips with velcro patches on seismic mat.

Install one of the following:

- Metal edge angle
- Net restraints
- Seismic Mat

Supplies Required

- Metal edge angle—1-1/2" × 1-1/2" × 10" gage
- Small wood screws—No. 10 × 3/4"

Installation

Metal Edge Angle Installation

1. Add metal edge angles to shelving.
2. Screw platform with wood screws at 18" on center.

Recommendation

Use net restraints for items that are bulky or stored high.

Supplies Required

- Net restraints—nylon netting
- Eye-hooks

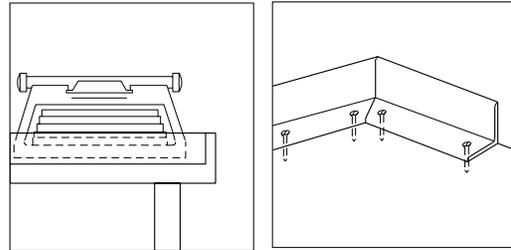
Installation

Net Restraint Installation

Secure nylon netting with eye-hooks.

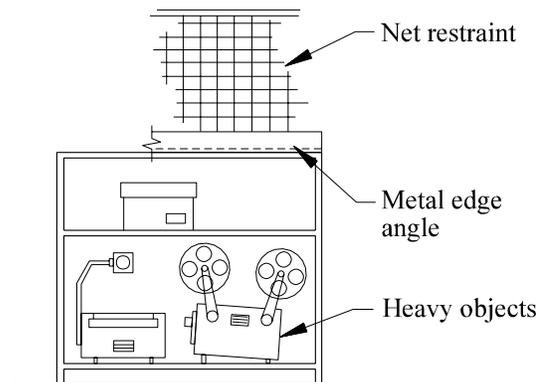
Note

- Do not use metal edge angles where top heavy items are stored.
- Store heavy objects as low as possible.
- Restrain boxes on shelves.



Shelf Lip

Metal Edge Angle



Securing Large Items

(Continued)

Recommendation

Use zee clips, bungee cords, or velcro to secure small items.

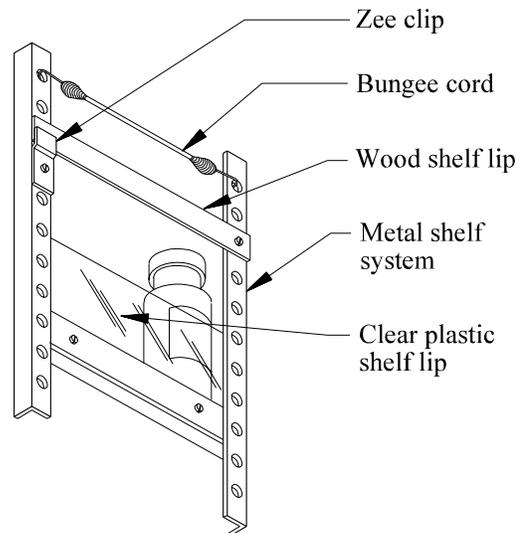
OR

Use shelf lip for small items.

Supplies Required

- Zee clips
- **OR**
- Shelf lip
- Bungee cord or wire
- Velcro
- Clear plastic or wood shelf lip
- Nylon netting

Note
<ul style="list-style-type: none"> ■ Make sure shelving is securely attached to walls. ■ Contain small items in boxes.



Securing Small Items

Purpose

To secure shelf units.

Recommendation

Install clip angles and steel struts for shelf units weighing less than 250 pounds.

Supplies Required

- Clip angles—1-1/2" × 1-1/2" × 1/8" (4' maximum spacing)
- Lag bolts—3/8" diameter (for wood shelving)
- Expansion bolts—3/8" diameter (for concrete floors and walls)
- Steel strut—1-1/2" × 1-1/2" × 1/8"
- Sheet metal screws—No. 10 × 3/4"
- Machine bolts—1/4" diameter
- Wood screws—No. 10 × 3/4"
- Steel plates—1/8" × 3" × 6"
- Strap bracing—16 gage × 1"

Installation

Clip Angle - Wall Attachment

1. Attach the shelf unit directly to the wall with a clip angle.
2. Secure the unit to the wall with a lag bolt for wood. Embed it into a stud at least 2". (Do not attach to gypsum wallboard only.)

OR

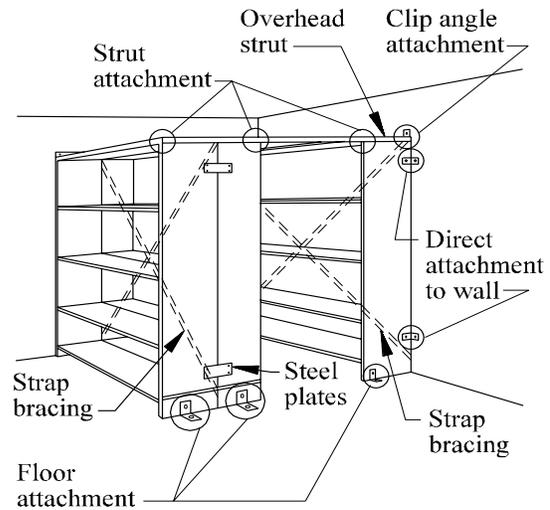
Secure to wall with an expansion bolt for concrete.

Clip Angle - Floor Attachment

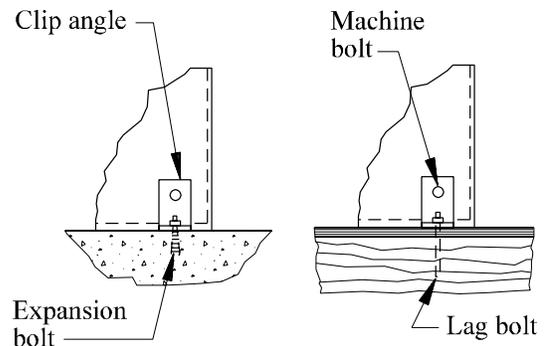
Attach a clip angle to a concrete floor with expansion bolts.

OR

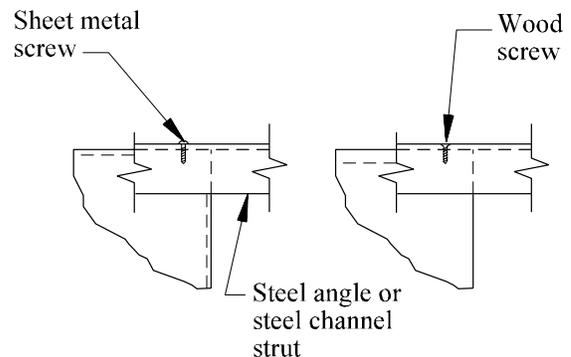
Attach a clip angle to a wood floor with lag bolts.



Shelf Unit Attachment



Concrete Or Masonry Floor Wood Floor



Metal Shelving Wood Shelving

<p>Caution</p> <p>When anchoring to post-tensioned slab, locate and avoid reinforcing.</p>

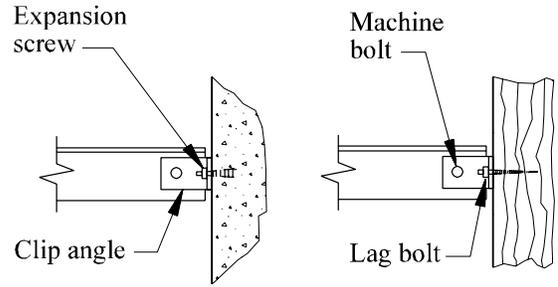
(Continued)

Steel Strut Installation

Overhead Strut Attachment

Secure overhead strut with screws to shelving.

Note	
<ul style="list-style-type: none"> ■ For shelf units that weigh over 250 pounds (including contents), consult a structural engineer. ■ Attach shelving to frames. ■ Connect adjacent shelf units with steel plates and machine bolts. ■ Install strap bracing across back of shelving. Provide three screws at each end of the bracing. 	



Concrete Or Masonry Wall

Wood Wall

Purpose

To secure vending machines.

Recommendation

Use angle brackets and pronged zee clips.

Caution

When anchoring to post-tensioned slab, locate and avoid reinforcing.

Supplies Required

- Angle bracket—4" × 2" × 1/8"
- Lag bolts—3/8" diameter (for wood)
- Expansion bolts—1/2" diameter × 4" (for concrete)
- Metal screws—No. 14
- Pronged zee clip

Installation

Angle Bracket Installation

Contact vending service company to install angle brackets.

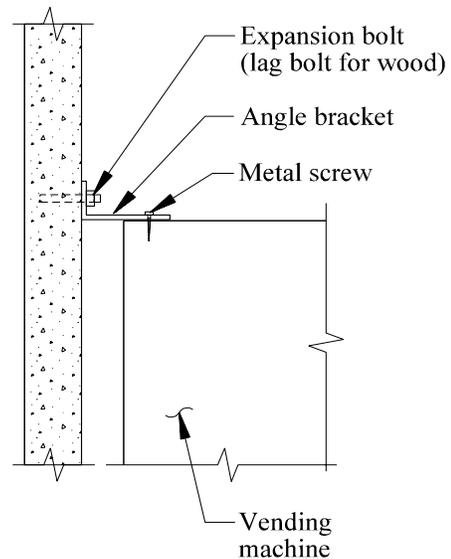
1. Secure angle bracket to wall with a lag bolt for wood.
OR
Secure to wall with an expansion bolt for concrete.
2. Attach bracket to the vending machine with metal screws.

Pronged Zee Clip Installation

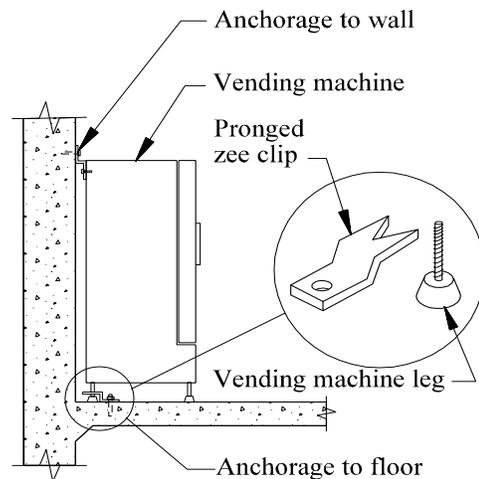
Align the clip with the leg of the vending machine.

Note

- Locate vending machines away from exits and hallways if possible.
- Enclose vending machine in confined space (if possible) to prevent the machine(s) from tipping over. Do not locate machine so as to impede servicing.



Wall Anchorage



Floor Anchorage



Purpose

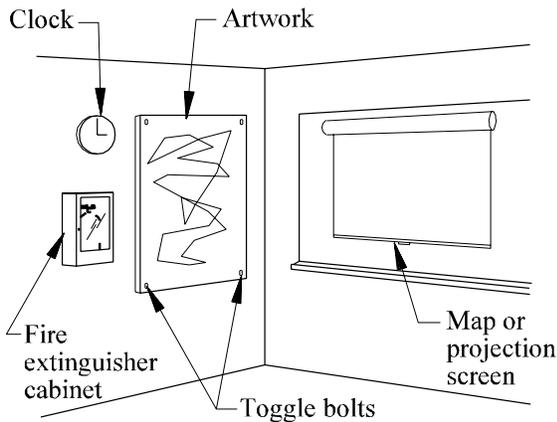
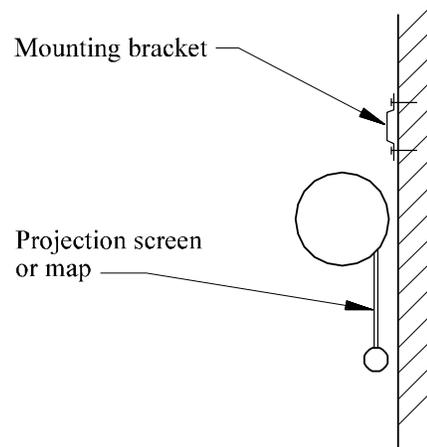
To secure wall-mounted objects.

Recommendation

- Secure wall-mounted objects to the wall using either brackets, toggle bolts, or retention straps.
- Secure projection screen by attaching it to a wall with two brackets.
- Secure artwork by attaching it to a wall with four toggle bolts.

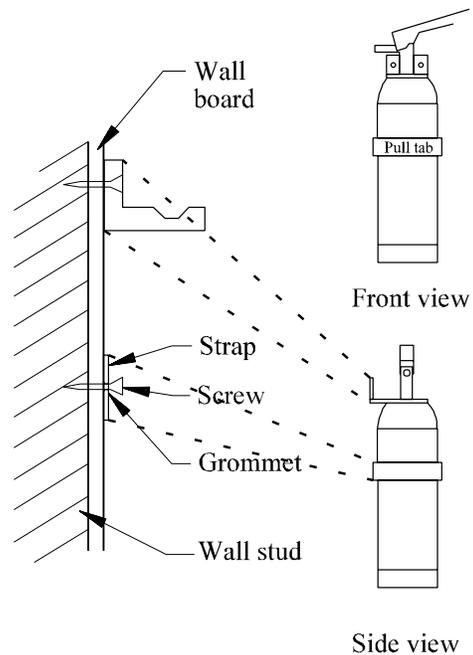
Supplies Required

- Brackets (including screws)
- Toggle bolts—1/4" diameter
- Retention strap with velcro pull tab, grommet, and 1-1/2" × 1/8" diameter screw



Wall-Mounted Objects

Maps, Projection Screens And Artwork



Fire Extinguisher With Retention Strap

Purpose

To secure wheel-mounted furniture.

Note
<ul style="list-style-type: none"> ■ As shaking increases, furniture may slide or—if it is top heavy—it may overturn. ■ Position wheel-mounted furniture away from occupants in the room.

Recommendation

Install restraints.

Supplies Required

- Eye-screws—1/4" diameter × 3"
OR
Eye-screws—1/2" diameter (for furniture over 1,000 lbs.)
- Restraints—Bungee cord or 1/8" diameter wire

Installation

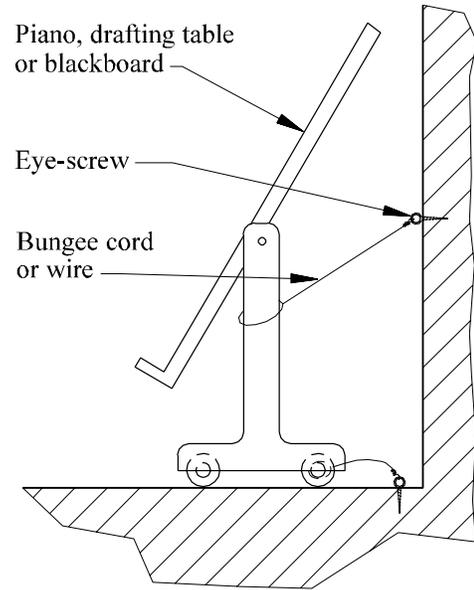
Wheel Lock Installation

Follow manufacturer's instructions.

Note
<ul style="list-style-type: none"> ■ Wheel locks can prevent furniture from rolling during moderate shaking. ■ Be consistent in setting wheel locks, returning furniture to storage, and tethering furniture. ■ The need to move of furniture may eliminate permanent restraint options.

Restraint Installation

1. Tether each leg to a wall or floor with bungee cord or wire when the furniture is not in use.
2. Tie a cord or wire to an eye-screw that has been screwed into the wall. Attach the cord or wire to the eye screw.



Anchoring Wheel-Mounted Furniture

Glazing / 7.0

Purpose

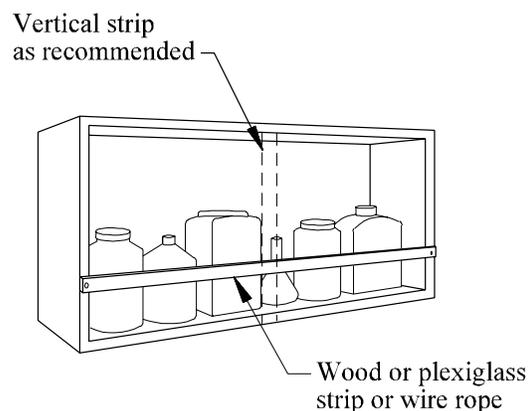
To reduce risks from breaking glass.

Note

- Large windows pose the greatest risk to safety.
- Locate seating away from windows to avoid injuries from shattering glass or untreated windows.
- Lower window blinds or close drapes if possible.

Caution

- Consult a structural engineer to determine if window frame is designed to support glass in the vent of a building.
- Do not coat or replace any glass panes if the coating or new glass would cause a large pane to drop as a unit.



Open Shelves

Recommendation

- To reduce the risks at glass windows, doors with glass, display cases, and skylights, follow the steps below.
- Store glassware or glass objects in closed cabinets (see Section 6.6) or restrain them on open shelves (see Section 6.6)
- Refer to Section 6.9 to secure mirrors.

Supplies Required

- Wood or Plexiglas strip—1/8" × 1"
- Wood or sheet metal screws—No. 10 × 1"
- Wire rope—No. 12 gage

Installation

1. Reinforce glass with polyester film or similar material.
OR
Replace glass with Plexiglas or safety glass.
2. Place film on one side of the glass only.
3. Secure items in the display cases (see Section 6.6).
4. Anchor the display case to the wall (see Section 6.9).

Hazardous Materials / 8.0

Purpose

To reduce the potential for risks from chemical spills.

Recommendation

Install wood or Plexiglas strips or wires to restrain containers on open shelves.

Supplies Required

- Wood or Plexiglas strip—1/8" × 1"
- Wood or sheet metal screws—No. 10 × 1"
- Wire rope—No. 12 gage

Installation

1. Attach a wood or Plexiglas strip to the shelf with wood or sheet metal screws.
OR
Attach wire rope to the shelf with wood or sheet metal screws.
2. Secure the wire rope with three tight turns at each end.
3. Provide intermediate vertical strips where horizontal strips span more than 3'. Attach vertical strips to each shelf.
4. Place horizontal restraint high enough to restrain tall objects while allowing easy access. Provide additional horizontal restraint as required for shorter objects.

Recommendation

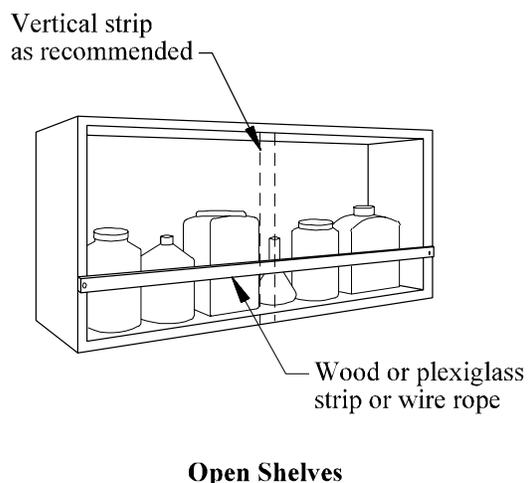
Secure cabinet doors with mechanical latches.

Supplies Required

- Mechanical latches

Installation

1. Provide mechanical latches on all doors.
Test latches to assure that they can remain closed during severe shaking.
2. Replace magnetic latches with mechanical latches.



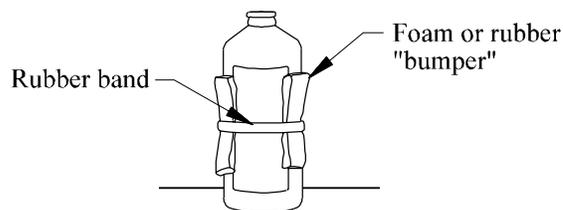
(Continued)

Recommendation

Wrap fragile bottles or dangerous materials with foam rubber or rubber bands to protect

OR

Replace glass containers with unbreakable containers.



Supplies Required

- Foam rubber or rubber
- Rubber bands

Bottle With Foam Or Rubber "Bumpers"

Note

- Store acids and other volatile chemicals separately and as close to the ground as possible.
 - Store heavy containers as close to the ground as possible
- For more information on storage of chemicals and chemical interaction contact the Washington State Dept. of Ecology for:
- Step-By-Step Guide for to Better Laboratory Management Practices, Publication No. 97-431, July 1997*

Purpose

To store and secure compressed gas cylinders or large fire extinguishers.

Recommendation

Secure cylinders with wire or rope.

Supplies Required

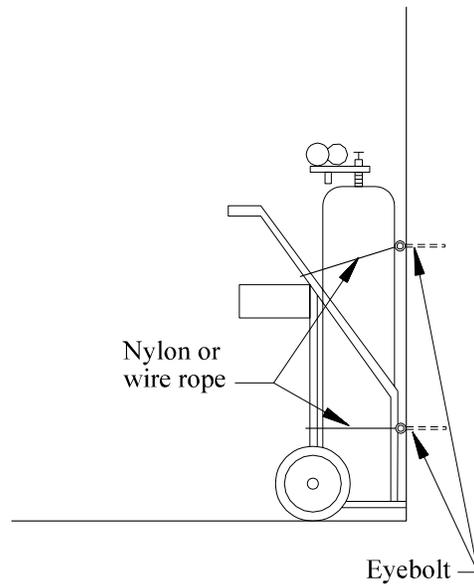
- Wire or nylon rope
- Eye-bolts—1/4" diameter

Installation

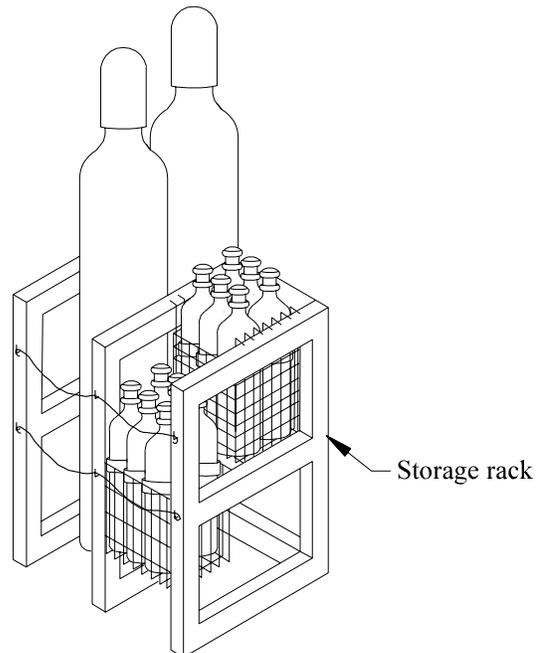
1. Strap top and bottom of cylinder and carrier with wire or nylon rope.
2. Secure rope with eye-bolts to the stud on each side of the canister.
3. For groups of cylinders, provide storage racks. Attach rope to racks.

Note

- Store gas cylinders in a separate area.
- Store cylinders away from people and exits.



Gas Cylinder



Group of Cylinders

Purpose

To secure propane tanks.

Caution

Large propane tanks will expand and contract. This may stress the tank wall or seismic connections. Consult a structural engineer and your propane supplier for assistance.

Recommendation

Install expansion bolts through existing brackets or provide steel pipe bollards. Steel pipe bollards are recommended for all large tanks.

Supplies Required

- Reinforcing steel—No. 4
- Expansion bolts
- Concrete (2,000 psi minimum)
- A36 steel pipe—6" diameter

Installation

Expansion Bolt

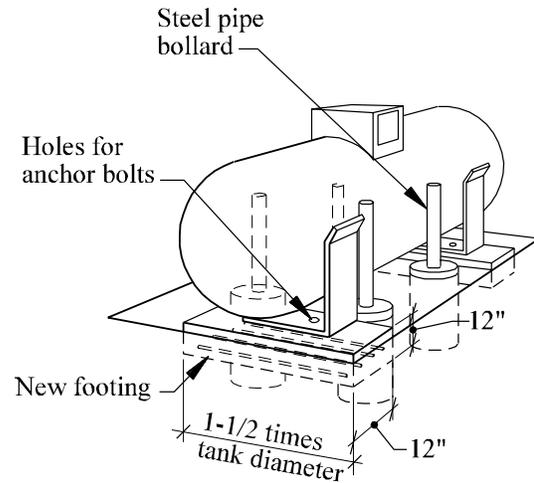
1. Provide new footings (if none exist) at each bracket.
2. Install expansion bolts in existing bracket holes. Fill the hole with the largest diameter bolt possible.

Steel Pipe Bollard

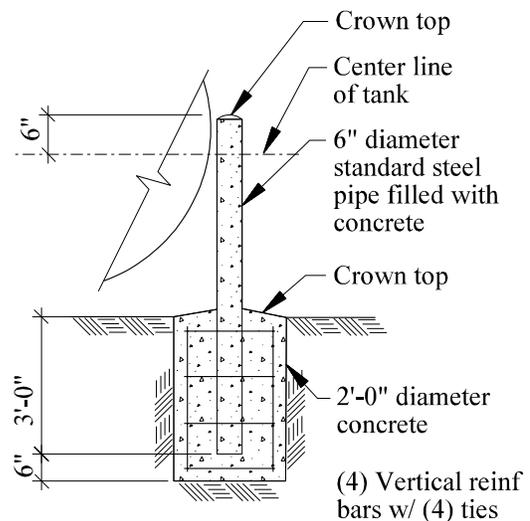
1. Provide bollards at one-quarter points on two sides of tank.
2. See steel pipe bollard figure for dimensions.

Note

Provide flexible supply line connections.



Propane Tank



Steel Pipe Bollard

Mechanical Systems / 9.0

Purpose

To secure filtration tanks.

Caution

When anchoring to post-tensioned slab, locate and avoid reinforcing.

Recommendation

Anchor filtration tanks.

Supplies Required

- Expansion bolts (various sizes)
- Steel plate—1/4" × 8" × 8"

Installation

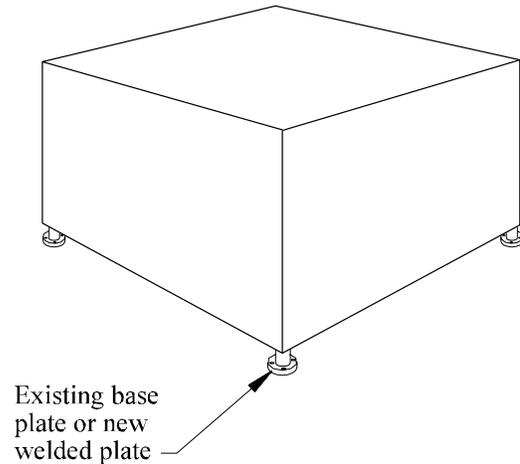
Anchor the tank at each leg with two expansion bolts that are the same diameter as the holes in the base plate.

OR

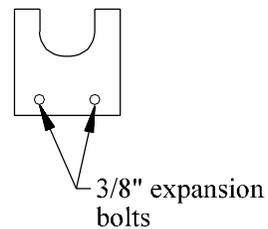
If a base plate hole cannot be accessed or does not exist, weld a plate to the existing base plate and secure this new plate with two expansion bolts (3/8") into the structure.

Note

- Store granular chlorine so that it cannot fall into the tank during ground shaking.
- Restrain chlorine gas cylinders (see Section 8.3).



Filtration Tank



Alternate Weld Plate

Purpose

To secure HVAC units mounted on vibration isolators.

Caution

When anchoring to post-tensioned slab, locate and avoid reinforcing.

Recommendation

Install restraint brackets or seismic snubbers.

Supplies Required

- Angle—6" × 6" × 1/2" × 4"
- OR
- Bent plate—3/8"
- Lag bolts—5/8" diameter × 6" (for wood)
- Expansion bolts—5/8" diameter × 4" (for concrete)
- Flex-line
- Steel Z snubbers (or other seismic type snubber)
- 4 × blocking (for wood construction)
- Framing clips (for wood construction)

Installation

Restrain Bracket Installation

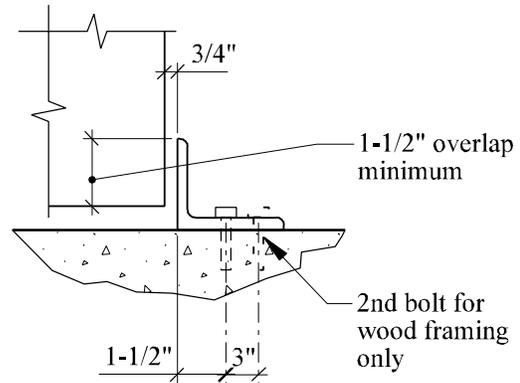
1. Provide two angles or bent plates at each corner of the unit.
2. Bolt to support with one bolt per angle. (For wood use (twp lag bolts at 3" spacing per angle.)

Seismic Snubber Installation

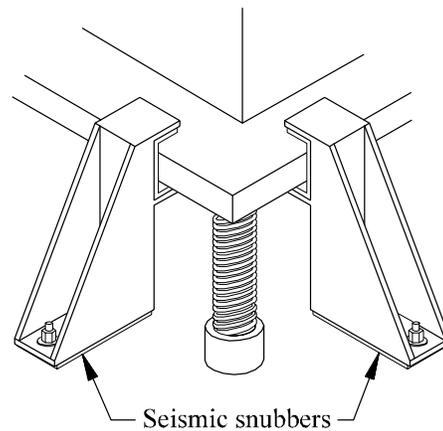
1. Provide two snubbers at each corner of the unit.
2. Bolt to support, providing sufficient free play to allow unit vibration under normal use.

Note

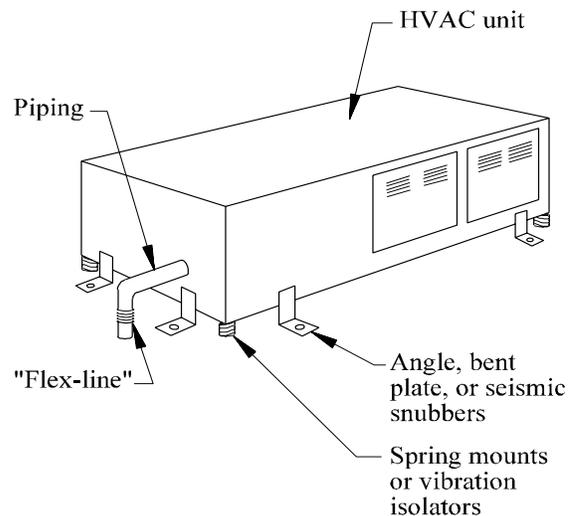
Provide Flex-line at piping (see Section 9.6).



Restrain Bracket



Seismic Snubbers



HVAC Unit

Purpose

To secure unit or duct to roof.

Recommendation

Install metal straps; brace unit supports

Supplies Required

- Metal straps (18 gage \times 2")
- Sheet metal screws—No. 10 \times 3/4"
- Angle—1-1/2" \times 1-1/2" \times 1/4"

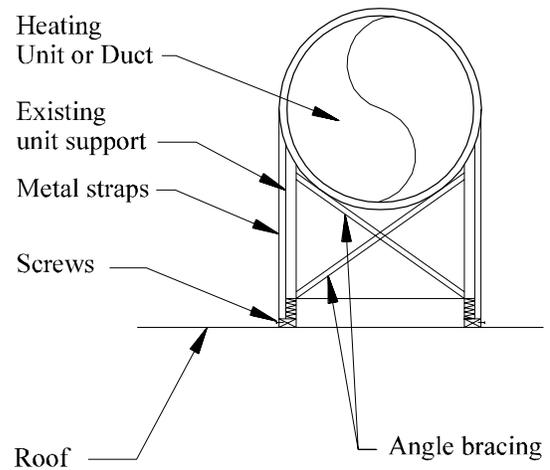
Installation

To attach metal straps to the unit or duct, follow these steps:

1. Wrap metal straps around heating/duct unit at each support location.
2. Attach metal strap to existing supports of the unit with screws.

To brace the unit or duct to the roof and strengthen the existing supporting, follow this step:

Weld or screw top and bottom of the angles to the existing supports.



Rooftop Heating Unit Or Duct With Metal Strap:

Purpose

To secure rooftop mechanical units.

Caution

When anchoring to post-tensioned slab, locate and avoid reinforcing.

Recommendation

Install clips and blocking.

Supplies Required

- Clips, Z and L—1/8" thick
- Lag bolts—3/8" diameter (for wood)
- Sheet metal screws—No. 10 × 3/4" (for steel)
- 4x blocking (for wood)
- Blocking—L2 × 2 × 3/8" (for steel)
- Drive pins
- Framing clips (for wood) Simpson A35

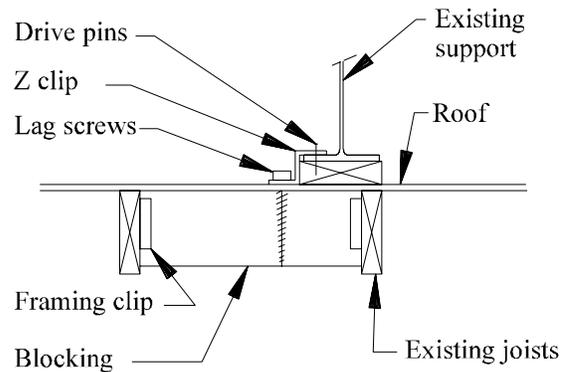
Installation

To install blocking and clips for a wood roof, follow these steps:

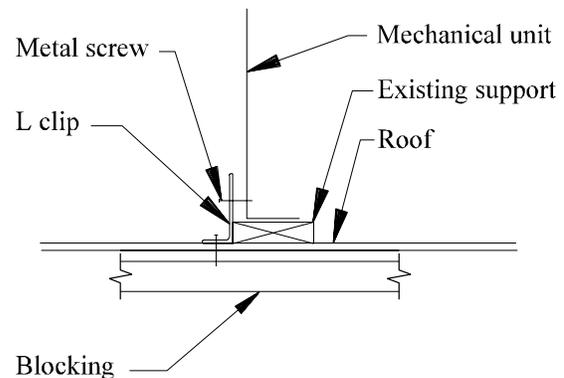
1. Insert 4x blocking between existing joists with framing clips
2. Attach Z or L clip to mechanical unit with corresponding fasteners and attach to blocking. Place clips at 24" on center minimum.
3. Patch roof as required.

To install blocking and clips for a steel roof, follow these steps:

1. Insert blocking between existing joists and weld in place.
2. Attach Z or L clip as mechanical unit with corresponding fasteners and attach to blocking. Position clips at 24" on center minimum.
3. Patch roof as required.



Mechanical Units With Blocking And Clips On A Wood Roof



Mechanical Units With Blocking And Clips On A Steel Roof

Purpose

To secure suspended air conditioning units.

Caution

When anchoring to post-tensioned slab, locate and avoid reinforcing.

Recommendation

Strengthen the existing supports with angle brace.

Supplies Required

- Angle—1-1/2" × 1-1/2" × 1/4"
- U-bolts—1/4" (if applicable at piping) (see Section 9.6)
- Sheet metal screws—No. 10 × 3/4"

Installation

1. Brace air conditioning (AC) unit with angles, installed diagonally at every other or on alternate sides.

OR

Weld angle bases to support rod.

2. Screw top and bottom of each angle to the supports with sheet metal screws.

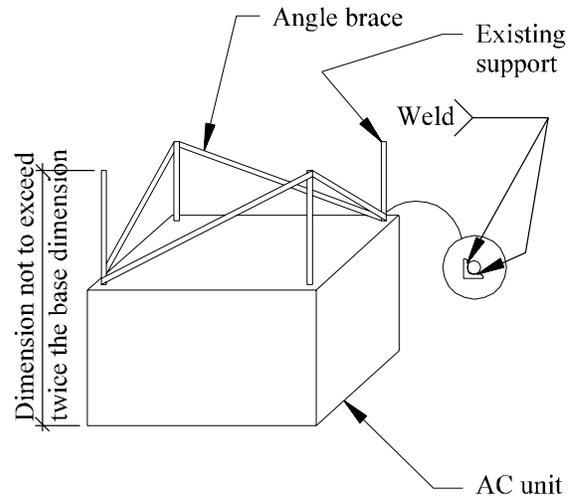
Note

- If the space between the ceiling and the bottom of any unit exceeds twice the minimum base dimension, move heater up so that space is less than two times the base dimension.

OR

Brace the unit to the side wall if the unit cannot be moved up. Build a support frame for the heater with diagonal braces.

- Consult a structural engineer for bracing design for other conditions.



**Suspended Air Conditioning Unit
Braced With Angle**

Purpose

To secure piping.

Caution

Secure ALL pipes that are used for fire protection systems.

When anchoring to post-tensioned slab, locate and avoid reinforcing.

Recommendation

Install pipe brackets as indicated in the following figures:

Supplies Required

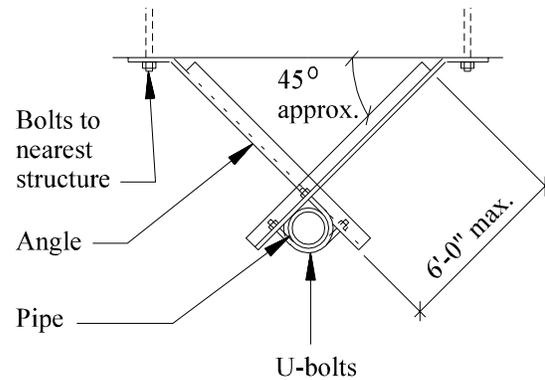
- Angle—2" × 2" × 1/8"
- Lag bolts—1/4" diameter × 3" (for wood)
- Expansion bolts—3/8" diameter (for concrete)
- U-bolts—1/4" diameter (for concrete)
- Flexible connections to equipment

Installation

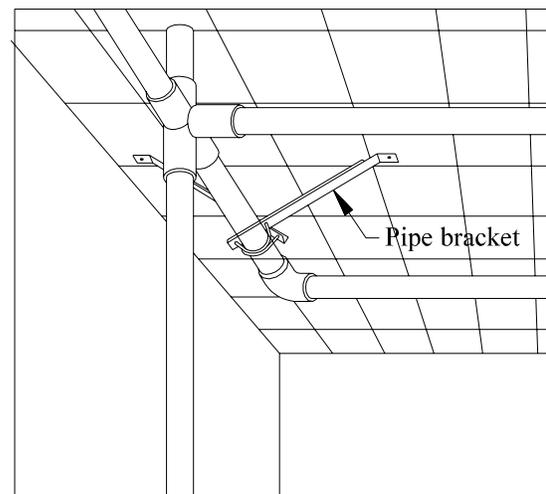
1. Install angle braces (cope as required) with lag bolts into wood joists, **OR** expansion bolts to concrete.
2. Attach each angle brace to the pipe with a U-bolt.
3. Locate at 90° turns in pipe where the pipe is continuous.
4. Place bracing brackets at 16' on center along unbraced runs of straight pipe.
5. Add flexible connections.

Note

- Brace fuel, oil, gas, or compressed air pipes that are greater than 1" in diameter.
- Do not use pipes to support other pipes.
- Wall openings for the pipe sleeves must be at least 2" larger than the pipe in fire-resistant systems. Consult a building official for the proper fill material in the wall gap.



Pipe Bracket



Typical Piping

Purpose

To secure water heaters.

Caution

When anchoring to post-tensioned slab, locate and avoid reinforcing.

Recommendation

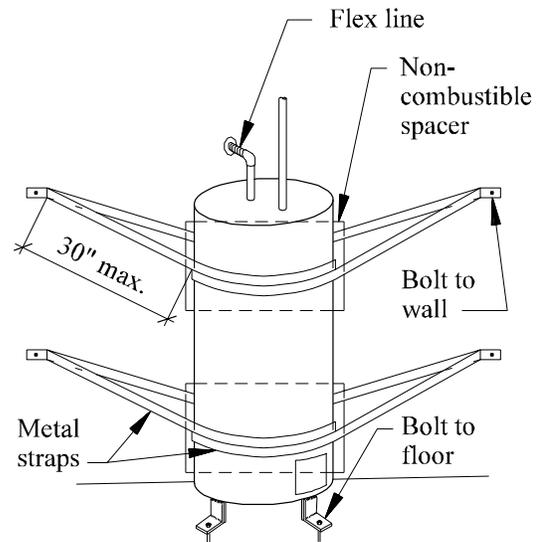
Anchor a heater to the wall with straps and bolt the heater legs to the floor.

Supplies Required

- Noncombustible spacer
- Metal strap (or plumbers tape)—20 gage \times 1"
- Expansion bolts— $3/8$ " diameter (for concrete)
- Lag bolts with washers— $5/16$ " \times 3" (for wood)
- Flex line
- Angle—3" \times 3" \times $1/4$ "
- Machine bolts— $3/8$ "

Installation

1. Place a noncombustible spacer between heater and the wall.
2. Wrap metal straps, two at the top and two at the bottom, around the heater, and anchor both ends of each strap together to the wall structure with bolts. (Do not attach the straps to gypsum wallboard only.)
3. Attach water heater legs to the floor as directed in Section 6.3.
4. Provide *flex line* in rigid water lines to avoid disruption of water service and water damage.
5. Install flexible gas line connections, if applicable.



Water Heater

Overhead Elements / 10.0

Purpose

To brace suspended ceilings.

Recommendations

- Provide splay brace wires and compression struts.
- Separate the edges of suspended ceilings from enclosing walls.
- Secure lay-in tiles and boards used in ceiling grids with clips at exitways and corridors.

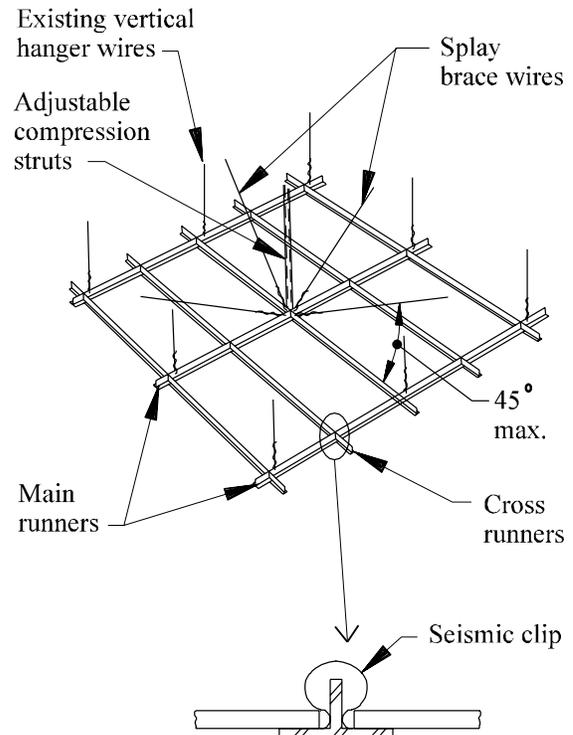
Supplies Required

- Wire—No. 12 gage
- Adjustable compression struts
- Ceiling panel clips

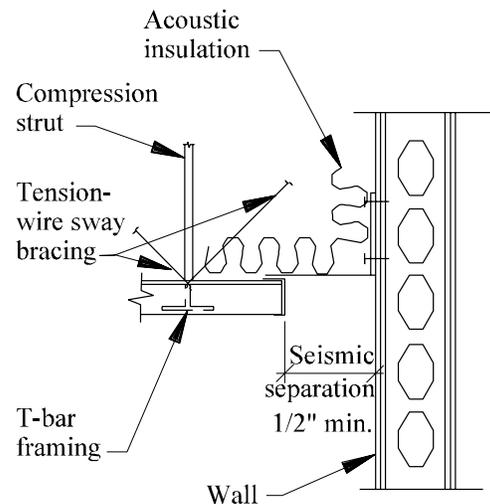
Installation

1. Install splayed wires at 12' on center in four directions.
2. Provide adjustable compression struts, at center of splayed wires, and attach to the structure above.
3. Provide ceiling tile clips at exits and stairwells.
4. Provide 1/2" minimum separation between the ceiling system and the enclosing walls.

Note
■ For installing ceiling bracing in concrete and steel buildings refer to Section 10.2.
■ For installing ceiling bracing in wood buildings refer to Section 10.3.



Typical Ceiling Grid



Seismic Separation Around Suspended Ceiling

Purpose

To brace suspended ceilings in concrete and steel buildings.

Caution

When anchoring to post-tensioned slab, locate and avoid reinforcing.

Recommendation

Provide splay wires and compression struts.

Supplies Required

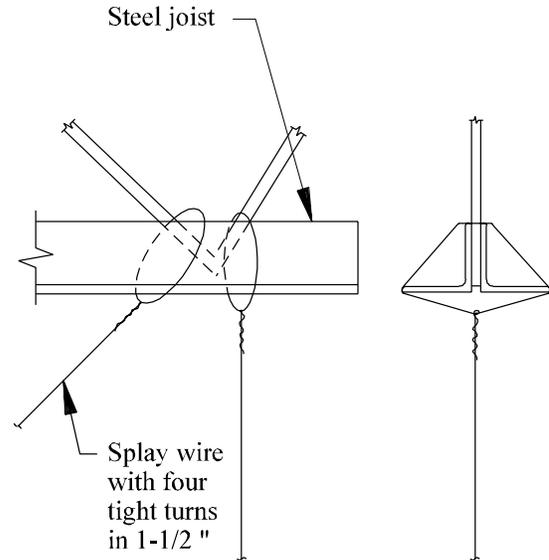
- Wire—No. 12 gage
- Adjustable compression struts
- Eye-bolts with expansion inserts—3/8" diameter

Installation

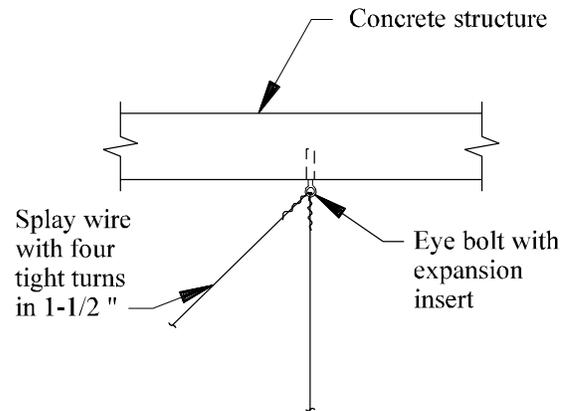
1. Install splay wires at 12' on center in four directions (See Section 10.1 for layout).
2. Attach adjustable compression struts, placed at the center of the splayed wires, to the structure above.

Note

- Secure lay-in tiles or boards in ceiling grids, located at exitways and corridors, with clips. See Section 10.1.
- Provide 1/2" minimum separation between the ceiling system and enclosing walls. See Section 10.1.



Ceiling Supported By Steel Framing



Ceiling Supported By Concrete Framing

Purpose

To brace suspended ceilings in wood buildings.

Recommendation

Provide splay wires and compression struts.

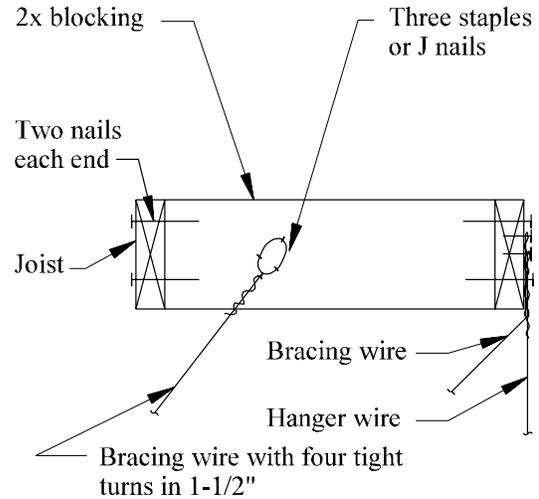
Supplies Required

- Wire—No. 12 gage
- Staples—No. 9 gage, 1-1/2"
- OR**
- Stronghold J nails
- Eye-screws—1/4" diameter
- Nails—16 penny common
- 2x blocking
- Adjustable compression struts

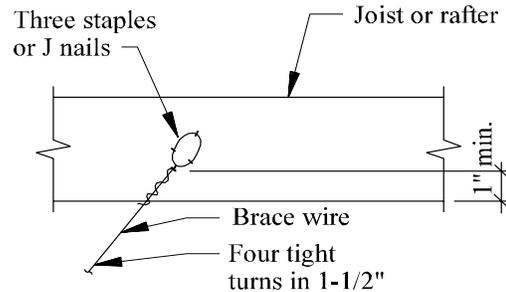
Installation

1. Install splay wires at 12' on center in four directions with staples, J nails, or eye-screws (see Section 10.1 for layout).
2. Install 2x blocking between joists with common nails, where required for the attachment of splayed wires.
3. Provide adjustable compression struts, at center of splayed wires, to the structure above (see Section 10.1).

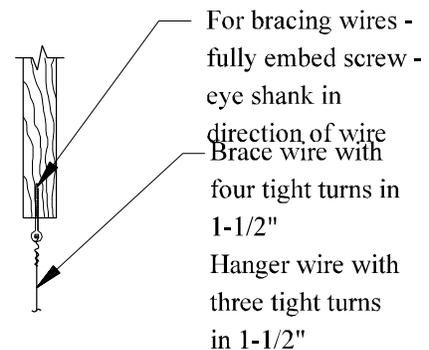
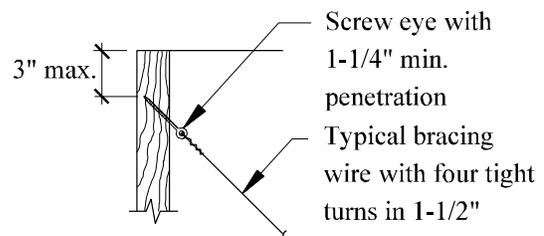
Note
<ul style="list-style-type: none"> ■ Secure lay-in tiles or boards in ceiling grids at exitways and in corridors with clips. (See Section 10.1.) ■ Provide 1/2" minimum separation between the ceiling system and enclosing walls. See Section 10.1.



Wire to Blocking



Wire To Joists



Wire To Joists With Eye Screws

Purpose

To secure lights and grills.

Recommendation

Brace lights with wire.

Supplies Required

- Wire—No. 12 gage

Installation

Wire

1. Brace ceiling-mounted lights with a diagonal wire at each corner to the structure above.
2. Secure wire with three tight turns at each end.

Note

- Replace diffuser panels with plastic panels.
- Add safety chains to panels if these are lacking.

Recommendation

Install slips to secure ventilation grills.

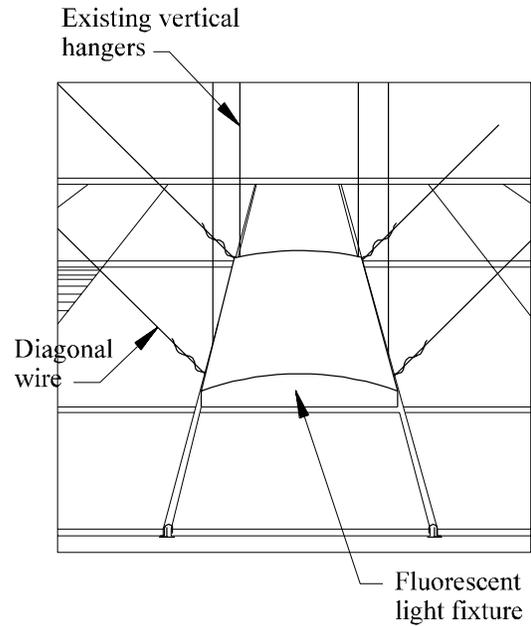
Supplies Required

- Clip—18 gage
- Sheet metal screws—No. 6

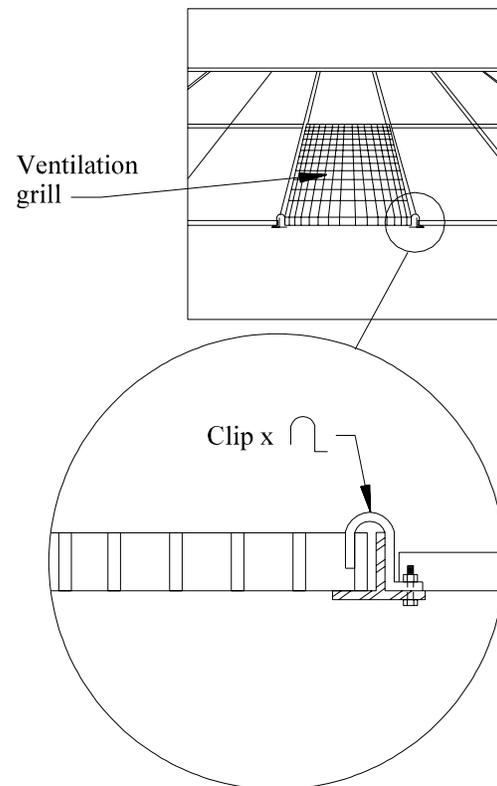
Installation

Clip Installation

1. Install one clip at each corner of the grill.
2. Attach the clip to T-grid with one screw.



Ceiling-Mounted Lights



Ventilation Grill

Purpose

To secure pendant-mounted lights or double-hung fluorescent lights.

Note

- Replace glass globes with unbreakable substitutes.
- Vertical support for the light should consist of wire, alongside cord, to the structure above.

Recommendation

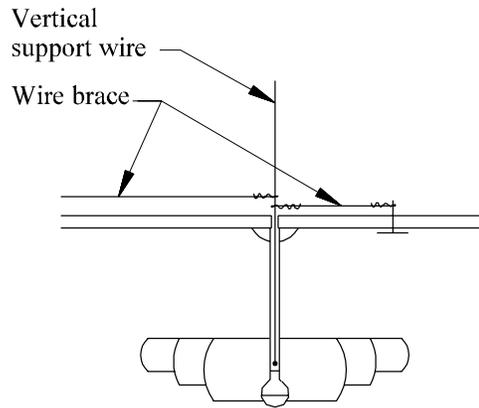
Brace vertical lamp support to the adjacent ceiling structure.

Supplies Required

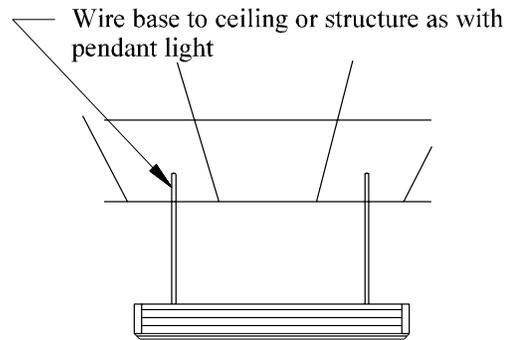
- Wire—No. 12 gage

Installation

1. Brace the vertical lamp support with wire to the adjacent ceiling grid in three directions.
2. Secure the wire brace with three tight turns at each end.



Pendant-Mounted Light



Double-Hung Fluorescent Light

Purpose

To brace ducts.

Recommendation

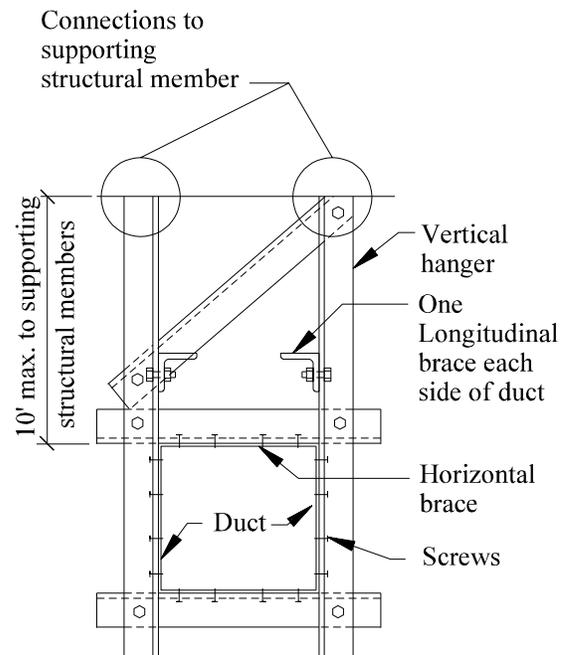
Provide transverse and longitudinal bracing in accordance with the SMACNA Seismic Restraint Manual Guidelines for Mechanical Systems.

Supplies Required

- Steel angles—size varies with ducts
- Machine bolts—1/2" diameter
- Sheet metal screws—No. 10

Installation

1. Provide angle braces sized in accordance with the SMACNA guidelines. Attach together with machine bolts. Maximum spacing is 40' for transverse bracing and 80' for longitudinal bracing.
2. Provide screws at 18" on center maximum from the bracing to the duct.
3. Attach bracing to the structure above in accordance with the SMACNA guidelines.



Duct Bracing

Note

- Bracing is required at ducts exceeding 6 square feet in cross-sectional areas, and for round ducts exceeding 28" in diameter.
- No bracing is required if the top of the duct is 12" or less from the support above. See SMACNA guidelines for hanger requirements.
- Walls, through which ducts pass, can be substituted for transverse braces. Provide blocking around the duct.

Purpose

To brace the space heaters.

Recommendation

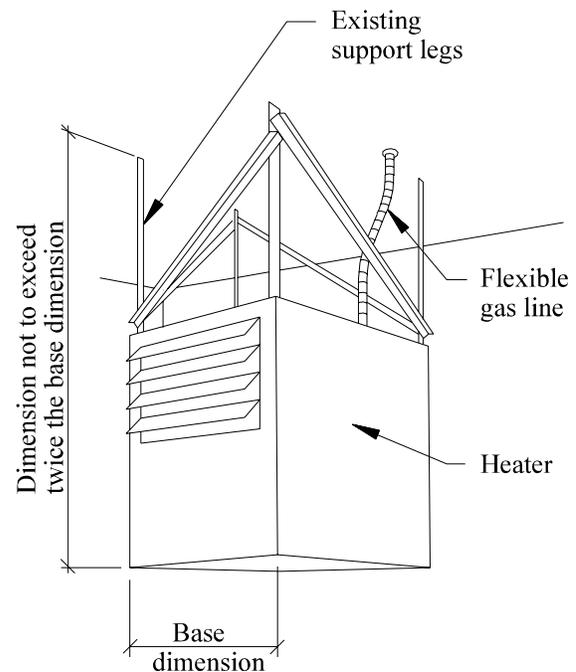
Install angles and flexible pipe connections.

Supplies Required

- Angle—1-1/2" × 1-1/2" × 1/8"
- U-bolts—if applicable (see Section 9.6)
- Flexible gas line—if applicable
- Sheet metal screws—No. 10

Installation

1. Brace the space heater with angles that are installed diagonally on each side.
2. Screw top and bottom of the angle to existing support legs or weld them together (See Section 9.5).
3. Install flexible gas pipe connections, if applicable.



Space Heater

Note

- If the space between the ceiling and the bottom of any space heater exceeds twice the minimum base dimension, move the heater up so that the space is less than two times the base dimension.
OR
Brace the heater to the side wall if the space heater cannot be moved up. Build a support frame for the heater with diagonal braces.
- Consult a structural engineer for bracing design for other conditions.

Partitions / 11.0

Purpose

To brace partitions that extend to the ceiling.

Caution

When anchoring to post-tensioned slab, locate and avoid reinforcing.

Recommendation

Install braces that extend to the structure above.

Supplies Required

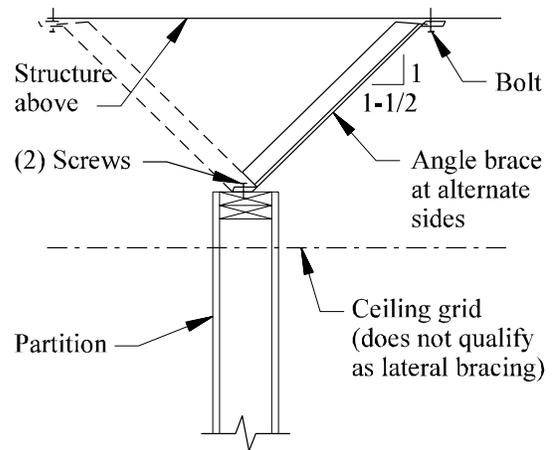
- Angle—2" × 2" × 1/8" (for bracing over 10" in length, use 3" × 3" × 3/16")
- Expansion bolts—3/8" diameter (for concrete)
- Lag bolts—3/8" diameter × 3" (for wood)
- Screws—No. 12

Installation

1. Install angle braces at 8'-0" on center, alternating sides, at least two per partition.
2. Attach the angle to the structure above with expansion bolts for concrete or lag bolts for wood.
3. Attach the angle to the top plate of the wall with two screws.

Note

Provide 1/2" minimum separation between the ceiling system and enclosing walls (see Section 10.1).



Full Height Wall Section

Purpose

To secure masonry partitions.

Recommendation

Install braces to the structure above.

Supplies Required

- Clip angles—3" × 4" × 1/4" × 1'-3"
- Expansion bolts—1/2" diameter (for concrete)
- Channel (appropriate for wall width)
- Angles—4" × 4" × 1/4"
- Angles—3" × 3" × 1/4"
- Drive pins—5/32" diameter (for steel)
- Lag bolts—3/8" diameter × 3" (for wood)
- Wood blocking—4x
- Framing clips—Simpson A35

Installation

Concrete Building Installation

1. Weld 3" angle braces at 4'-0" on center to continuous channel over wall.
OR
Install clip angles at 4'-0" on center each side of the wall.
2. Attach the angles to the structure above with expansion bolts. Use two bolts for each clip angle.

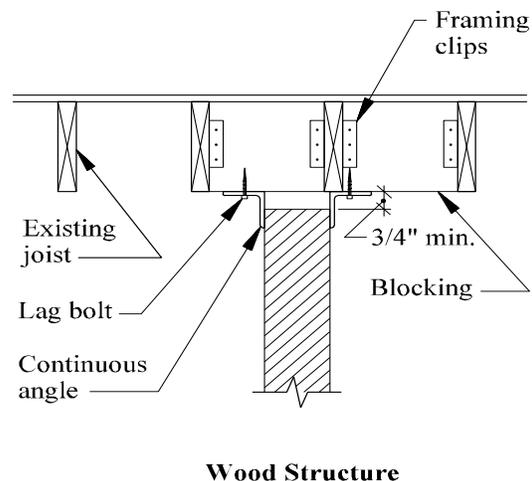
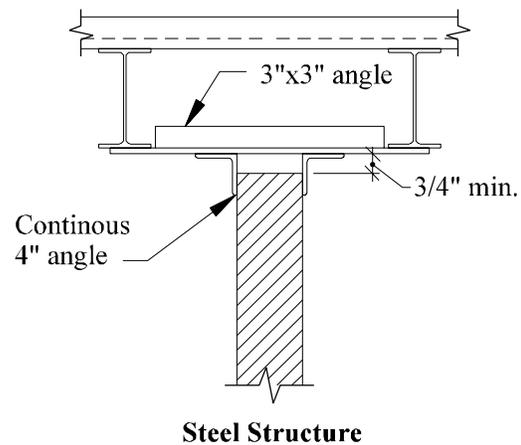
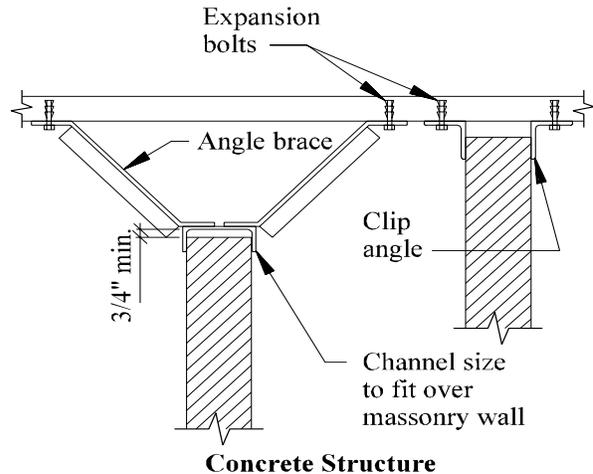
Steel Building Installation

1. Install 3" angle braces at 4'-0" on center.
2. Attach angle to the structure with drive-pins.
3. Weld continuous 4" angle on each side of the partition to 3" angles.

Wood Building Installation

1. Position 4x blocking between joists with framing clips.
2. Install continuous 4" angle on each side of the wall.
3. Attach angles to new 4x blocking with lag bolts at 4'-0" on center.

Caution
<ul style="list-style-type: none"> ■ Unreinforced masonry partitions are extremely hazardous and should be removed if possible. ■ When anchoring to post-tensioned slab, locate and avoid reinforcing.



Purpose

To secure modular partitions.

Recommendation

Arrange multiple partitions in a zigzag or tee-shape fashion. Install restraints to single modular partitions.

Supplies Required

- Angles—3" × 3" × 1/4"
- Expansion bolts—3/8" diameter (for concrete)
- Lag bolts—3/8" diameter (for wood)
- Thru-bolts

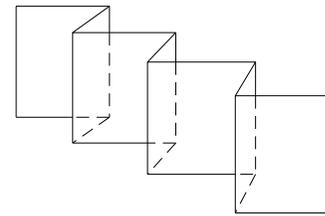
Installation

1. Install angle braces at each end on each side of the partition with thru-bolts.
2. Attach the angles (or partition feet) to the floor with expansion bolts for concrete or lag bolts for wood.

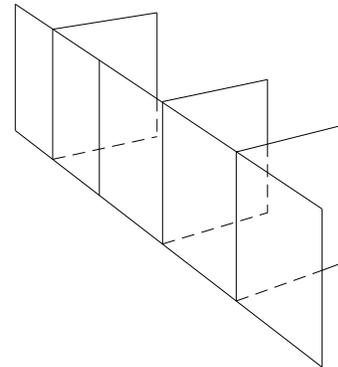
OR

Anchor the partition to the adjacent desk.

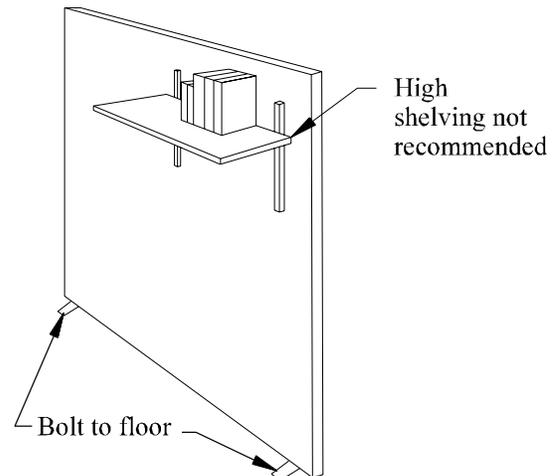
Caution
When anchoring to post-tensioned slab, locate and avoid reinforcing.



Zig-Zag Partition Arrangement



Tee-Shape Partition Arrangement



Single Partition

REFERENCES

- Federal Emergency Management Agency. 1994. *Reducing the Risks of Nonstructural Earthquake Damage. A Practical Guide.* (FEMA 74). Prepared by Wiss, Janney, Elstner Associates, Inc., third edition, Washington, D.C.: FEMA.
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- Thorsen, G.W., compiler. 1986. *The Puget Lowland Earthquakes of 1949 and 1965- Reproductions of selected articles describing damage.* Washington Division of Geology and Earth Resources Information Circular 81, 113p. Olympia, Washington.
- Wood, H. O., Neumann, Frank. 1931. *Modified Mercalli Intensity Scale of 1931.* Seismological Society of American Bulletin, v.21, no. 4, p. 277-283.

VENDOR LIST

Vendor/Address	Phone/Fax/Email/Web	Contact	Product
ArmorCoat of Washington 956 Industry Drive Seattle, WA 98188	Phone: 206-575-4777 Fax: no fax		Glass films
C.M. Hoskins Co., Inc. 7353 15th NW Seattle, WA 98117-5498	Phone: 206-789-1600 Fax: 206-789-1604		Variety of fastening products
Earthquake Preparedness Society 7981 168th Avenue NE Redmond, WA 98052	Phone: 425-556-0911 Fax: 425-556-0734		Variety of fastening products
Earthquake Safety Systems 7716 Balboa Avenue Van Nuys, CA 91406	Phone: 818-501-0628 Fax: 818-781-3223 www.earthquakeservices.com		Gas
Earthquake Services Corporation 1670 Alvarado Street, Suite 14 San Leandro, CA 94577	Phone: 800-890-8566 Phone: 510-987-3907 Fax: 510-352-2415	Jerry Florence	Specializes in commercial
Fastening Solutions, Inc. 15236 Burbank Boulevard, Suite 101 Van Nuys, CA 91411	Phone: 818-994-6398 Fax: 818-997-1371		Thumb locks (CMHoskins local distributor)
Quake Defense, Inc. 861 Hinckley Road Burlingame, CA 94010	Phone: Fax:		Gas shut-offs
Real Enterprising 5530 Weber Road Vacaville, CA 95687	Phone: 916-678-5638 Fax:		Seismic shelf guard
Spacesaver 819 Industry Drive, Building 19 Seattle, WA 98188	Phone: 206-575-1460 Fax:	Steve Englung	Mobile storage and filing systems
Strand Earthquake Consultants 1436 Bentley Avenue, #6 Los Angeles, CA 90052	Phone: 213-473-2316	Carl Strand	Generators, gas shut-offs
STRS (Safe-T-Rack Systems) 325 Dominguez Road, Suite A Rocklin, CA 95677	Phone: 800-344-0619 Phone: 916-632-1121 Fax: 916-632-1173		Gas cylinders (Strand local distributor)
Taylor Electric Supply 1709 SE Third Avenue Portland, OR 97214	Phone: 501-233-5321 Fax:		Electrical supply
TERRA Technology Corporation Redmond, WA	Phone: Fax:		Toxic gas seismic trigger (Strand)
WorkSafe Northwest 17315 N.E. 42nd Street Redmond, WA 98052	Phone: 425-556-0911 Fax: 425-556-0734		Seismic Protection Services

DRAFT LIST OF DISTRICT MANAGER ACCESS DATABASE TABLES

Item	Description
1	School location table (name of school, address, city, state, zip code)
2	Occupant information (type of school—elementary, middle, high school; number of students, number of staff)
3	Building information table (type of construction, age, square footage, number of floors, irregular plan, irregular elevation) This is difficult because each school will have many buildings and many additions to each building.
4	Nonstructural element inventory (location, name of element, quantity, cost to correct, vendors(?), expertise, permits)
5	Nonstructural priority table?
6	Opportunity table (what elements can be done when other work is scheduled)