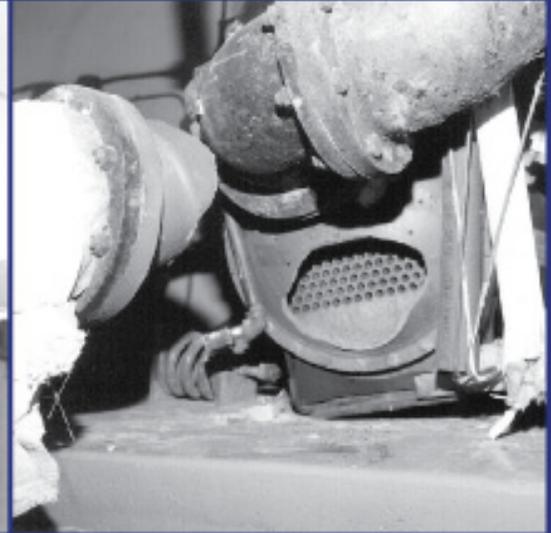
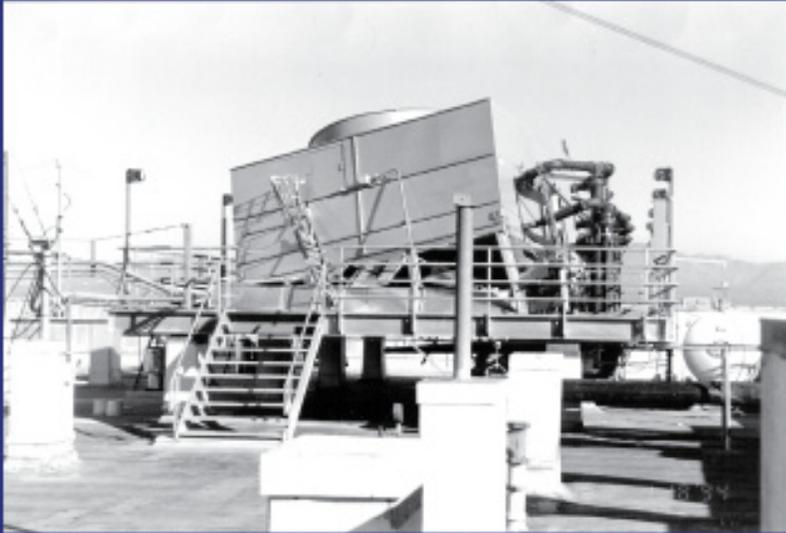


EARTHQUAKE PROTECTION



The following details can be used to help prevent the effects of earthquakes on:

- **Mechanical Systems**
 - Piping
 - Ductwork
 - Suspended Equipment
 - Floor Mounted Equipment
- **Electrical Systems**
 - Cable Trays,
 - Bus Ducts
 - Conduit
- **Plumbing Systems**
 - Piping
- **Fire Protection Systems**
 - Piping

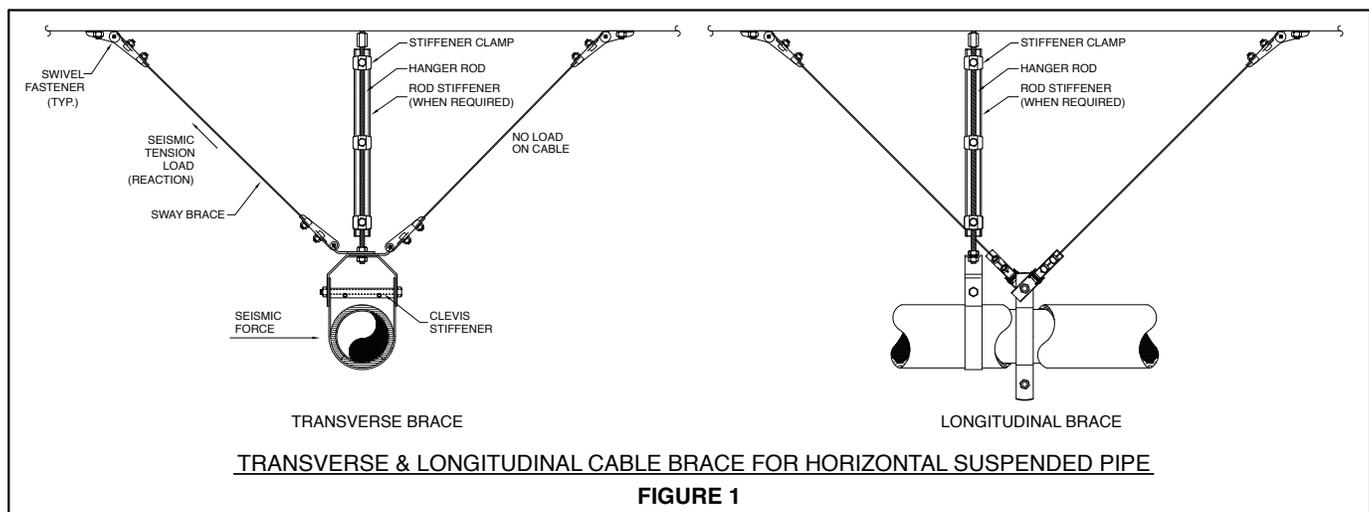


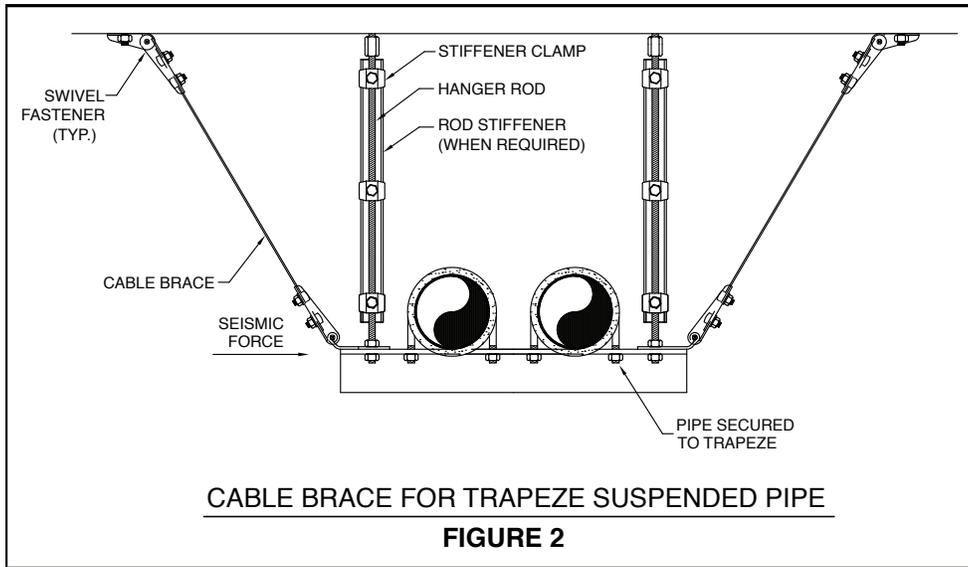
American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc.

Suspended systems such as piping, equipment and ductwork need seismic braces to keep them from swaying during an earthquake. Seismic braces can be flexible using aircraft quality cables, or rigid (solid) using steel sections such as pipe, angles, or strut channels. Braces are typically installed 30-40 ft (10-13 m) apart, at system turns and at the end of runs. Braces are attached to the pipe/duct at horizontal supports such as clevis's or trapezes. The other end is attached to structure such as overhead concrete slabs or structural steel. Suspended equipment requires a minimum of four braces, one at each corner. Floor mounted equipment needs to be anchored to the structural slab. This also includes equipment that is Vibration Isolated with seismic snubbers.

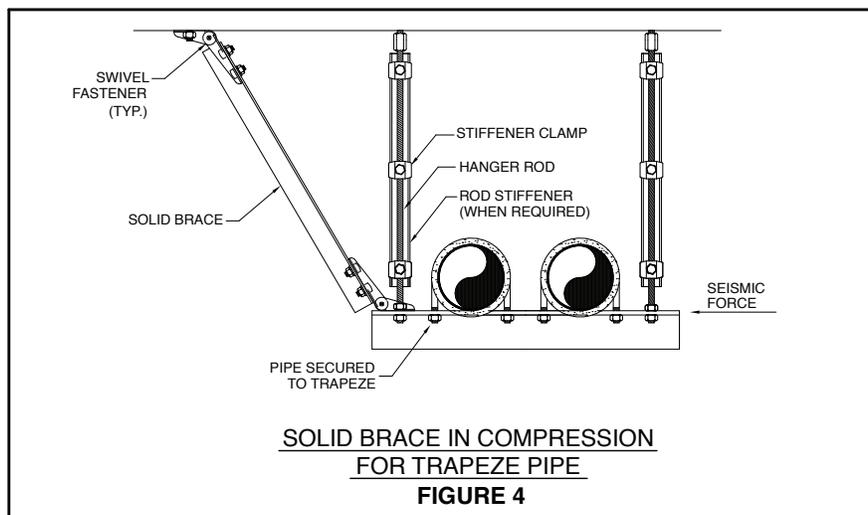
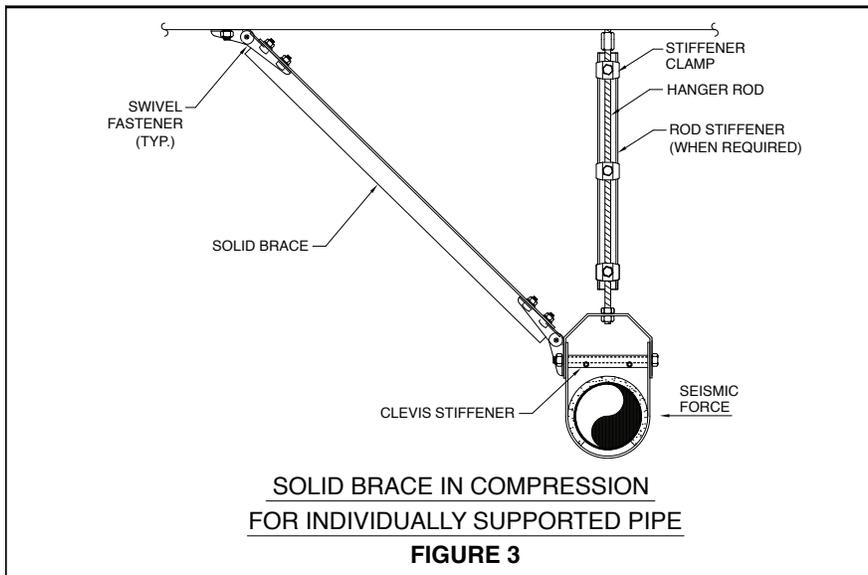
Pipe, Cable Trays, Bus Ducts & Conduit Bracing Details

Cable Bracing



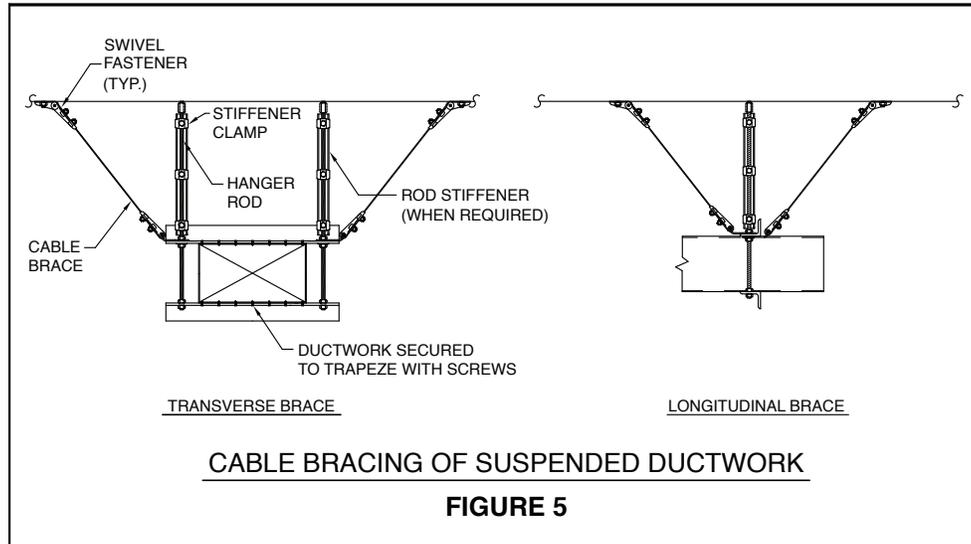


Rigid or Solid Bracing

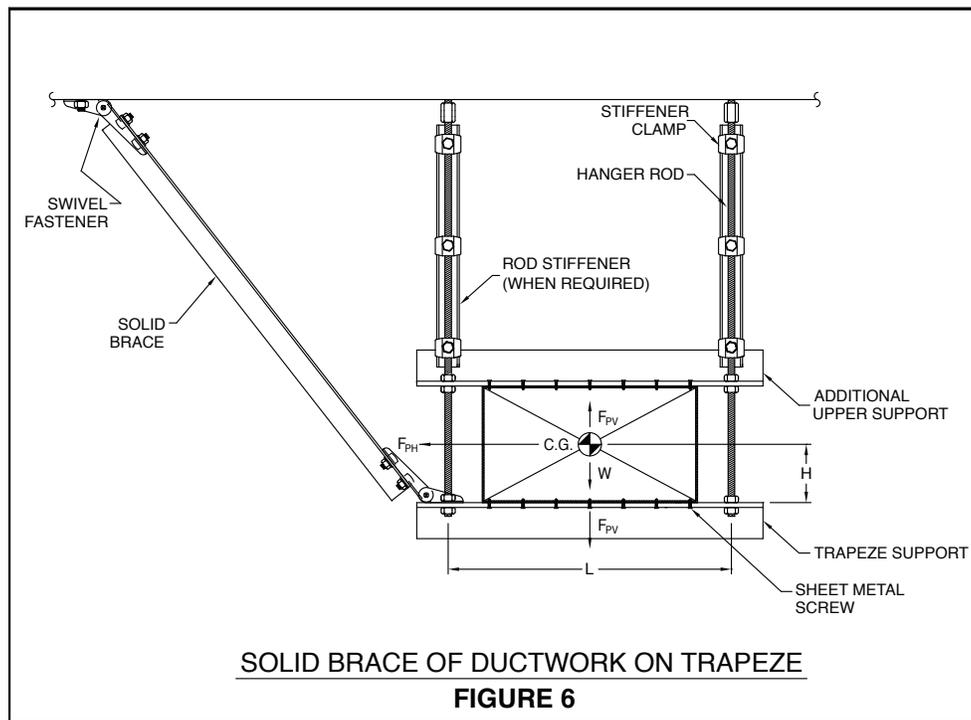


Duct Bracing Details

Cable Bracing

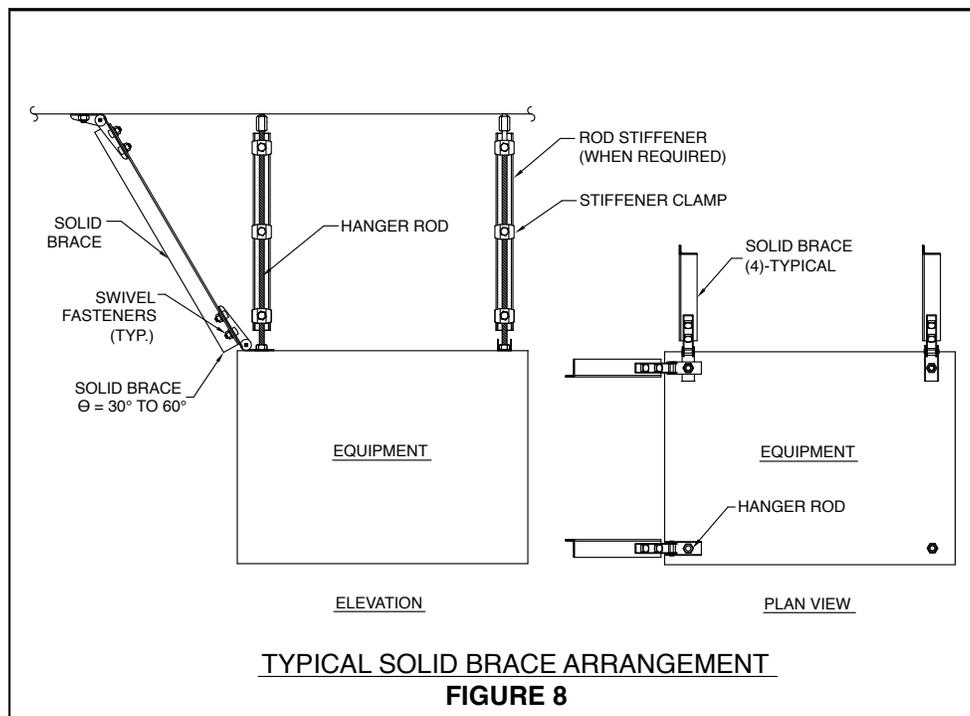
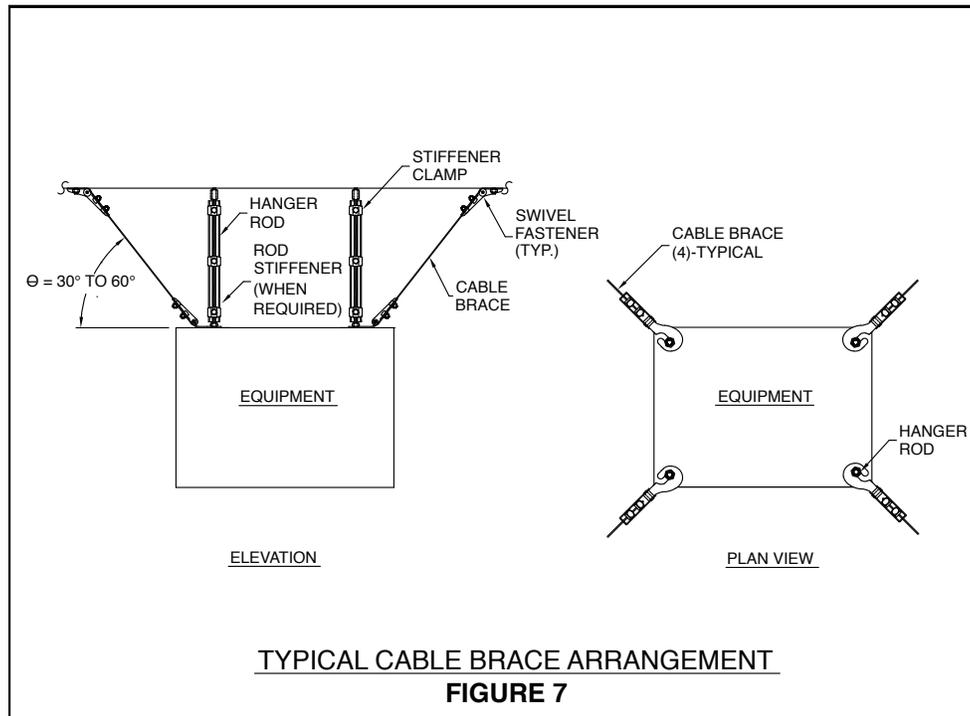


Rigid or Solid Bracing



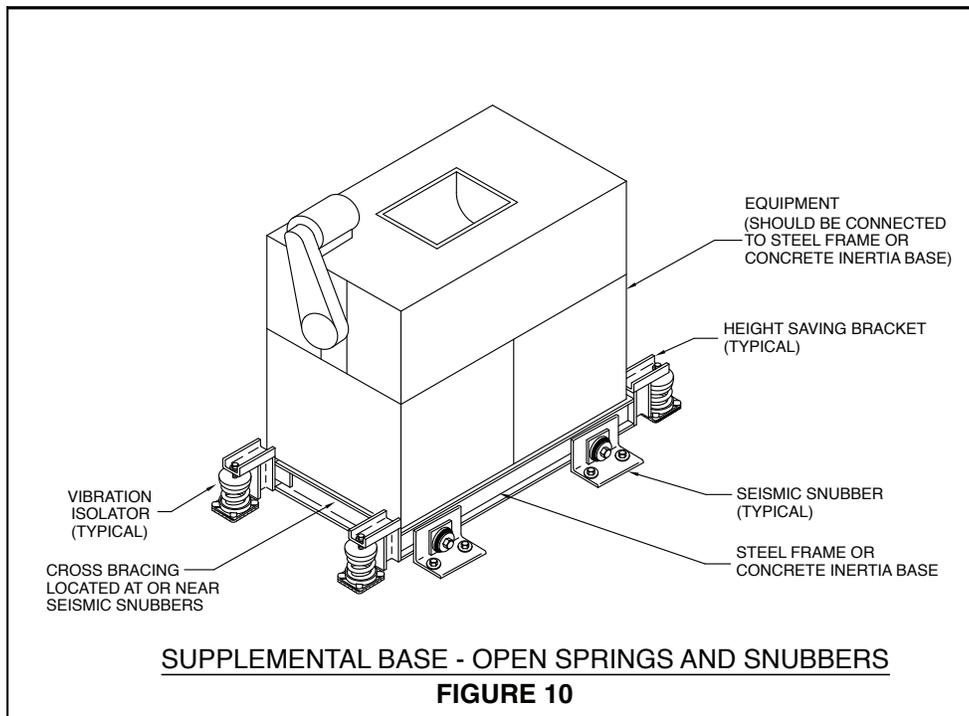
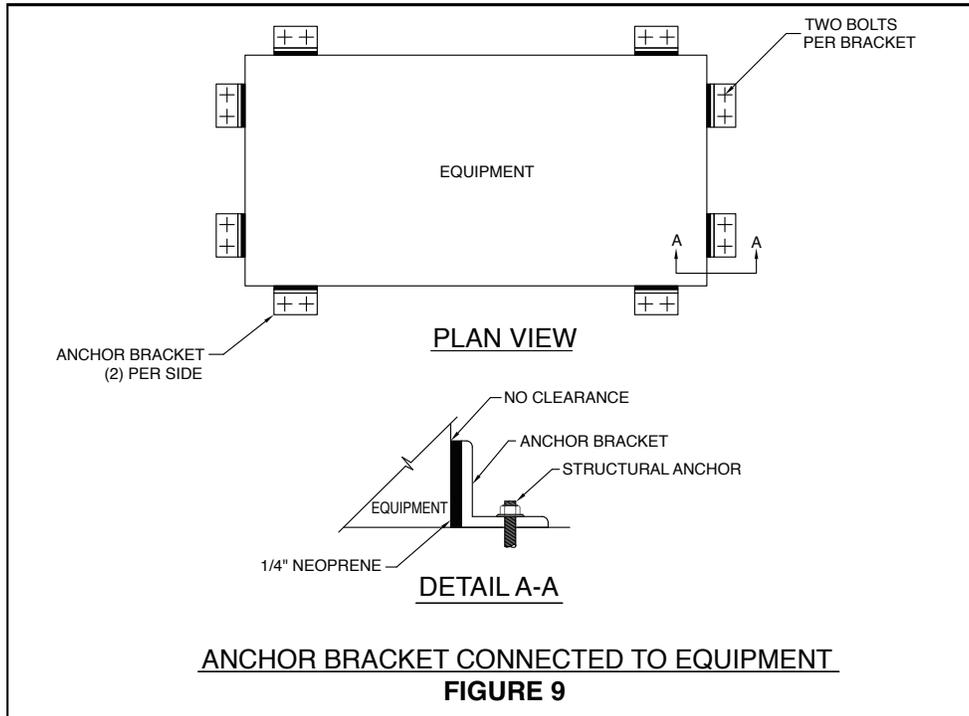
Suspended Equipment Bracing

Suspended equipment requires bracing as shown in Figure 8 using rigid steel sections or Figure 7 using cables. Connections to the equipment such as piping, conduit or ductwork should be made with flexible connections.



Floor Supported Equipment

Floor mounted equipment may be bolted down if no vibration isolation is required. If the equipment is isolated then the equipment must either have bumpers as shown in Figure 9 or snubbers as shown in Figure 10.



Anchor Bolts

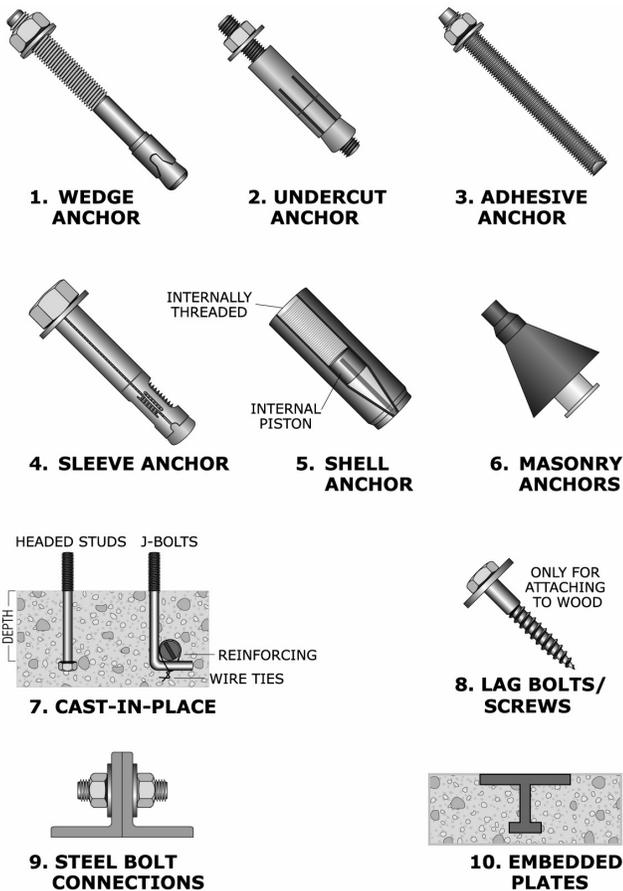


FIGURE 11

Anchor bolts are one of the most important parts of a correctly designed and installed Seismic Restraint System. The most widely used anchors for seismic restraints are the wedge, adhesive and undercut.

Proper installation of anchors is important.

Basic installation methods for shell and adhesive anchors is shown in Figure 12.

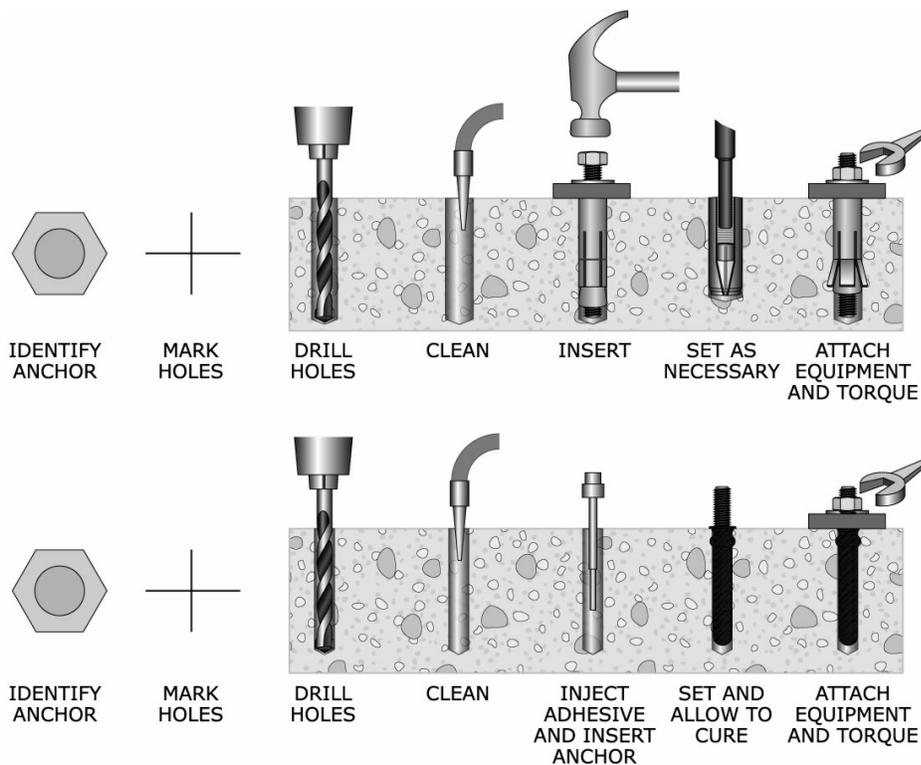


FIGURE 12

Sites with additional information:

- ASHRAE, American Society of Heating Refrigerating and Air Conditioning Engineers, www.ASHRAE.org
- ASHRAE Technical Committee TC 2.7 Seismic & Wind Restraint Design, www.ASHRAE.org/technology/page/1727
- FEMA, www.FEMA.gov , Publications 412, 413 & 414
- USGS, United States Geological Survey, www.USGS.gov
- SMACNA, Sheet Metal and Air Conditioning Contractors National Association, www.SMACNA.org
- VISCMA, Vibration Isolation and Seismic Control Manufacturers Association, www.VISCMA.com
- ICC, International Code Council, www.ICCSAFE.org
- National Fire Protection Association, www.NFPA.org
- AHRI, Air Conditioning, Heating and Refrigeration Institute, www.ahrinet.org

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