6.4 Mechanical, Electrical, and Plumbing Components

6.4.6 Ductwork

6.4.6.1 Suspended Ductwork

This category covers suspended HVAC ducts; see Section 6.4.1.5 for suspended HVAC equipment.

Provisions

BUILDING CODE PROVISIONS

Ductwork, including its supports, is designed using the provisions of ASCE/SEI 7-10, *Minimum Design Loads for Buildings and Other Structures*, (ASCE, 2010), Chapter 13. The principal objective is to prevent the duct system from falling. Depending on the configuration of the ductwork, it may also be sensitive to building displacements if it is connected to multiple levels in the same structure, or is supported by adjacent structures.

- ASCE/SEI 7-10 exempts ductwork from seismic bracing requirements in Seismic Design Category C if $I_p = 1.0$.
- ASCE/SEI 7-10 requires seismic design for all ductwork in Seismic Design Categories D, E, and F that weighs more than 5 pounds per linear foot.
- Unbraced piping attached to equipment in-line with the ductwork must be provided with flexibility adequate to accommodate seismic relative displacements.
- ASCE/SEI 7-10 contains a number of bracing exemptions for ductwork that does not carry toxic or flammable gases or is used for smoke control. Ductwork is exempt if:
    - Trapeze assemblies are used to support ductwork and the total weight of the ductwork supported by trapeze assemblies is less than 10 lb/ft.
    - The ductwork is supported by hangers and each hanger in the duct run is 12 inches or less in length from the duct support point to the supporting structure. Rod hangers must be detailed to prevent bending of the rod.
    - Design for the seismic forces and relative displacements are not be required where provisions are made to avoid impact with larger ducts or mechanical components or to protect the ducts in the event of such impact, and HVAC ducts have a cross sectional area of less than 6 square feet, or weigh less than 17 lb/ft.
- HVAC duct systems fabricated and installed in accordance with approved bracing standards meet the lateral bracing requirements ASCE/SEI 7-10.

RETROFIT STANDARD PROVISIONS

ASCE/SEI 41-06, *Seismic Rehabilitation of Existing Buildings*, (ASCE, 2007) classifies ductwork as force controlled, meaning that the principal objective is to prevent the ductwork from falling. Where ductwork runs between floors or crosses seismic joints it as also deformation controlled. Ductwork must meet the force and deformation requirements of the standard when:

- The performance level is Immediate Occupancy,
- The performance level is Life Safety in regions of high or moderate seismicity, and:
    - The ductwork conveys hazardous materials, or
    - The ducts are 6 square feet or more in area, or
    - The ducts are suspended more than 12 inches from the structure.

Prescriptive standards for seismic bracing may be used for ductwork meeting the life safety and immediate occupancy performance objectives.

Typical Causes of Damage

- Unbraced ducts may swing and impact other items. They may become damaged at restraints or "hard spots" along the duct path such as at connections of braced in-line equipment, at connections to floor-mounted equipment, or at wall or slab penetrations. Inadequately supported ducts may come loose from the HVAC equipment or diffusers to which they are connected and fall.
- Ducts may be damaged by differential movement such as at building separations.

DAMAGE EXAMPLES

Figure 6.4.6.1-1 Unbraced ducts separated at bend in the 1994 magnitude-6.7 Northridge Earthquake (Photo courtesy of Mason Industries).

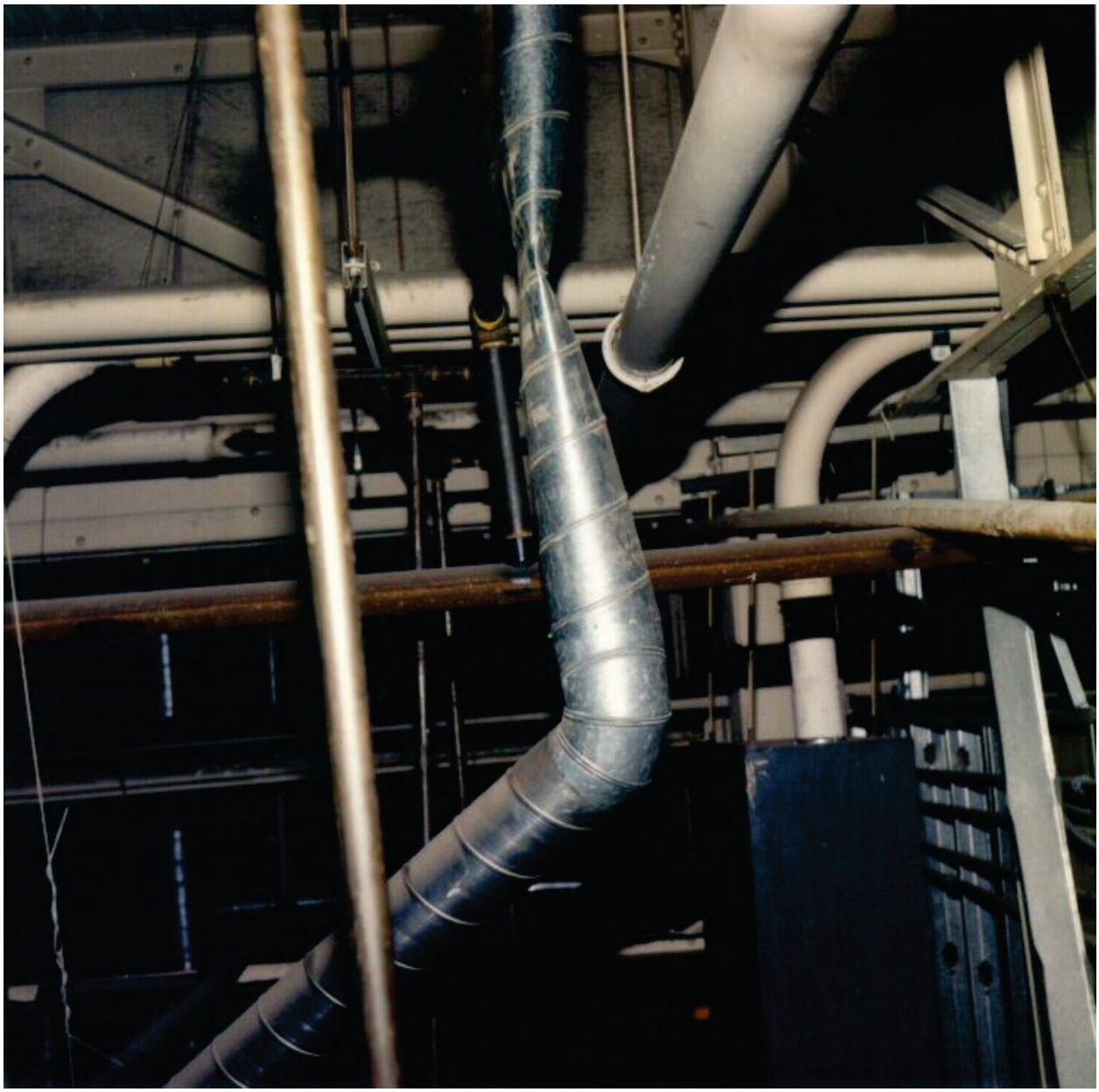

Figure 6.4.6.1-2 Unbraced duct damaged by impact with piping in 1994 Northridge Earthquake (Photo courtesy of Mason Industries).

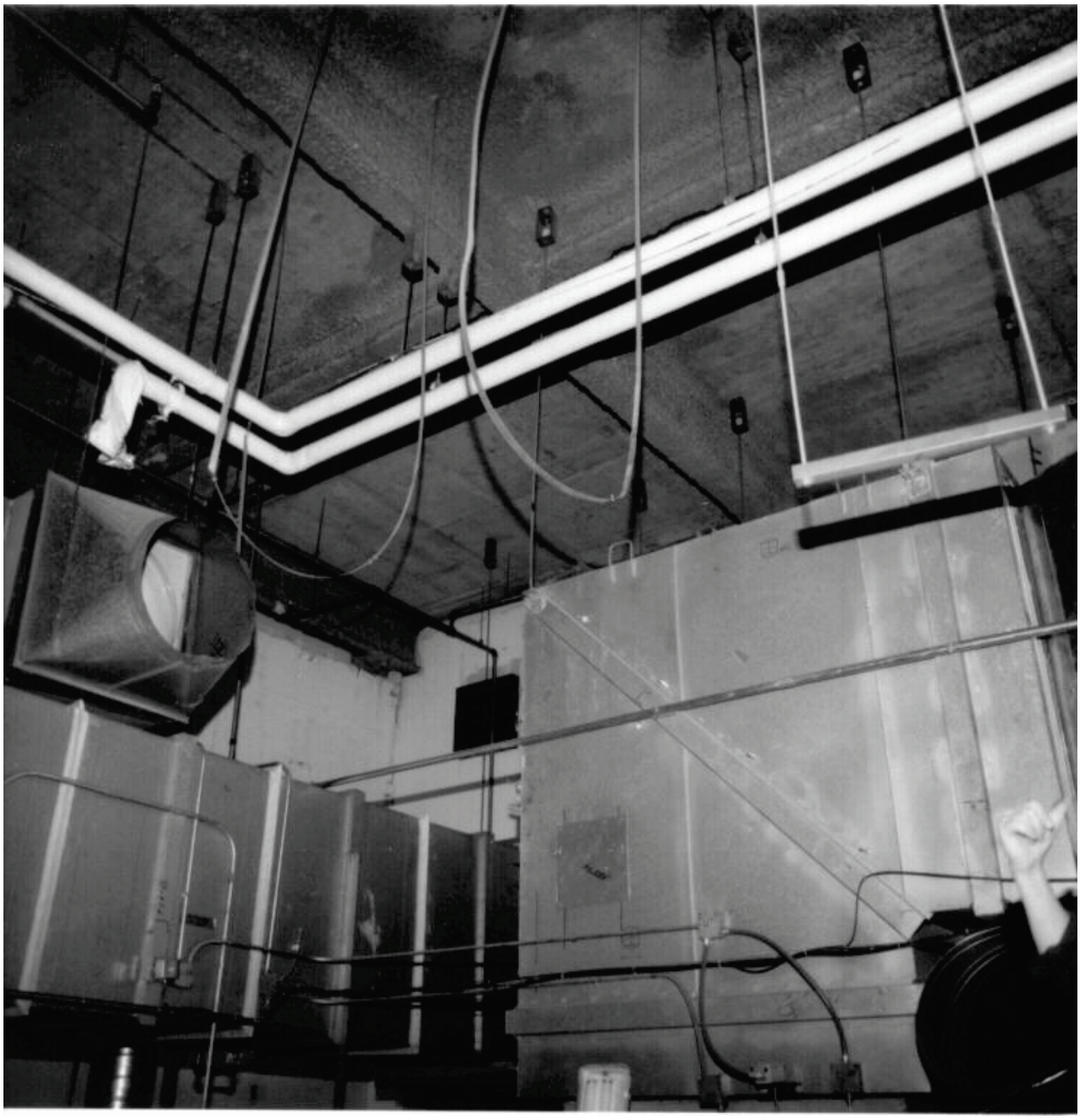

Figure 6.4.6.1-3 Collapsed unbraced ducts and hangers dangling from floor above in the 1994 Northridge Earthquake (Photo courtesy of Mason Industries).

Seismic Mitigation Considerations

- Details shown here are for suspended ducts. Ducts may also be floor-, wall- or roof-mounted, may cross building separations, or may be located in vertical chases. Refer to FEMA 414 *Installing Seismic Restraints for Duct and Pipe* (2004) for attachment details, for other conditions and general information about installation.

- Ductwork required for HVAC systems in hospitals or other essential facilities may be classified as designated seismic systems with a component importance factor of 1.5. Such designated seismic systems may require engineering calculations, equipment certification, and additional inspections. Check ASCE 7-10 and the jurisdiction for specific requirements.

MITIGATION EXAMPLES

Figure 6.4.6.1-4 Rectangular duct supported by steel shapes with cable braces (Photo courtesy of Mason Industries).

Figure 6.4.6.1-5 Floor-mounted rectangular duct supported on braced support stand built up from steel angles (Photo courtesy of Maryann Phipps, Estructure).

Figure 6.4.6.1-6 Roof-mounted rectangular duct supported on braced support stand built up from steel channels (Photo courtesy of Maryann Phipps, Estructure).

MITIGATION DETAILS

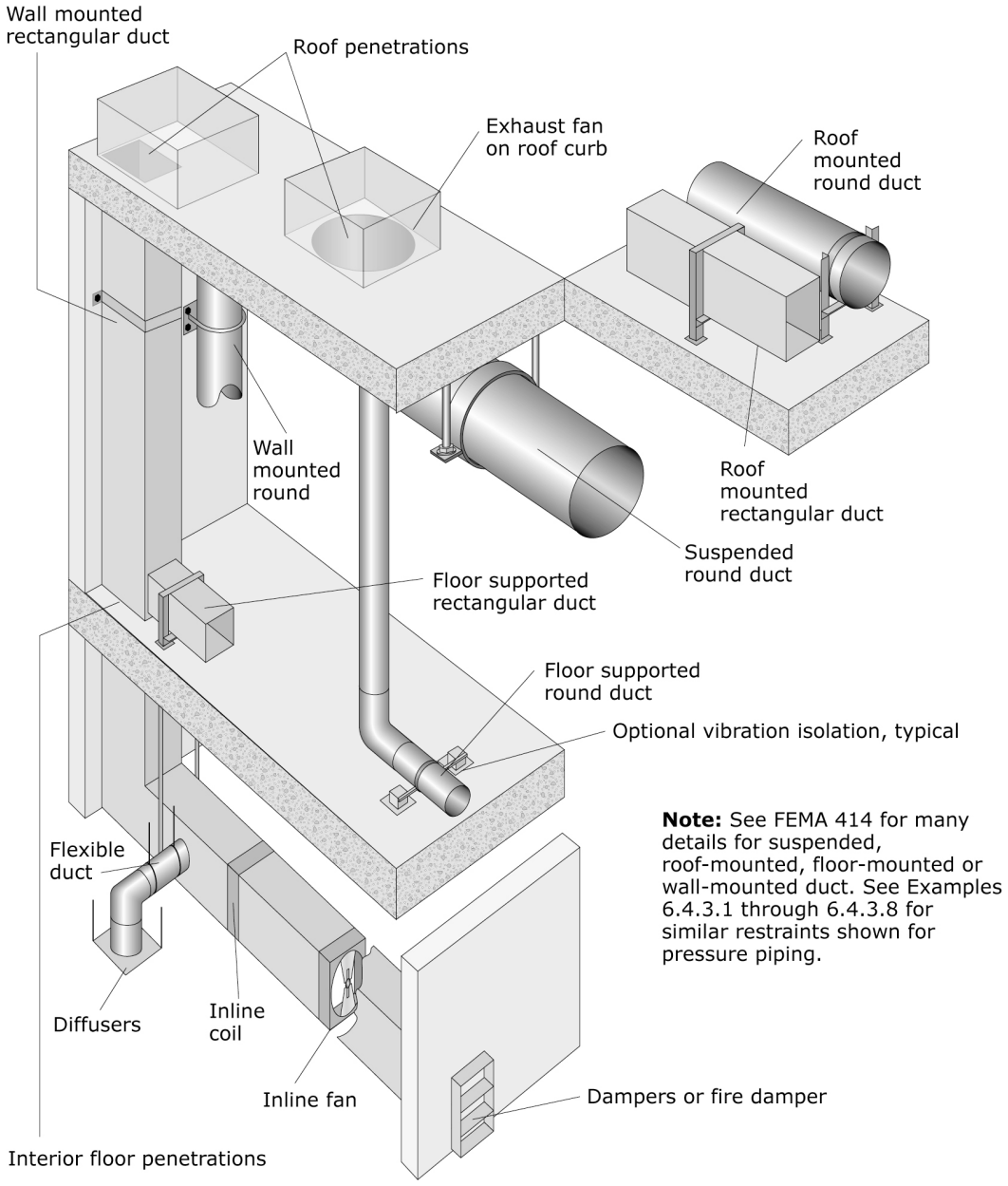

Figure 6.4.6.1-7 Overview of ductwork restraints (ER).

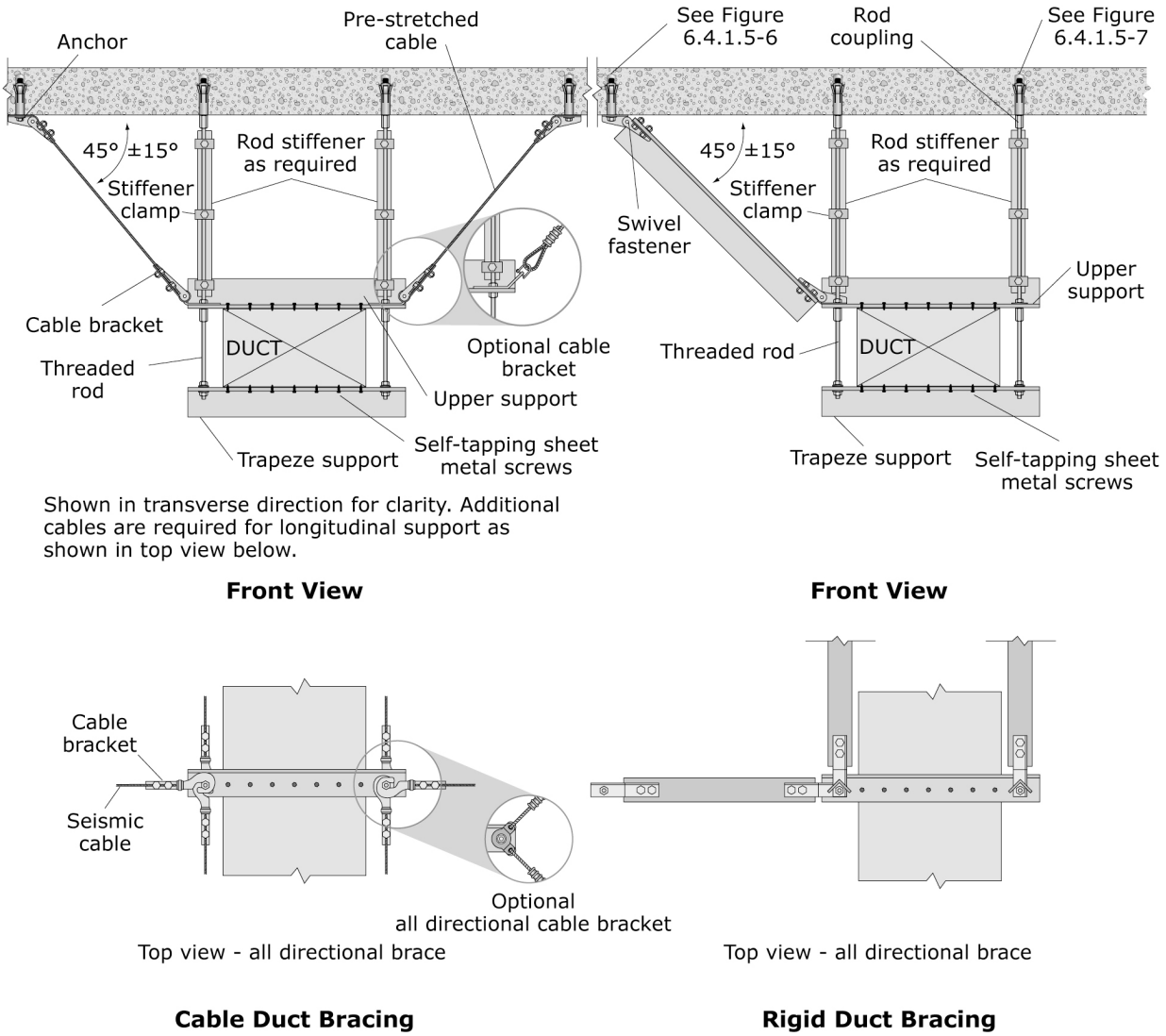

Figure 6.4.6.1-8 Suspended ductwork (ER).