6.4 Mechanical, Electrical, and Plumbing Components

6.4.5 Fluid Piping, not Fire Protection

6.4.5.2 Nonhazardous Materials Piping

This category covers fluid piping, other than pressure piping or fire protection piping, that transfers fluids under pressure, by gravity, or that are open to the atmosphere. Pressure piping covers piping where the internal pressure is in excess of 15 psf; this category covers piping with pressures lower than 15 psf. The fluids in this category include drainage and ventilation piping, hot, cold, and chilled water piping; and piping carrying other nonhazardous liquids. These fluids, in case of line rupture, would cause property damage, but pose no immediate life safety danger. Like any other piping, failure of the pipes or pipe supports could results in falling hazards.

Provisions

BUILDING CODE PROVISIONS

Piping systems, including their supports, are 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 system from falling. Depending on the configuration of the piping, 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 piping from seismic bracing requirements in Seismic Design Category C if $I_p = 1.0$.
- ASCE/SEI 7-10 requires seismic design of piping in Seismic Design Categories D, E, and F that weighs more than 5 pounds per linear foot.
- Unbraced piping attached to in-line equipment must be provided with flexibility adequate to accommodate seismic relative displacements.
- ASCE/SEI 7-10 contains a number of bracing exemptions for suspended piping based on the pipe size and support conditions:
    - Trapeze assemblies are used to support piping whereby no single pipe exceeds the certain size limits and the total weight of the piping supported by the trapeze assemblies is less than 10 lb/ft.
    - Suspended piping where the hangers are less than 12 inches long. Rod hangers must be detailed to prevent bending of the rod.

- High-deformability or limited deformability piping (such as steel and copper pipe) where the pipe diameter is small (anywhere from 1- to 3-inch diameter depending on the building location and occupancy). Provisions must be made to accommodate anticipated movement (such as by providing flexible connections, as shown in Section 6.4.3.3) and to avoid impact with other structural or nonstructural components or to protect the piping in the event of such impact. Allowable stresses are provided in ASCE/SEI 7-10 for suspended pressure piping.

RETROFIT STANDARD PROVISIONS

ASCE/SEI 41-06, *Seismic Rehabilitation of Existing Buildings*, (ASCE, 2007) classifies suspended pressure piping as force controlled, meaning that the principal objective is to prevent piping from falling. Where piping runs between floors or crosses seismic joints it as also deformation controlled. Piping must meet the force and deformation requirements of the standard when the performance level is Immediate Occupancy, and the pipes are 2 inches or more in diameter and suspended more than 12 inches from the structure.

Typical Causes of Damage

- Nonhazardous fluid piping is sensitive to both acceleration and deformation. Vulnerable locations include joints, bends, connections to rigidly mounted equipment and risers subjected to significant relative movement between floors. These piping systems have failure modes common to all piping systems.
- Fluids may leak from damaged joints or broken pipe; water leakage has been a major source of damage in past earthquakes.
- Damage to any part of the piping system may compromise its functionality and connected equipment or systems may be disabled due to piping leaks or failures.

DAMAGE EXAMPLES

Figure 6.4.5.2-1 Broken copper hot water piping for at the San Carlos Hospital in the 2010 Chile Earthquake. Piping failure caused by movement of inadequately braced boiler shown at left (Photos courtesy of Gilberto Mosqueda, SUNY Buffalo).

Figure 6.4.5.2-2 Broken copper piping for hot water supply in residential building in the 2010 Chile Earthquake. Trapeze shown not laterally braced but hangers appear to be less than 12″ in length and may not have required lateral restraints per ASCE 7-10 (Photo courtesy of Gokhan Pekcan).

Figure 6.4.5.2-3 Photos displaying resilience of piping systems; this building suffered a partial structural collapse along one side in the 2010 Chile Earthquake. The only broken pipe (shown at lower right) was along the collapsed side; the other piping had broken pipe supports in some locations but the joints remained largely intact, even with these very large deformations (Photos courtesy of Eduardo Fierro, BFP Engineers).

Seismic Mitigation Considerations

- Seismic restraint details for pressure piping shown in Sections 6.4.3.1 through 6.4.3.8 can be adapted for use with fluid piping. The same types of suspended, wall-, floor-, or roof-mounted details also apply to these types of piping.
- Insulation must be coordinated with pipe supports; the presence of insulation or a protective sleeve between the pipe and the pipe strap or clamp may allow the pipe to slip longitudinally.
- Note that where a pipe carries water in a facility that uses magnesium, it should be treated the same as hazardous material piping due to the potentially violent reaction between some forms of magnesium and water.

MITIGATION EXAMPLES

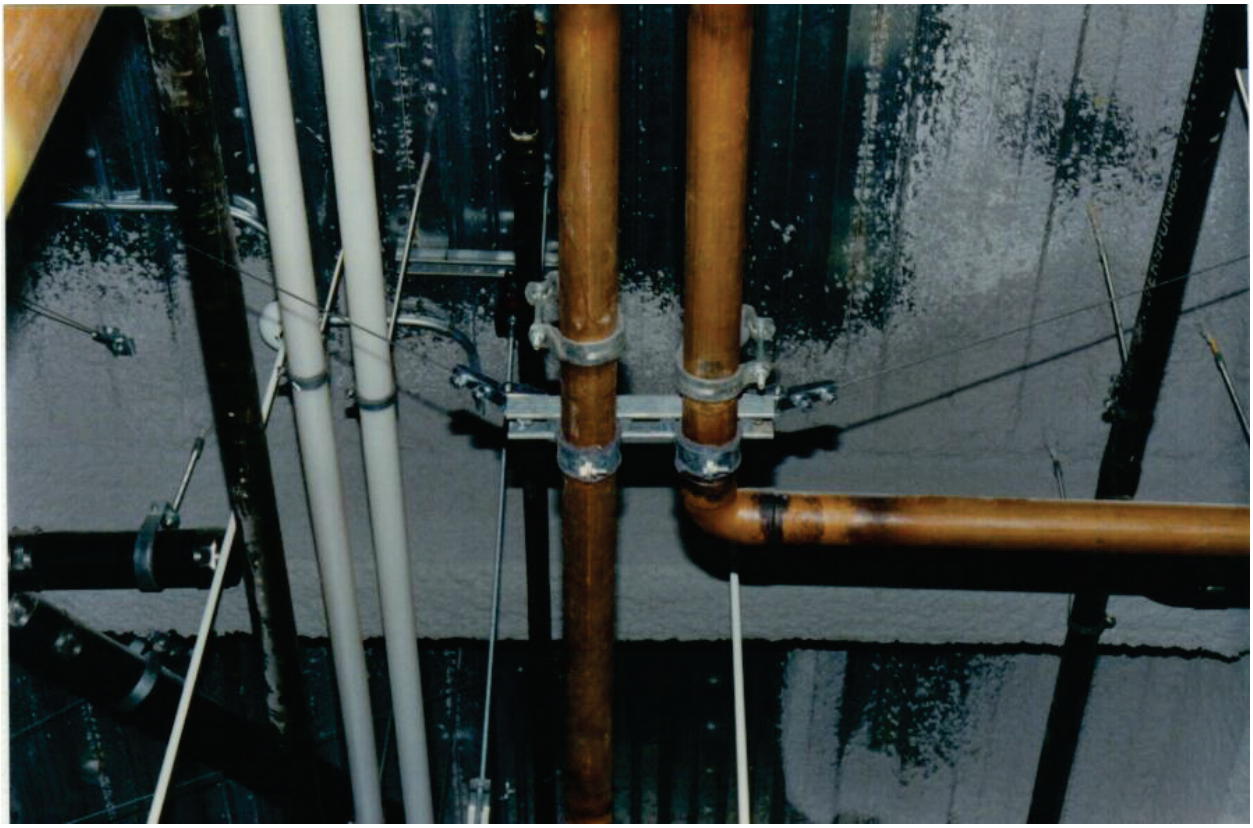

Figure 6.4.5.2-4 Cable bracing used to restrain overhead copper piping (Photo courtesy of Mason Industries).

Figure 6.4.5.2-5 Poor example of sanitary sewer pipe support installed in San Francisco Bay Area in 2010; strut clamp has inadequate edge distance to end of strut and could slip off the end (Photo courtesy of Cynthia Perry, BFP Engineers).

Figure 6.4.5.2-6 Piping installation in garage of mixed commercial/residential building San Francisco Bay Area completed in 2010. Note piping and trapeze supports do not have lateral restraints as all hangers were kept under 12″ in length; only the sprinkler lines were laterally restrained. (Photo courtesy of Cynthia Perry, BFP Engineers).