6.4 Mechanical, Electrical, and Plumbing Components

6.4.3 Pressure Piping

6.4.3.4 Pipe Risers

This category covers pipe risers for pressure piping, that is, vertical runs of pressurized piping such as those used in multistory buildings. Risers are typically supported by a combination of wall-mounted supports and additional floor-mounted or roof-mounted supports at the locations of penetrations. Due to their length, thermal movement may be an important consideration and seismic restraints must be designed to accommodate the anticipated inter-story drift and the thermal movement.

Provisions

BUILDING CODE PROVISIONS

Displacement demands for pipe risers are determined using ASCE/SEI 7-10, *Minimum Design Loads for Buildings and Other Structures*, (ASCE, 2010), Chapter 13. The objective is to provide sufficient capacity to accommodate the design building drifts without failure. The effects of story drifts must be considered in combination with displacements caused by other loads such as those due to thermal expansion. The required displacement capacity can be accomplished through pipe flexibility or connections with sufficient flexibility to avoid failure of the pipe.

RETROFIT STANDARD PROVISIONS

Pipe risers are considered deformation and acceleration sensitive in ASCE/SEI 41-06, *Seismic Rehabilitation of Existing Buildings*, (ASCE, 2007). Pipe risers running between floors must be capable of accommodating the required relative displacements. Detailed requirements depend upon the nature of the piping system. Refer to the discussions of different piping systems for more specific information.

Typical Causes of Damage

Pipe risers must be designed to accommodate inter-story drift between adjacent floors, that is, differential movement between the points of support located on different floors of the building. If the pipe supports are not designed to accommodate this movement during an earthquake, the supports may fail or the pipes or pipe joints may fail and leak. Improperly supported pipes can become dislodged and fall; unbraced risers can sway and impact adjacent items.

- Pipes are vulnerable at penetrations, thus floor and roof penetrations must be sufficiently oversized to prevent impact. Unrestrained movement of pipes at penetrations may damage the piping and pipe restraints but may also damage flooring, ceilings, partitions, insulation, fire-proofing or other architectural finishes. For insulated risers, the piping insulation may also be damaged if the pipe chafes at the restraint. If risers are mounted to lightweight partitions, the partitions may be damaged unless they have been designed and braced to resist the piping loads.
- Because risers often involve very long pipe runs, the thermal movement may be significant. Unless seismic restraints are designed to accommodate thermal movement, the piping, pipe joints or rigid seismic restraints could be damaged under operating conditions and fail to perform properly in an earthquake.
- Pipe risers in multistory buildings are typically located in utility shafts or pipe chases; thus, they usually do not pose a significant falling hazard to occupants but riser damage could cause significant leakage resulting in property losses and business outage.

DAMAGE EXAMPLES

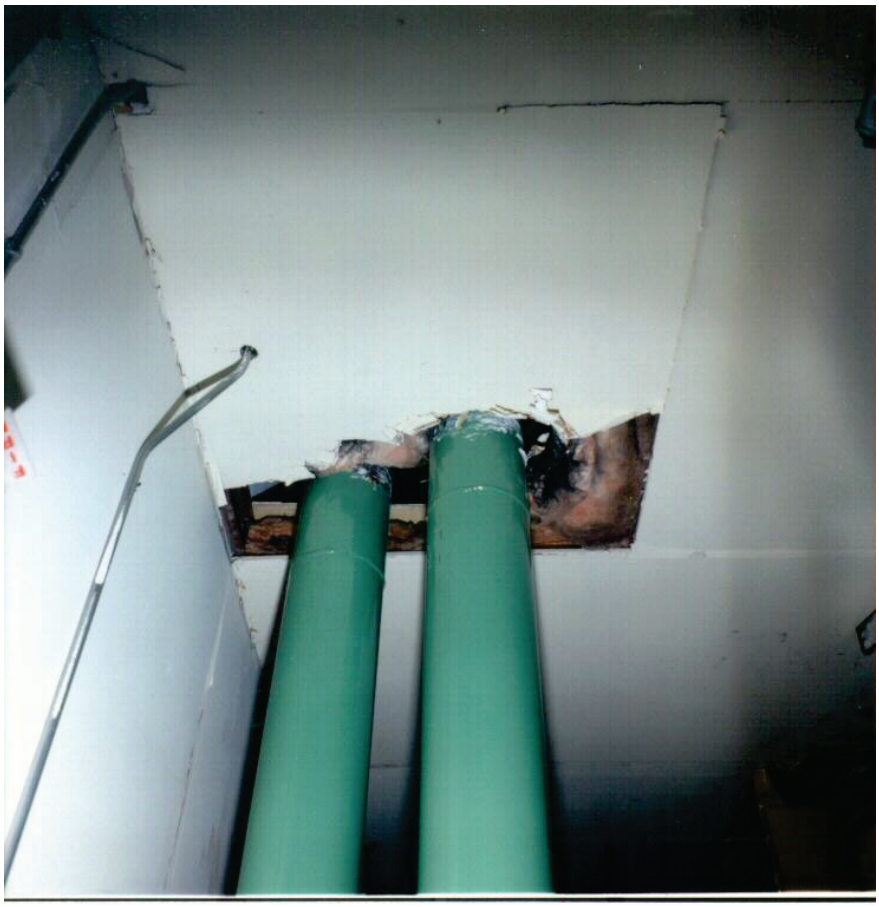

Figure 6.4.3.4-1 Movement of unbraced risers damaged ceiling finishes and insulation in the 1994 magnitude-6.7 Northridge Earthquake (Photo courtesy of Mason Industries).

Seismic Mitigation Considerations

- See the general discussion of pipe bracing in Section 6.4.3.1.
- It is usually preferable for pipe risers to be detailed to accommodate seismic relative displacements by means of pipe flexibility, or flexible supports where this is not possible. When the riser cannot accommodate seismic relative displacements by such means, connections having sufficient flexibility are needed. Flexible connections may be less desirable due to the need for greater maintenance.
- Standard steel pipe expands or contracts at a rate of 0.8 inch per 100 feet per 100 degrees Fahrenheit; supports and bracing for tall risers or piping subject to large temperature variations must be explicitly designed to accommodate thermal movement. Riser details for chilled water piping may need to accommodate additional insulation.

Riser calculations should be performed assuming the full weight of water is at the bottom of the pipe riser.

- Pipe risers require vertical support (longitudinal restraints) as well as lateral bracing. Risers are typically supported and braced by a combination of wall-mounted restraints and floor- or roof-mounted supports or guides at the locations of penetrations. They may also be supported by hangers located on horizontal branch lines within 24 inches of the centerline of the riser. Suspended support details are sometimes used at the top of the riser. The pipes may be rigidly mounted, for instance at the base of the riser, or mounted with elastomeric pads, sliding guides or vibration isolation. Specially designed riser clamps are often used to provide vertical support for pipe risers. Isolated piping should be supported independently from rigidly braced piping; rigid pipe attachments to lightweight walls may cause vibration problems under operating conditions.
- All vertical risers should have lateral restraints at the top and bottom of the riser and at each intermediate floor at a maximum spacing of 30 foot intervals. When installed as a riser, nonductile piping, such as no-hub cast iron piping, should include joint stabilizers where the joints are unsupported between floors.
- Pipe penetrations through structural elements such as beams, walls, and slabs must be coordinated with a structural engineer. Pipe penetrations through nonstructural walls, architectural finishes or roof membranes must be coordinated with an architect. Riser penetrations may require thermal insulation, fire proofing, sound proofing or weather proofing and unless properly detailed, these architectural and safety features may be compromised during an earthquake. See Section 6.4.3.8 for additional information about detailing pipe penetrations.

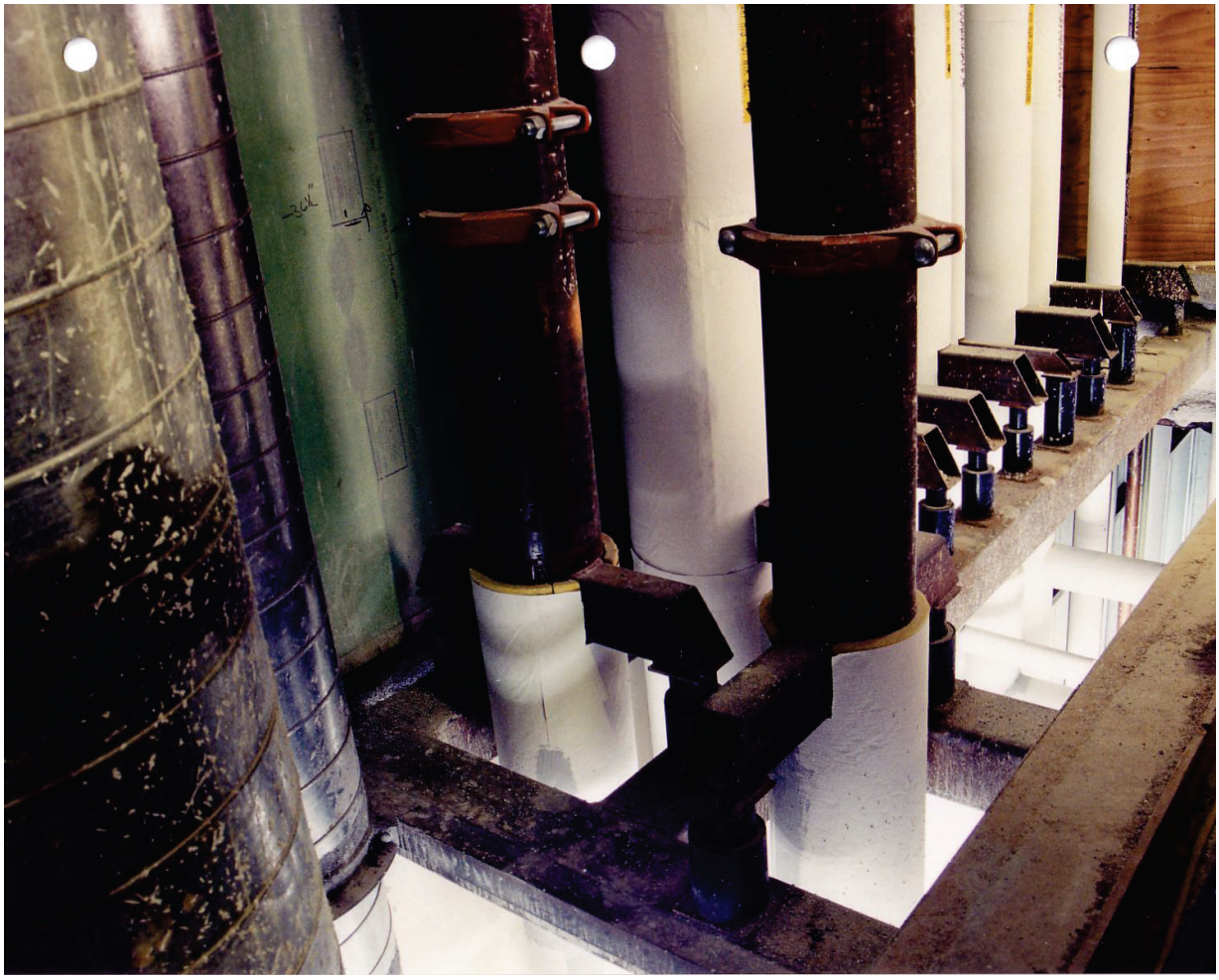

Figure 6.4.3.4-2 Riser supports provide lateral restraint with vertical sliding guides that allow thermal movement; restraint hardware consisting of tube sections is welded to either side of pipe (Photo courtesy of Mason Industries).

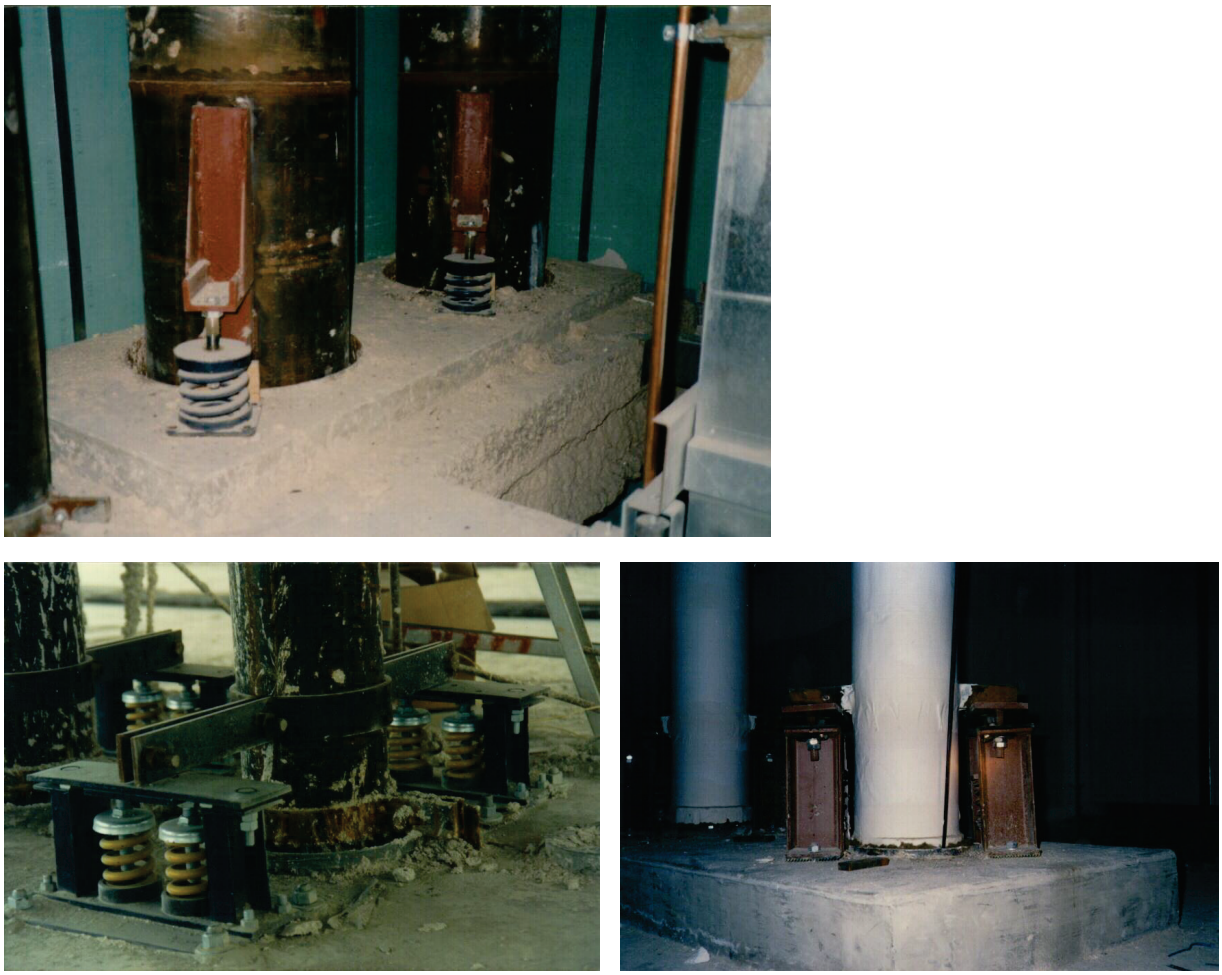

Figure 6.4.3.4-3 Different schemes for riser supports at floor penetrations with vibration isolation: first one with restraint hardware welded to pipe, second with two sets of riser clamps, and third with riser clamp inside the insulation (Photos courtesy of Mason Industries).

Figure 6.4.3.4-4 Insulated boiler pipe risers with welded lugs (small pipe sections) which travel vertically in guides providing lateral seismic restraint (Photo courtesy of Eduardo Fierro, BFP Engineers).

MITIGATION DETAILS

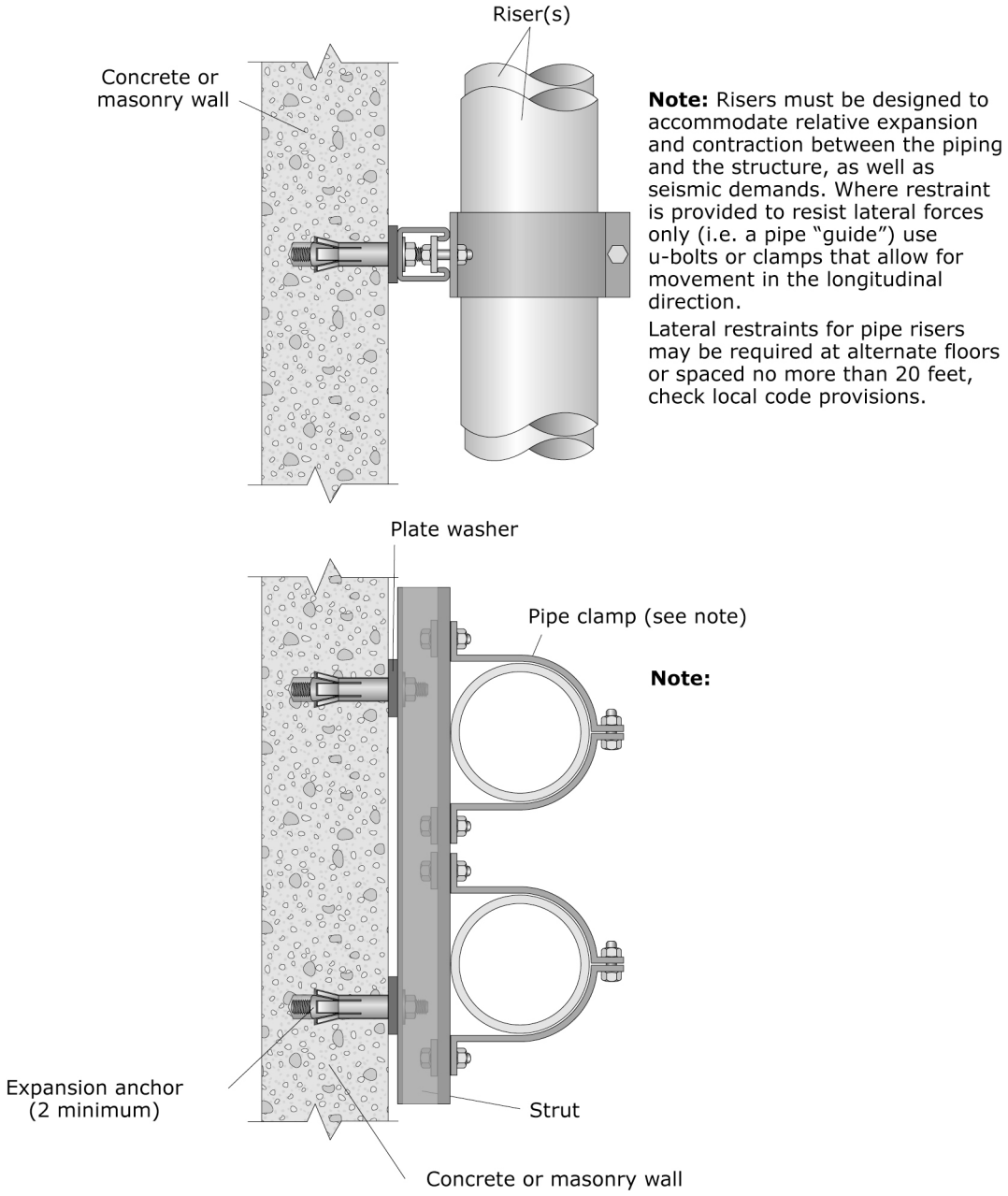

Figure 6.4.3.4-5 Wall-mounted pipe riser restraint/support (ER).

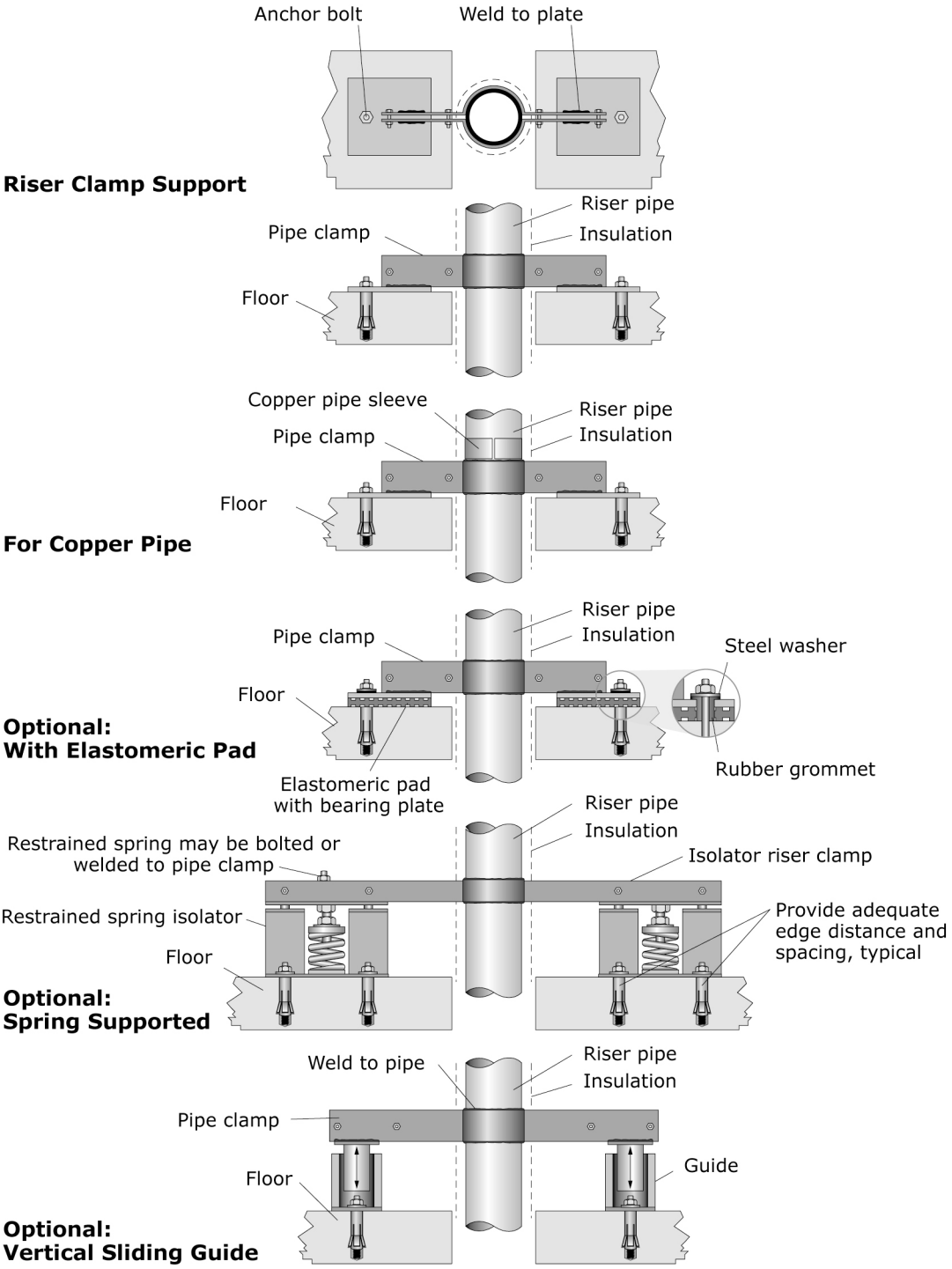

Figure 6.4.3.4-6 Riser restraint/support at floor penetrations – variations with pipe clamp, vibration isolation, and sliding guides (ER).

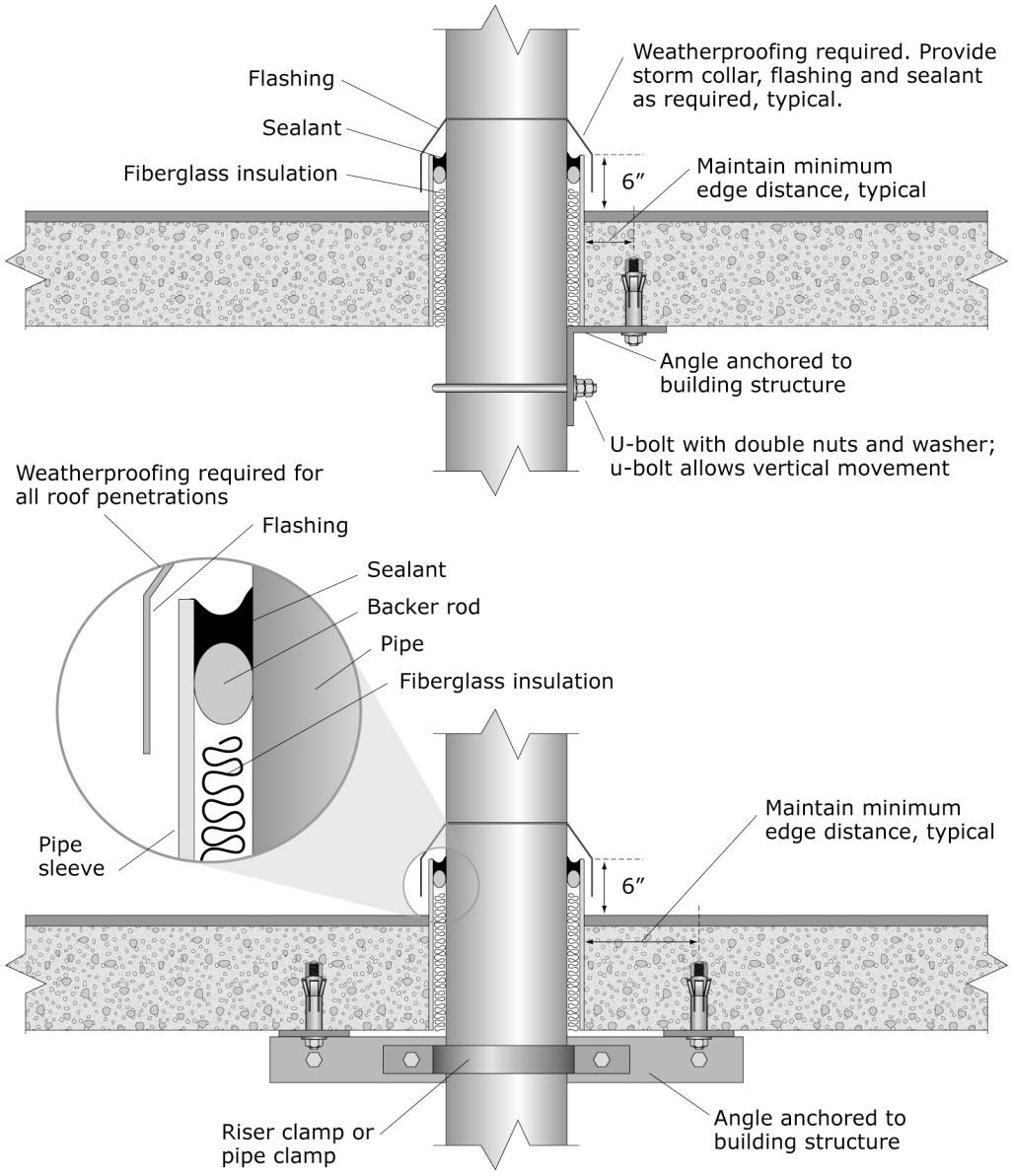

Figure 6.4.3.4-7 Riser restraint/support at roof penetration – variations with U-bolt or pipe clamp (ER).

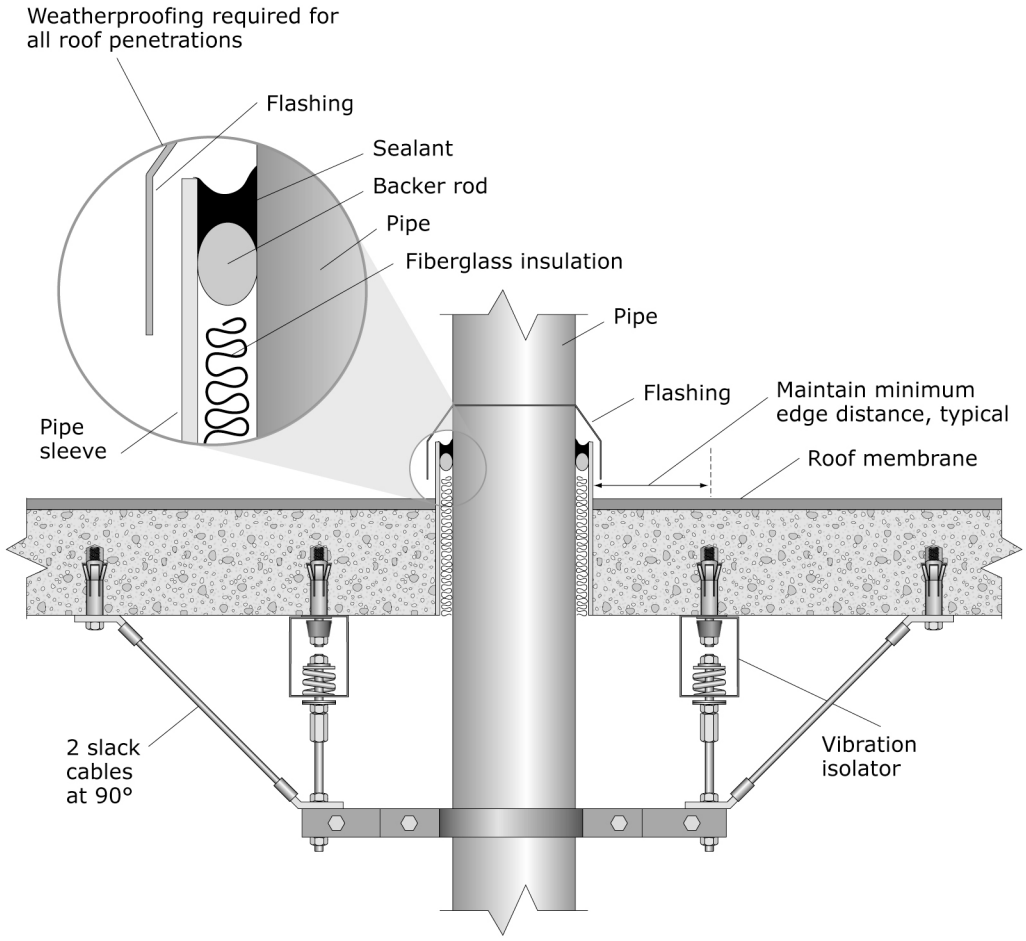

Figure 6.4.3.4-8 Roof penetration with vibration isolation (ER).