6.4 Mechanical, Electrical, and Plumbing Components

6.4.3 Pressure Piping

6.4.3.7 Wall-Mounted Supports

This category covers wall-mounted supports for pressure piping. Wall-mounted supports may be used to support either horizontal or vertical pipe runs, may be used with or without vibration isolation, and may be used either indoors or outdoors. Wall-mounted supports may be mounted flush or be built up out of assemblies of steel shapes anchored to structural framing or a structural wall.

Provisions

BUILDING CODE PROVISIONS

ASCE/SEI 7-10, *Minimum Design Loads for Buildings and Other Structures*, (ASCE, 2010), Chapter 13 classifies wall-mounted supports as "Component Supports". The design for component supports may be based on reference standards, proprietary systems, or calculated forces. When calculating seismic forces, the design coefficients for the supports are typically the same as those used for the piping. However, in no case should the value of R_p used for support design be greater than 6.0.

- 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 for all distribution systems including piping in Seismic Design Categories D, E, and F that weighs more than 5 pounds per linear foot.
- ASCE/SEI 7-10 exempts 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 Seismic Design Category 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.

The stiffness of the support should be designed to be compatible with its' intended function. For example, a relatively slender, flexible cantilever pipe support may not provide effective restraint for a stiff, large diameter steel pipe.

RETROFIT STANDARD PROVISIONS

The requirements for component supports in ASCE/SEI 41-06, *Seismic Rehabilitation of Existing Buildings*, (ASCE, 2007) depend on the type of piping system. Refer to the discussions of different distribution systems for more specific application information. Wall-mounted supports are acceleration sensitive, and when retrofit is required, they must meet the force requirements of the standard.

Typical Causes of Damage

- Failure of pipe supports may result in damage to the support in question, damage to adjacent supports which are overloaded due to the initial failure, damage to the piping or pipe joints, damage to insulation, leakage of the contents, and outage of the system that the pipes support.
- Joints may fail if the layout of the seismic restraints is poor or where the restraints are inadequate for the anticipated forces and displacements. Piping damage may occur at building separations or seismic joints if the piping has not been detailed to account for the differential movement. Wall-mounted piping often passes thru penetrations; piping may be vulnerable unless the penetrations are properly detailed.
- Several failure mechanisms exist for wall-mounted supports: failure at wall plate if anchorage is undersized, yielding of cantilever elements causing excessive deflection, and buckling of braced elements if braces are undersized. Piping attached to nonstructural walls or walls of insufficient strength may also result in damage to the wall or partition and the architectural finishes or fire-proofing.

DAMAGE EXAMPLES

Figure 6.4.3.7-1 Wall-mounted supports for horizontal and vertical pipe runs with exterior exposure. Photo shows minor damage at wall penetration of green pipe and minor movement at some U-bolts, but restraints generally performed well (Photo courtesy of Eduardo Fierro, BFP Engineers). Note that lateral restraint near an elbow can be used to provide longitudinal restraint for a perpendicular pipe run.

Figure 6.4.3.7-2 Pipe supports attached to wall of damaged silo (Photo courtesy of Eduardo Fierro, BFP Engineers). In spite of structural damage to silo, cast-in-place pipe supports were still intact and the piping did not fall.

Seismic Mitigation Considerations

- Horizontal and vertical pipe runs need vertical, lateral and longitudinal restraints. Wall-mounted supports can be used to provide restraint for any combination of these loads, can be designed for many different configurations, may be used with or without vibration isolation, and may be used either indoors or outdoors. Pipes may be mounted flush to the wall or offset; make sure to check that the wall or partition is capable of carrying the piping loads and will not develop vibration problems.
- If the pipe supports are vibration isolated, analysis is required to determine the appropriate seismic design force.
- Longitudinal restraints require positive support to the pipe with a pipe clamp or welded lug; U-bolts do not provide sufficient longitudinal restraint. For insulated piping, longitudinal restraint hardware may need to be located beneath the insulation in order to prevent longitudinal slip.
- In an existing concrete or masonry wall, care must be taken to locate rebar prior to drilling holes for anchor bolts so the rebar is not cut. Anchorage for isolated piping should be independent of anchorage for rigidly mounted pipe. In addition, some types of anchors are not recommended for use with vibratory loads. FEMA 414, Installing

Seismic Restraints for Duct and Pipe (2004), provides additional precautions regarding the installation of anchor bolts and general guidance on pipe restraints.

MITIGATION EXAMPLES

Figure 6.4.3.7-3 Wall-mounted pipe restraint examples using standard strut shapes and connectors (Photo courtesy of Cynthia Perry, BFP Engineers). Bottom view still under construction; pipes temporarily attached with plastic ties.

MITIGATION DETAILS

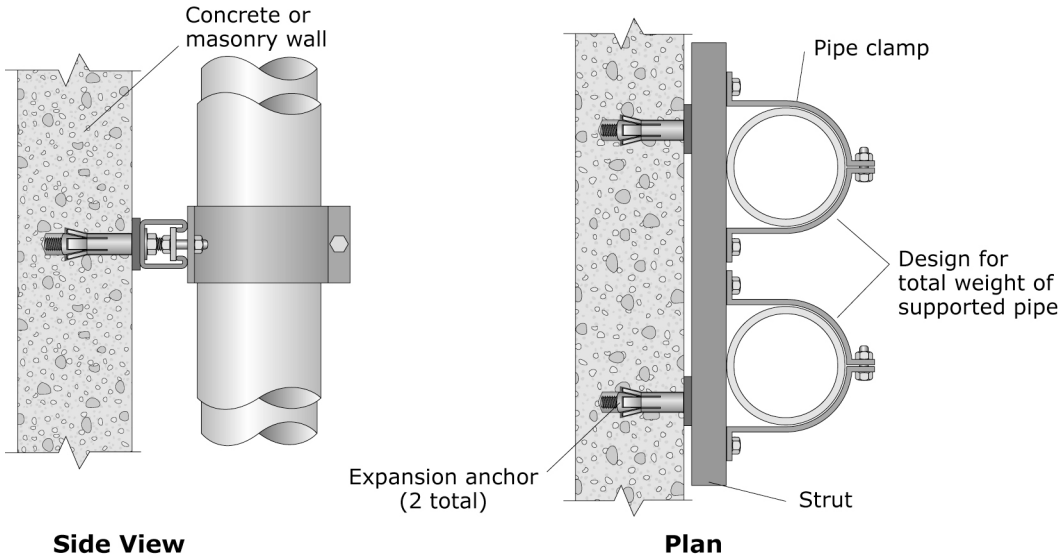

Figure 6.4.3.7-4 Surface-mount to structural wall (ER).

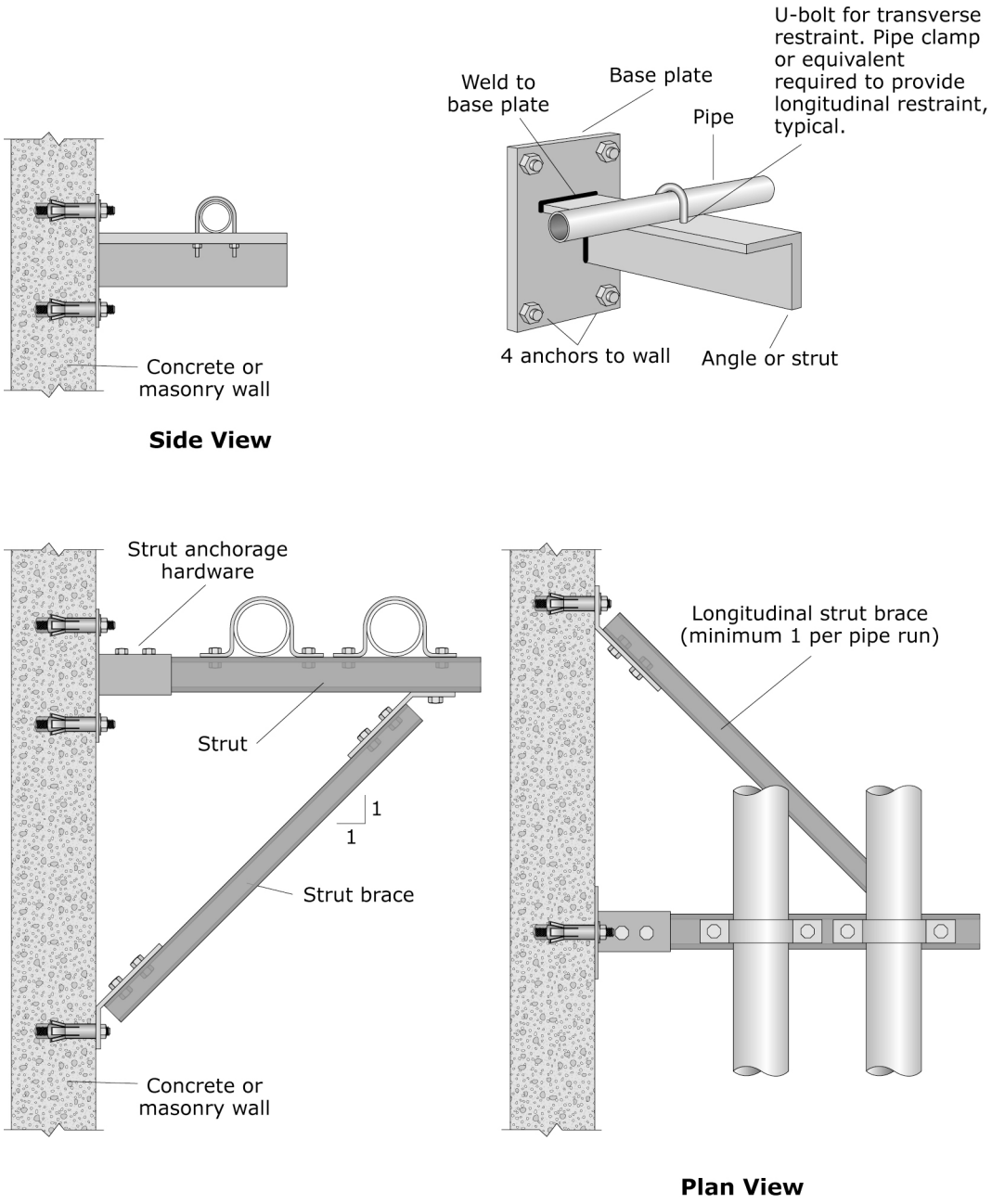

Figure 6.4.3.7-5 Wall-mount with steel shape or struts welded to concrete wall (ER).

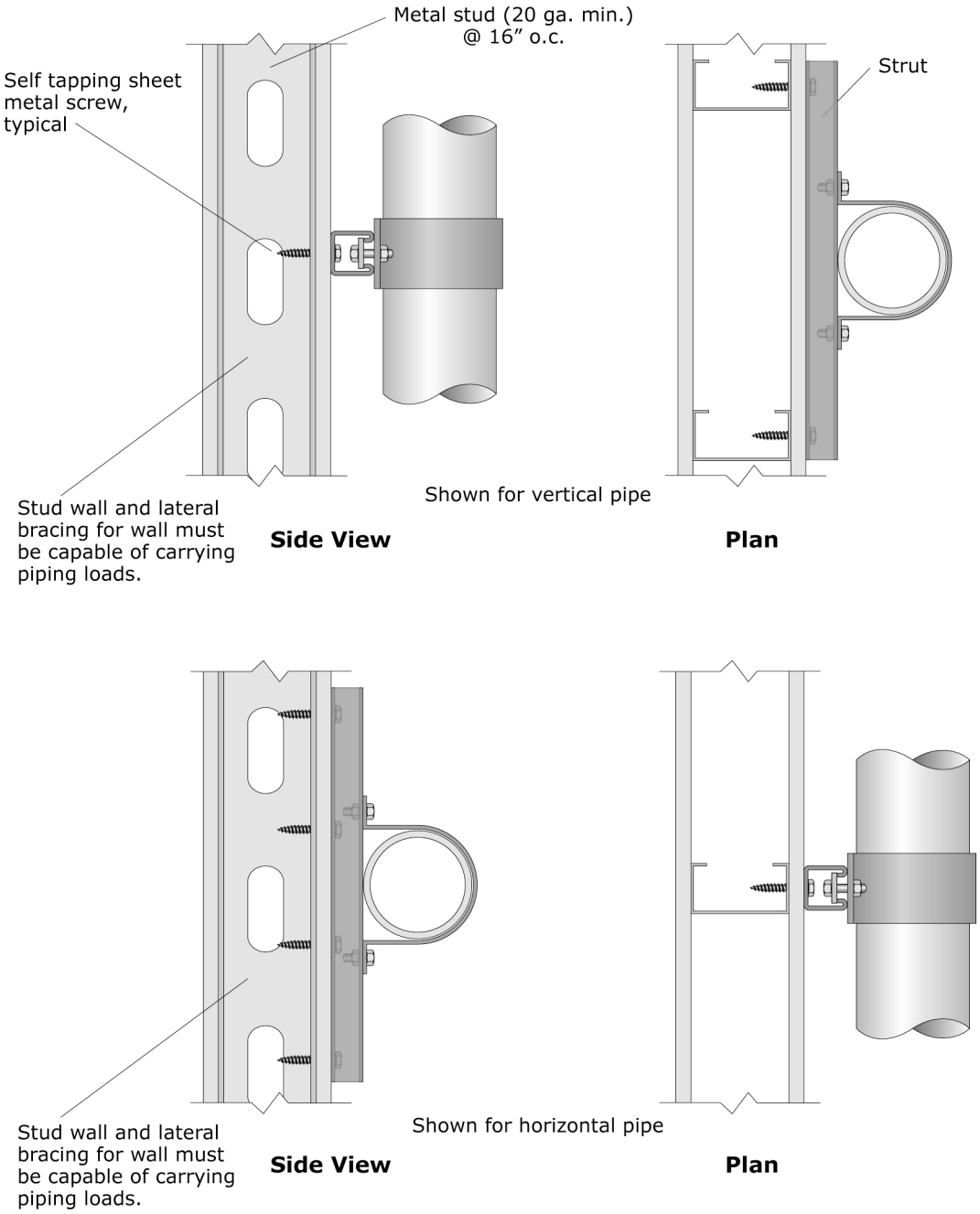

Figure 6.4.3.7-6 Wall-mount using strut channels to metal stud wall (ER).

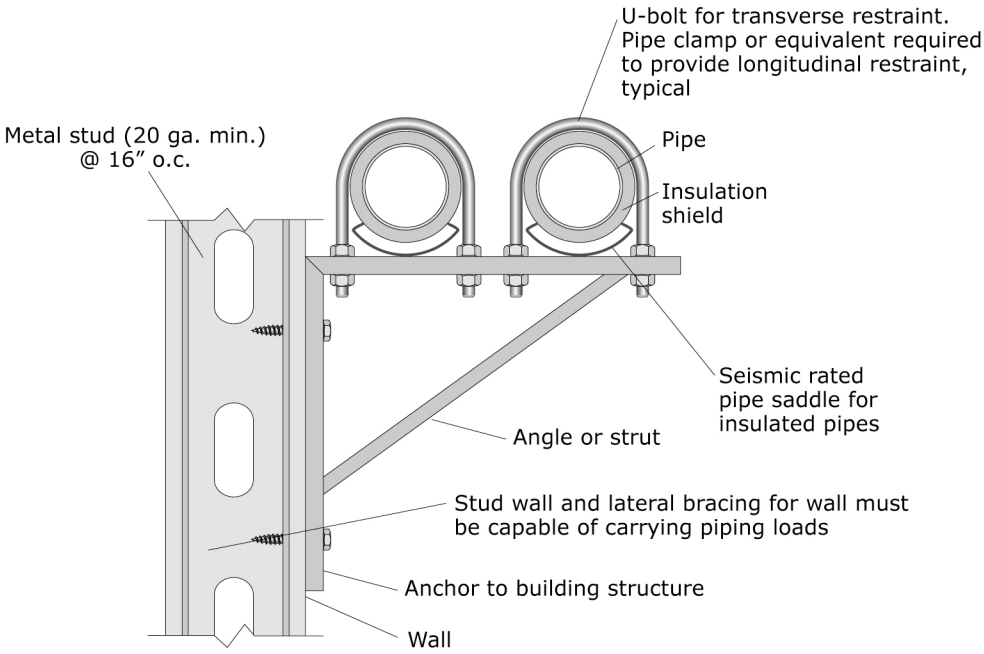

Figure 6.4.3.7-7 Wall-mount to stud wall with pre-manufactured brackets (ER).