6.4 MECHANICAL, ELECTRICAL, AND PLUMBING COMPONENTS

6.4.2 STORAGE TANKS AND WATER HEATERS

6.4.2.2 FLAT BOTTOM TANKS AND VESSELS

This category covers any type of flat bottom tank or vessel resting on a concrete pad at the base. These tanks may be made of steel, stainless steel, polyethylene, polypropylene, fiberglass reinforced plastic (FRP), or concrete.

TYPICAL CAUSES OF DAMAGE

- Unanchored tanks may slide or overturn; poorly anchored tanks may damage the hold down, damage the tank wall, and potentially slide or overturn.
- Connections of supply lines or fuel lines may be damaged; contents may slosh or spill.

Damage Examples

Figure 6.4.2.2-1 Damage to ductile connection at base of a 5000 cubic meter diesel fuel tank in the 2001 magnitude-8.4 Peru Earthquake. All eight connections were damaged; damage included bolt elongation, deformation of tank wall, and cracked concrete pad (Photo courtesy of Eduardo Fierro, BFP Engineers).

Figure 6.4.2.2-2 Tank with "elephant's foot" buckle at the base in the 1964 magnitude-9.2 Anchorage, Alaska earthquake (Photo courtesy of PEER, Steinbrugge Collection, No. S2508)

Figure 6.4.2.2-3 Tank with "elephant's foot" and "elephant knee" in Port-au-Prince in the 2010 magnitude-7 Haiti Earthquake (Photo courtesy of Eduardo Fierro, BFP Engineers).

Figure 6.4.2.2-4 Anchored tank damaged at base when anchorage failed; tank slid and ruptured attached piping in 2010 magnitude-8.8 Chile Earthquake (Photo courtesy of Eduardo Fierro, BFP Engineers).

SEISMIC MITIGATION CONSIDERATIONS

- Provide adequate connections around the base of the tank. Do not weld to tanks with flammable contents.
- Provide flexible connections for fuel lines and piping.
- The detail shown is for a rigid connection; larger tanks require ductile details such as those shown in Figure 6.4.2.2-1.

Mitigation Examples

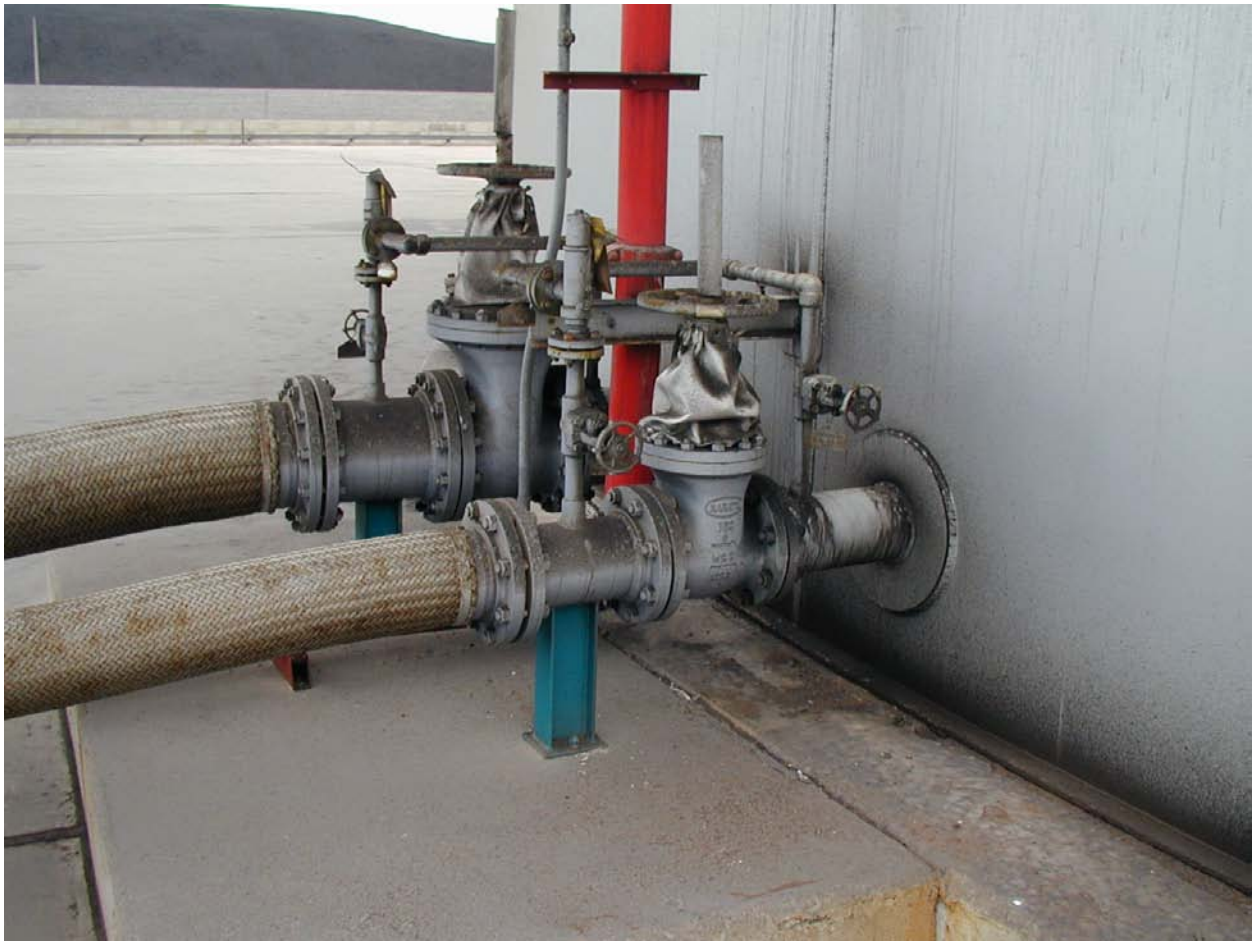

Figure 6.4.2.2-5 Flexible connections prevented piping damage in 2001 Peru Earthquake (Photo courtesy of Eduardo Fierro, BFP Engineers).

Figure 6.4.2.2-6 Anchors at base of fiberglass reinforced plastic tank (Photo courtesy of Jeffrey Soulages, Intel).

Figure 6.4.2.2-7 Examples of rigid base anchorage for small circular tanks (Photos courtesy of Maryann Phipps, Estructure).

Mitigation Details

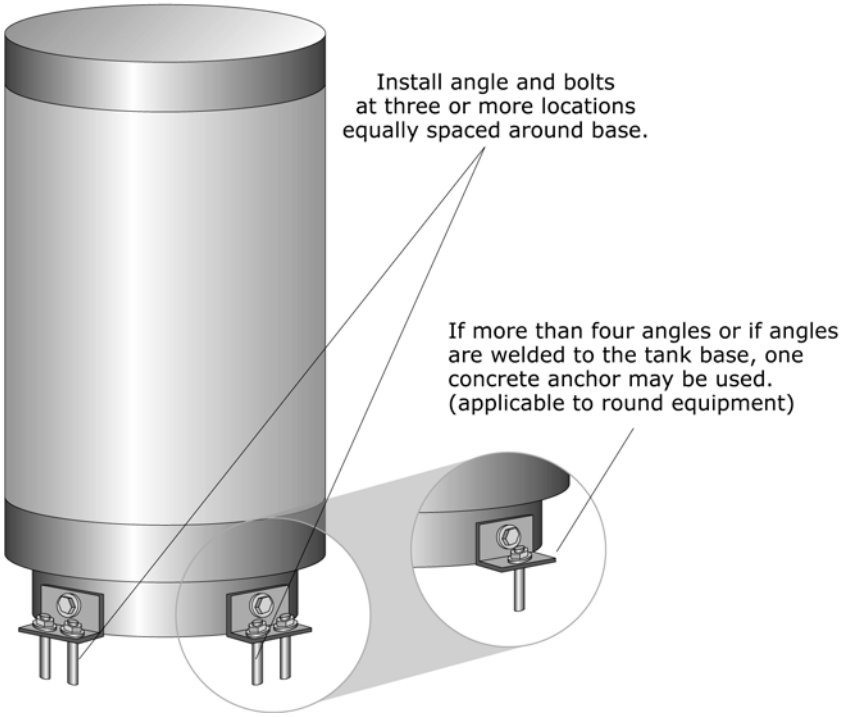

Figure 6.4.2.2-8 Flat bottom tank (ER).