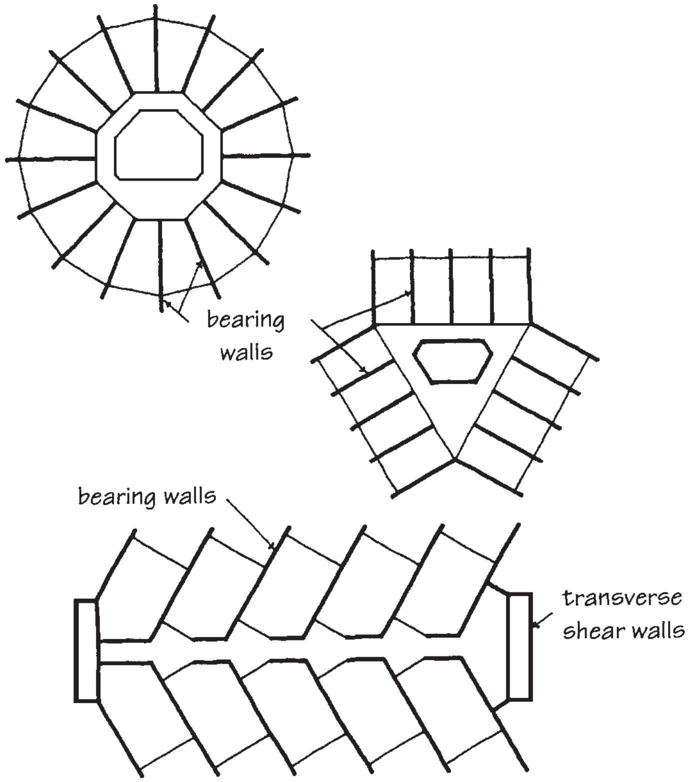

Figure 12-8 Examples of loadbearing walls oriented in multiple directions and functioning as shear walls to resist lateral loads in those directions.

inadequate connections. When the various elements of a structure are rigidly connected to one another and one element is deflected by a force, the other elements must move equally at the point of connection or failure will occur somewhere in the system.

Analysis of the damage to masonry walls caused by earthquake stress shows that cracks in shear walls typically follow a diagonal path. The plane of failure extends from near the top corner, where the maximum load is applied, diagonally downward toward the bottom support (*see Fig. 12-10*). This is the same mode of failure produced by diagonal tension or racking tests, in which 4 × 4-ft masonry panels are subjected to diagonal loading at opposing corners. Shear strength at the joints is independent of unit properties such as initial rate of absorption, but it is affected by mortar type, compressive strength, and workmanship. Since the failure is in tension, masonry with weak mortar bond also has low diagonal tensile or shear strength. Failure, however, occurs without explosive popping or spalling of unit faces. The steel reinforcement holds the wall together after a shear failure to prevent the panel from separating after joint cracking occurs. This stability under maximum stress prevents catastrophic structural failure and increases the factor of safety in the aftermath of seismic disturbances.

Where masonry is used as non-loadbearing infill panels in steel or concrete frame structures, this diagonal shear strength increases the building's lateral stiffness (*see Fig. 12-11*). In the 1985 Mexico City earthquake, medium- and high-rise reinforced concrete frame structures with masonry infill performed much better than similar buildings without masonry infill. Even

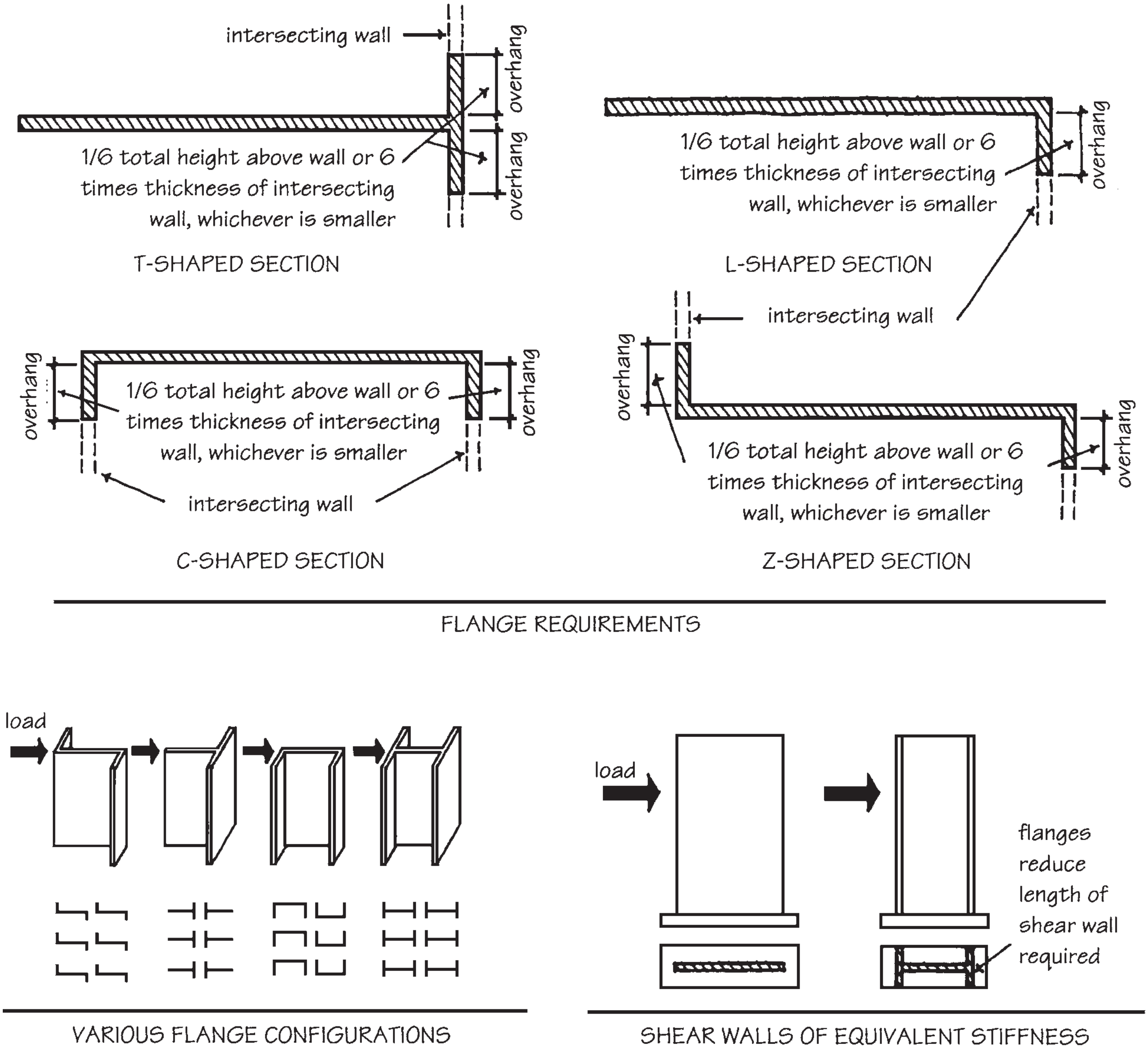

Figure 12-9 Shear walls with flanges. (*From Brick Industry Association,* Technical Note 24C, *BIA, Reston, VA*; *and National Concrete Masonry Association,* Design Manual—The Application of Non-Reinforced Concrete Masonry Load-Bearing Walls in Multistory Structures, *NCMA, Herndon, VA.*)

when the infill panels served only as a backup for veneer systems and were not designed as structural elements, were not reinforced, and were not correctly anchored to the surrounding frames, they absorbed large amounts of seismic energy, and in many cases apparently prevented structural collapse. When infilling was omitted in lower stories to provide access to retail businesses, the buildings proved more susceptible to damage at the lower levels. Corner buildings in which the masonry infill was omitted on two sides for retail access suffered severe damage. Investigators also found masonry infill panels to have increased the strength and resistance of nearby buildings when the World Trade Center Buildings collapsed after the terrorist attacks. Many buildings, including older and historic structures, withstood the