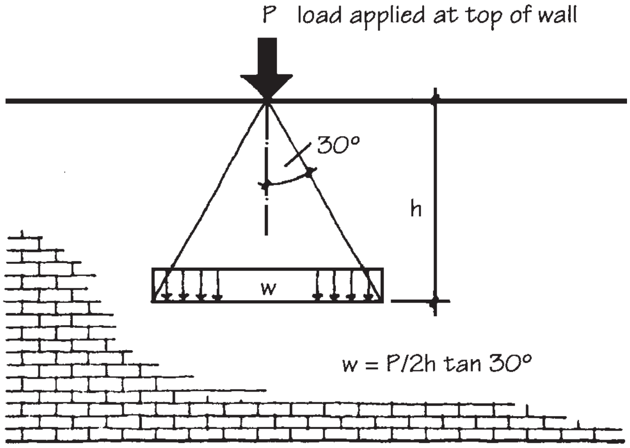

Figure 12-3 Axial load distribution in masonry laid in running bond patterns. (*From BIA,* Recommended Practice for Engineered Brick Masonry.)

ute concentrated load stresses and to permit any slight differential lateral movement which might occur. When a joist, beam, or girder bears directly on a masonry wall, the reaction will not generally occur in the center of the bearing area because deflection of the bearing member moves the reaction toward the inner face of the support. If significant eccentricity develops, the addition of reinforcing steel may be required to resist the tensile bending stresses which result. Multi-wythe walls may be designed with composite or non-composite action between the wythes (*see Fig. 12-4*).

12.1.2 Lateral Load Distribution

Skeleton frame systems transfer lateral loads from wind and seismic forces through rigid connections at column and beam intersections, and through diagonal bracing. This results in a concentration of stresses at joints in the frame and at the foundation. In a bearing wall system, or box frame, the structural floors and walls constitute a series of intersecting planes with the resulting forces acting along continuous lines rather than at intermittent points. The use of masonry in multi-story loadbearing applications is dependent on the cohesive action of the structure as a whole. Floor and roof framing systems must be sufficiently rigid to function as horizontal diaphragms transferring lateral loads to shear walls without excessive in-plane deflection.

Seismic forces are caused by a stress buildup within the earth's crust. An earthquake is the sudden relief of this stress and consequent shifting of the earth mass along an existing fault plane. Primary vibration waves create a push–pull effect on the ground surface. Secondary waves traveling at about half the speed of the primary set up transverse movements at right angles to the first shock. Structures may experience severe lateral dynamic loading under such conditions, and must be capable of absorbing this energy and withstanding the critical temporary loading of seismic ground motion.

Framing systems designed to withstand seismic and high wind loads may be either *flexible structures* with low damping characteristics, such as concrete and steel frame buildings, or *rigid structures* with high damping, such as masonry buildings.

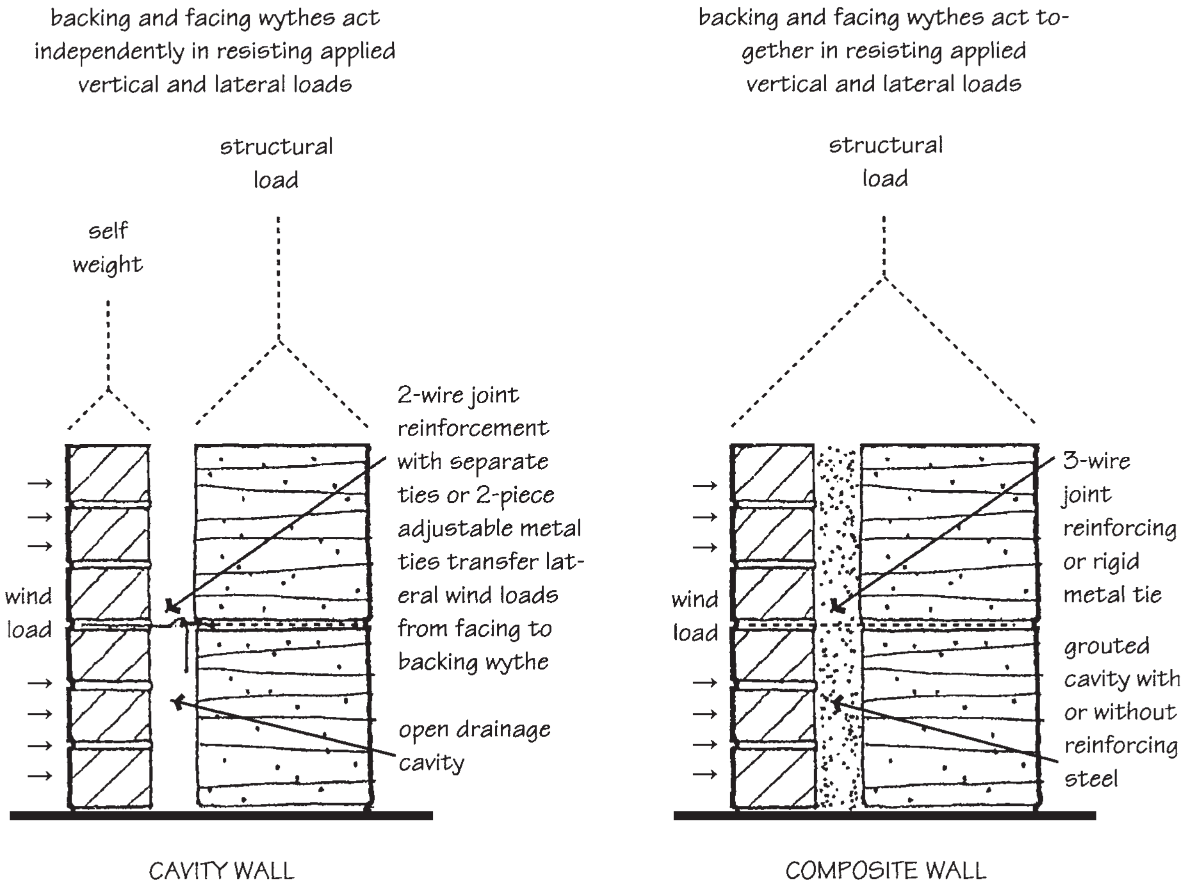

Figure 12-4 Load distribution in multi-wythe masonry walls.

Damping is the ability of a structure to diminish its amplitude of vibration with time through dissipation of energy by internal frictional resistance. It is generally recognized that structural response to earthquake motion is influenced by the building's fundamental period of vibration (the time it takes to complete its longest cycle of vibration). Low-rise masonry buildings typically have fundamental periods of vibration of 0.3 second or less, compared to 0.6 second for low-rise flexible frame buildings. The damping effect of masonry construction and its resulting low period of vibration accounted for good performance of many low-rise masonry buildings in the 1985 Mexico City earthquake, which registered 8.1 on the Richter scale. The soft clay soil under the city caused long-lasting ground motions with long periods of vibration. Such movements collapsed many buildings of 5 to 20 stories in height that had long periods of vibration in the same range as those of the ground motion. Base motions were greatly amplified in the upper stories of these buildings because the similar periods of vibration set up a condition of resonance. Rigid, low-rise masonry structures, however, including many unreinforced historic structures, suffered little damage.

Different soil and rock conditions produce different periods of ground motion, but the capacity of masonry structures to absorb seismic energy through damping is such that unit stresses remain extremely low, factors of safety very high, and damage negligible.