The axial load on basement walls is usually transmitted eccentrically at some point between the centerline of the wall and the inner surface, thus inducing a bending moment. Additional moment is induced at any point where flexural members are restrained by their connection to the wall. These moments tend to counteract the bending moments from lateral earth pressures at the exterior face. In other words, vertical compressive loads are effective in reducing the tensile stresses developed in resisting lateral loads. In this regard, it is important to remember that only dead loads may be safely considered as opposing lateral bending stresses, since live loads may be intermittent. Precautions must also be taken in construction scheduling to ensure that the amount of dead load calculated for such resistance is actually present before the lateral load is applied. If early backfill is unavoidable, temporary bracing must be provided to prevent actual stresses from exceeding those assumed in the design.

Other loads applied to below-grade walls may be variable, transient, or moving, such as surcharge, wind, snow, earthquake, or impact forces. The pressures from wind that ordinarily affect basement and foundation walls are those transmitted indirectly through the superstructure: compressive, uplift, shearing, or racking loads. Stresses developed in resisting overturning are not often critical except for lightweight structures subject to high wind loads, or for structures having a high ratio of exposed area to depth in the direction of wind flow. Analytical design procedures may be used to analyze and calculate such forces so that the masonry structure will adequately resist all applied loads and induced stresses.

13.2.2 Unreinforced Walls

Unreinforced masonry basement walls may be designed by the empirical or analytical procedures described in Chapter 12. Empirical requirements in some codes include only minimum wall thickness, height limitations, and height- or length-to-thickness ratios which dictate column or pilaster spacing (*see Fig. 13-7*). In the *International Residential Code*, minimum wall thickness and unbalanced fill height are also tied to soil type (*see Fig. 13-8*). Using analytical design, exact load determinations will dictate spacing of pilasters or placement of reinforcing at critical locations. Compressive and flexural strength, slenderness coefficients, and eccentricity ratios are all considered in the analysis, and the wall is designed for safety and efficiency.

13.2.3 Reinforced Walls

If unreinforced masonry walls are not adequate to resist the anticipated service loads, reinforced walls can be designed to accommodate higher compressive and flexural stresses. Reinforced walls are analytically designed so that the steel reinforcement resists flexural stresses higher than those permitted for unreinforced walls. A detailed structural analysis will determine exact requirements and criteria for reinforcement. For residential foundations, the *International Residential Code* provides tables of minimum reinforcing requirements which may be used in lieu of engineering analysis for 8-in., 10-in., and 12-in.-thick walls (*see Figs. 13-9 through 13-11*).

13.2.4 Footings

Some general rules of thumb may be applied to the preliminary design of footings for below-grade masonry walls: (1) cast-in-place concrete should have a

MSJC Code Requirements for Minimum Masonry Foundation Wall Thickness for Empirically Designed Masonry		
Foundation Wall Construction	Min. Nominal Thickness (in.)	Maximum Depth of Unbalanced Backfill (ft.)
Ungrouted hollow masonry units	8	5
	10	6
	12	7
Solid masonry units	8	5
	10	7
	12	7
Hollow or solid masonry units fully grouted	8	7
	10	8
	12	8

MSJC Code Empirical Span-to-Thickness Ratios for Lateral Support of Masonry Foundation Walls	
Wall or Element	Maximum Unsupported Height or Length to Nominal Thickness (*l/t* or *h/t*)
Bearing walls	
solid or grouted solid	20
all other walls	18
Non-bearing walls, exterior	18

Figure 13-7 MSJC empirical design requirements for masonry foundation walls. (*From MSJC* Building Code Requirements for Masonry Structures, *ACI 530/ASCE 5/TMS 402.*)

minimum compressive strength of 2500 psi, (2) footing depth should be equal to the wall thickness and footing width equal to twice the wall thickness (*see Fig. 13-12*), and (3) the bottom of the footing should be placed in undisturbed soil below the frost line. For residential construction, the *International Residential Code* prescribes minimum dimensions (*see Fig. 13-12*). Allowable soil bearing pressure, of course, must be checked against actual loads in the final design.

13.2.5 Drainage and Waterproofing

Proper drainage and waterproofing of below-grade walls is essential, not only to prevent build-up of hydrostatic pressure, but also to maintain dry conditions and eliminate dampness in interior spaces. *Figures 13-13 and 13-14* show some typical methods of waterproofing masonry basement walls.

Damp or wet conditions in basements can be caused by vapor diffusion through the walls or by condensation of moist air inside the space. Condensation will occur anytime the surface temperature of the wall is below the dew-point temperature of the interior air. Condensation can usually be controlled by increasing ventilation or by the proper location and installation of vapor retarders and wall insulation (see Chapters 8 and 19). *Figure 13-15* shows how soil moisture vapor can be blocked out using materials with low vapor permeance on the outside of the walls and below the basement slab.