jurisdiction for specific requirements related to obstructions, enclosures, and breakaway walls.

Where breakaway walls are used, they must meet the prescriptive requirements of NFIP regulations or be certified by a registered professional engineer or architect as having been designed to meet the NFIP performance requirements. The prescriptive requirements call for breakaway wall designs that are intended to collapse at loads not less than 10 psf (0.48 kN/m^2) and not more than 20 psf (0.96 kN/m^3). Inasmuch as wind or earthquake loads often exceed 20 psf (0.96 kN/m^2), breakaway walls may be designed for higher loads, provided the designer certifies that the walls have been designed to break away before base flood conditions are reached, without damaging the elevated building or its foundation. A reference (FEMA 1999a) provides guidance on how to meet the performance requirements for certification.

C5.4.1 Load Basis

Water loads are the loads or pressures on surfaces of buildings and structures caused and induced by the presence of floodwaters. These loads are of two basic types: hydrostatic and hydrodynamic. Impact loads result from objects transported by floodwaters striking against buildings and structures or parts thereof. Wave loads can be considered a special type of hydrodynamic load.

C5.4.2 Hydrostatic Loads

Hydrostatic loads are those caused by water either above or below the ground surface, free or confined, which is either stagnant or moves at velocities less than 5 ft/s (1.52 m/s). These loads are equal to the product of the water pressure multiplied by the surface area on which the pressure acts.

Hydrostatic pressure at any point is equal in all directions and always acts perpendicular to the surface on which it is applied. Hydrostatic loads can be subdivided into vertical downward loads, lateral loads, and vertical upward loads (uplift or buoyancy). Hydrostatic loads acting on inclined, rounded, or irregular surfaces may be resolved into vertical downward or upward loads and lateral loads based on the geometry of the surfaces and the distribution of hydrostatic pressure.

C5.4.3 Hydrodynamic Loads

Hydrodynamic loads are those loads induced by the flow of water moving at moderate to high velocity above the ground level. They are usually lateral loads caused by the impact of the moving mass of water and the drag forces as the water flows around the obstruction. Hydrodynamic loads are computed by recognized engineering methods. In the coastal high-hazard area the loads from high-velocity currents due to storm surge and overtopping are of particular importance. U.S. Army Corps of Engineers (2002) is one source of design information regarding hydrodynamic loadings.

Note that accurate estimates of flow velocities during flood conditions are very difficult to make, both in riverine and coastal flood events. Potential sources of information regarding velocities of floodwaters include local, state, and federal government agencies and consulting engineers specializing in coastal engineering, stream hydrology, or hydraulics.

As interim guidance for coastal areas, FEMA (2000) gives a likely range of flood velocities as

$$V = d_s/(1\ \text{s}) \qquad \text{(C5-1)}$$

to

$$V = (gd_s)^{0.5} \qquad \text{(C5-2)}$$

where

V = average velocity of water in ft/s (m/s)
d_s = local stillwater depth in ft (m)
g = acceleration due to gravity, 32.2 ft/s/s (9.81 m/s^2)

Selection of the correct value of a in Eq. 5-1 will depend upon the shape and roughness of the object exposed to flood flow, as well as the flow condition. As a general rule, the smoother and more streamlined the object, the lower the drag coefficient (shape factor). Drag coefficients for elements common in buildings and structures (round or square piles, columns, and rectangular shapes) will range from approximately 1.0 to 2.0, depending upon flow conditions. However, given the uncertainty surrounding flow conditions at a particular site, ASCE 7-05 recommends a minimum value of 1.25 be used. Fluid mechanics texts should be consulted for more information on when to apply drag coefficients above 1.25.

C5.4.4 Wave Loads

The magnitude of wave forces (lb/ft^2) (kN/m^2) acting against buildings or other structures can be 10 or more times higher than wind forces and other forces under design conditions. Thus, it should be readily apparent that elevating above the wave crest elevation is crucial to the survival of buildings and other structures. Even elevated structures, however, must be designed for large wave forces that can act