over a relatively small surface area of the foundation and supporting structure.

Wave load calculation procedures in Section 5.4.4 are taken from U.S. Army Corps of Engineers (2002) and Walton et al. (1989). The analytical procedures described by Eqs. 5.4-2 through 5.4-9 should be used to calculate wave heights and wave loads unless more advanced numerical or laboratory procedures permitted by this standard are used.

Wave load calculations using the analytical procedures described in this standard all depend upon the initial computation of the wave height, which is determined using Eqs. 5.4-2 and 5.4-3. These equations result from the assumptions that the waves are depth-limited and that waves propagating into shallow water break when the wave height equals 78 percent of the local stillwater depth and that 70 percent of the wave height lies above the local stillwater level. These assumptions are identical to those used by FEMA in its mapping of coastal flood hazard areas on FIRMs.

Designers should be aware that wave heights at a particular site can be less than depth-limited values in some cases (e.g., when the wind speed, wind duration, or fetch is insufficient to generate waves large enough to be limited in size by water depth, or when nearby objects dissipate wave energy and reduce wave heights). If conditions during the design flood yield wave heights at a site less than depth-limited heights, Eq. 5-2 may overestimate the wave height and Eq. 5-3 may underestimate the stillwater depth. Also, Eqs. 5-4 through 5-7 may overstate wave pressures and forces when wave heights are less than depth-limited heights. More advanced numerical or laboratory procedures permitted by this section may be used in such cases, in lieu of Eqs. 5-2 through 5-7.

It should be pointed out that present NFIP mapping procedures distinguish between A Zones and V Zones by the wave heights expected in each zone. Generally speaking, A Zones are designated where wave heights less than 3 ft (0.91 m) in height are expected. V Zones are designated where wave heights equal to or greater than 3 ft (0.91 m) are expected. Designers should proceed cautiously, however. Large wave forces can be generated in some A Zones, and wave force calculations should not be restricted to V Zones. Present NFIP mapping procedures do not designate V Zones in all areas where wave heights greater than 3 ft (0.91 m) can occur during base flood conditions. Rather than rely exclusively on flood hazard maps, designers should investigate historical flood damages near a site to determine whether or not wave forces can be significant.

C5.4.4.2 Breaking Wave Loads on Vertical Walls

Equations used to calculate breaking wave loads on vertical walls contain a coefficient, C_p. Walton et al. (1989) provides recommended values of the coefficient as a function of probability of exceedance. The probabilities given by Walton et al. (1989) are not annual probabilities of exceedance, but probabilities associated with a distribution of breaking wave pressures measured during laboratory wave tank tests. Note that the distribution is independent of water depth. Thus, for any water depth, breaking wave pressures can be expected to follow the distribution described by the probabilities of exceedance in Table 5-2.

This standard assigns values for C_p according to building category, with the most important buildings having the largest values of C_p. Category II buildings are assigned a value of C_p corresponding to a 1 percent probability of exceedance, which is consistent with wave analysis procedures used by FEMA in mapping coastal flood hazard areas and in establishing minimum floor elevations. Category I buildings are assigned a value of C_p corresponding to a 50 percent probability of exceedance, but designers may wish to choose a higher value of C_p. Category III buildings are assigned a value of C_p corresponding to a 0.2 percent probability of exceedance, while Category IV buildings are assigned a value of C_p corresponding to a 0.1 percent probability of exceedance.

Breaking wave loads on vertical walls reach a maximum when the waves are normally incident (direction of wave approach perpendicular to the face of the wall; wave crests are parallel to the face of the wall). As guidance for designers of coastal buildings or other structures on normally dry land (i.e., flooded only during coastal storm or flood events), it can be assumed that the direction of wave approach will be approximately perpendicular to the shoreline. Therefore, the direction of wave approach relative to a vertical wall will depend upon the orientation of the wall relative to the shoreline. Section 5.4.4.4 provides a method for reducing breaking wave loads on vertical walls for waves not normally incident.

C5.4.5 Impact Loads

Impact loads are those that result from logs, ice floes, and other objects striking buildings, structures, or parts thereof. U.S. Army Corps of Engineers (1995) divides impact loads into three categories: (1) normal impact loads, which result from the isolated impacts of normally encountered objects, (2) special impact loads, which result from large objects, such as broken up ice floats and accumulations of debris,