Table 2.1 Perpendicular Wind Speed Versus Average Pressure on Surface

Wind Speed ft/sec	Resulting Pressure lbf/sq ft
10	0.23
20	0.93
30	2.10
40	3.73
50	5.83
60	8.39
70	11.4
80	14.9
90	18.9
100	23.3
120	33.6
150	52.4

By solving Equation (iii) for a number of wind speeds, Table 2.1 is generated. The table shows the relationship between a wind impinging perpendicularly on a flat surface and coming to a complete stop, and the resulting average pressure on that surface.

In practice, the pressure numbers generated by Equation (iii) and listed in Table 2.1 are higher than that actually encountered. This is because the wind does not fully impact the wall and then bounce off at a negligible speed, as was assumed. What actually occurs is that a portion of the wind "parts" or diverts from the flow and smoothly flows over and away from the wall without actually slamming into it, as is depicted in Figure 2.1. Therefore, to be more accurate, Equation (ii) can be modified as follows.

$$P = k\rho(v_1^2 - v_2^2) \text{ or } = C\rho(v_1^2) \qquad \text{(iv)}$$

where P = average pressure on vertical wall, k = units conversion factor, ρ = density of air, about 0.0023 slugs/ft^3, v_1 = average velocity of air flow as it approaches wall, v_2 = average velocity of air flow as it departs wall, and C = overall factor which accounts for the velocity of the departing flow and the fraction of the flow that diverts.

In general, the actual average pressure on a vertical wall when the wind is steady is about 60–70% of that generated by Equation (iii) or listed in Table 2.1. However, in consideration of the momentary pressure increases caused by gusting and other factors, using the figures generated by Equation (iii) is conservative and similar to those used in actual design.

This is because most codes introduce a multiplier factor in the wall pressure calculations to account for pressure increases due to gusting, building geometry, and aerodynamic drag. Often, the end result of using this multiplier is a vertical wall design pressure criteria similar, if not the same, as that generated by Equation (iii). In a sense, the very simplified model equation ends up producing nearly the same results as that of the complicated model equation, with all the individual components factored in. This is, perhaps, an example of the *fuzzy central limit theorem* of statistics at work.

Getting back to the second thing that wind does when it approaches a house, some of the wind flows up and over the house and gains speed as it becomes constricted between the rising roof and the air flowing straight over the house along an undiverted streamline. Again, assuming that the air is relatively incompressible in this range, as the cross-sectional area through which the air flows decrease, the air speed must increase proportionally in order to keep the mass flow rate the same, as per Equation (v).

$$\Delta m/\Delta t = \rho A v \quad \text{(v)}$$

where $\Delta m/\Delta t$ = mass flow rate per unit time, A = area perpendicular to flow through which the air is moving (an imaginary "window," if you please), ρ = average density of air, and v = velocity of air.

Constriction of air flow over the house is often greatest at the roof ridge. Because of the increase in flow speed as the wind goes over the top of the roof, the air pressure drops in accordance with Bernoulli's equation, Equation (i). Where the air speed is greatest, the pressure drop is greatest.

Thirdly, air also flows around the house, in a fashion similar to the way the air flows over the house.

Lastly, on the leeward side of the house, there is a stagnant air pocket next to the house where there is no significant air flow at all. Sometimes this is called the wind shadow. A low pressure zone occurs next to this leeward air pocket because of the Bernoulli effect of the moving air going over and around the house.

A similar effect occurs when a person is smoking in a closed car, and then opens the window just a crack. The air inside the car is not moving much, so it is at high pressure. However, the fast moving air flowing across the slightly opened window is at a lower pressure. This difference in relative pressures causes air to flow from the higher pressure area inside the car to the low pressure area outside the car. The result is that smoke from the cigarette flows toward and exits the slightly opened window.

If a wind is blowing at 30 mph and impinges against the vertical side wall of a house like that shown in Figure 2.1, from the simplified momentum flow considerations noted in Equation (iii), an average pressure of 4.5 lbf/ft^2 will be exerted on the windward side vertical wall.