If the same 30-mph wind increases in speed to 40 mph as it goes over the roof, which is typical, the air pressure is reduced by 4.0 lbf/ft^2. Because the air under the roof deck and even under the shingles is not moving, the air pressure under those items is the same as that of still air, 14.7 lbf/in^2 or 2116.8 lbf/ft^2. The air pressure under the roof and under the shingles then pushes upward against the slightly lower air pressure of the moving air going over the roof. This pressure difference causes the same kind of lift that occurs in an airplane wing. This lifting force tries to lift up the roof itself, and also the individual shingles.

While 4.0 lbf/ft^2 of lift may not seem like much, averaged over a roof area of perhaps 25 × 50 ft, this amounts to a total force of 5000 lbf trying to lift the roof. At a wind speed of 80 mph, the usual threshold for code compliance in the Midwest, the pressure difference is 16 lbf/ft^2 and the total lifting force for the same roof is 20,000 lbf.

If the roof in question does not weigh at least 20,000 lbf, or is not held down such that the combined total weight and holding force exceed 20,000 lbf in upward resistance, the roof will lift. This is why in Florida, where the code threshold is 90 mph, extra hurricane brackets are required to hold down the roof. The usual weight of the roof along with typical nailed connections is not usually enough to withstand the lift generated by 90 mph winds.

It is notable that the total force trying to push the side wall inward, as in our example, is usually less than the total lift force on the roof and the shingles. This is a consequence of the fact that the area of the roof is usually significantly larger than the area of the windward side wall (total force = ave. pressure × area). Additionally, a side wall will usually offer more structural resistance to inward pressure than a roof will provide against lift. For these reasons, it is typical that in high winds a roof will lift off a house before a side wall will cave in.

Lift is also the reason why shingles on a house usually come off before any structural wind damages occur. Individual asphalt shingles, for example, are much easier to pull up than roof decking nailed to trusses. Shingles tend to lift first at roof corners, ridges, valleys, and edges. This is because wind speeds are higher in locations where there is a sharp change in slope. Even if the workmanship related to shingle installation is consistent, shingles will lift in some places but not in others due to the variations in wind speed over them.

Most good quality windows will not break until a pressure difference of about 0.5 lbf/sq in, or 72 lbf/sq ft occurs. However, poorly fitted, single pane glass may break at pressures as low as 0.1 lbf/sq in, or about 14 lbf/sq ft. This means that loosely fitted single pane glass will not normally break out until wind gusts are at least over 53 mph, and most glass windows will not break out until the minimum wind design speed is exceeded.

Assuming the wind approaches the house from the side, as depicted in Figure 2.1, as the wind goes around the house, the wind will speed up at the corners. Because of the sharpness of the corners with respect to the wind flow, the prevalent 30-mph wind may speed up to 40 mph or perhaps even 50 mph at the corners, and then slow down as it flows away from the corners and toward the middle of the wall. It may then speed up again in the same manner as it approaches the rear corner of the house.

Because of this effect, where wind blows parallel across the vertical side walls of a house, the pressure just behind the lead corner will decrease. As the wind flows from this corner across the wall, the pressure will increase again as the distance from the corner increases. However, the pressure will then drop again as the wind approaches the next corner and speeds up. This speed-up–slow-down–speed-up effect due to house geometry causes a variation in pressure, both on the roof and on the side walls.

These effects can actually be seen when there is small-sized snow in the air when a strong wind is blowing. The snow will be driven more or less horizontal in the areas where wind speed is high, but will roil, swirl, and appear cloud-like in the areas where the wind speed significantly slows down. Snow will generally drift and pile up in the zones around the house where the air speed significantly slows down, that is, the stagnation areas. The air speed in those areas is not sufficient to keep the snow flakes suspended. During a blizzard when there is not much else to do anyway, a person can at least entertain himself by watching snow blow around a neighbor's house and mapping out the high and low air flow speed areas.

Plate 2.3 Roof over boat docks loaded with ice and snow, collapsed in moderate wind.