many times the stall speed will require due consideration of the operating strength limits.

The structural design of the aircraft must consider the possibility of negative load factors from maneuvers. Since the pilot cannot comfortably tolerate large prolonged negative "g", the aircraft need not be designed for negative load factors as great as the positive load factors.

The effect of airplane gross weight during maneuvers must be appreciated because of the particular relation to flight operating strength limitations. During flight, the pilot appreciates the degree of a maneuver from the inertia forces produced by various load factors; the airplane structure senses the degree of a maneuver principally by the airloads involved. Thus, the pilot recognizes *load factor* while the structure recognizes only *load*. To better understand this relationship, consider an example airplane whose basic configuration gross weight is 20,000 lbs. At this basic configuration assume a limit load factor for symmetrical flight of 5.6 and an ultimate load factor of 8.4. If the airplane is operated at any other configuration, the load factor limits will be altered. The following data illustrate this fact by tabulating the load factors required to produce identical airloads at various gross weights.

Gross weight, lbs.	Limit load factor	Ultimate load factor
20,000 (basic)	5.60	8.40
30,000 (max. takeoff)	3.73	5.60
13,333 (min. fuel)	8.40	12.60

As illustrated, at high gross weights above the basic configuration weight, the limit and ultimate load factors may be seriously reduced. For the airplane shown, a 5-*g* maneuver immediately after a high gross weight takeoff could be very near the "disaster regime," especially if turbulence is associated with the maneuver. In the same sense, this airplane at very low operating weights below that of the basic configuration would experience greatly increased limit and ultimate load factors. Operation in this region of high load factors at low gross weight may create the impression that the airplane has great excess strength capability. This effect must be understood and intelligently appreciated since it is not uncommon to have a modern airplane configuration with more than 50 percent of its gross weight as fuel.

GUST LOAD FACTORS. Gusts are associated with the vertical and horizontal velocity gradients in the atmosphere. A horizontal gust produces a change in dynamic pressure on the airplane but causes relatively small and unimportant changes in flight load factor. The more important gusts are the vertical gusts which cause changes in angle of attack. This process is illustrated in figure 5.2. The vectorial addition of the gust velocity to the airplane velocity causes the change in angle of attack and change in lift. The change in angle of attack at some flight condition causes a change in the flight load factor. The increment change in load factor due to the vertical gust can be determined from the following equation:

$$\Delta n = 0.115 \frac{m\sqrt{\sigma}}{(W/S)} V_e (KU)$$

where

Δn = change in load factor due to gust
m = lift curve slope, unit of C_L per degree of α
σ = altitude density ratio
W/S = wing loading, psf
V_e = equivalent airspeed, knots
KU = equivalent sharp edged gust velocity ft. per sec.

As an example, consider the case of an airplane with a lift curve slope $m=0.08$ and wing loading, $(W/S)=60$ psf. If this airplane were flying at sea level at 350 knots and encountered an effective gust of 30 ft. per sec., the gust would produce a load factor increment of *1.61*. This increment would be added to the flight load factor of the airplane prior to the gust,