Structural Strength

It is an obvious requirement for a glider to withstand the loads it encounters. Without a doubt, the crossbar is under the greatest compression. However, the leading edge is the most vulnerable due to its unsupported free end. Higher performance gliders utilize shorter keels and longer leading edges. This changes the relationship of the forces so that the side wires experience a greater load while the fore and aft wires are under little tension. The leading edges must be very strong, and thus heavy, to support the required load. Tighter sails improve performance but also produce greater stress so that crossbars and leading edges must be made stouter still. This is the reason the new higher performance gliders are so heavy. A heavy pilot will also increase the forces proportionately for the same size of glider.

We have been speaking of one “G” loads. This means the glider is lifting only the weight of the pilot due to the force of gravity. However, much greater G loads can be experienced when encountering vertical gusts or performing maneuvers. When a glider encounters a gust, a bump is felt and the angle of attack changes. This change is due to the fact that the air in the gust is moving in a different direction from the normal air. Now, there is a unique angle of attack associated with each airspeed, regardless of the direction of air movement. This is only true if directional changes in the air are slow enough so that the glider can adjust its airspeed to any new angle of attack presented. In a gust, a wing can suddenly acquire a high angle of attack while glider momentum maintains a high speed. This combination results in the sudden creation of a large lift force, upward acceleration, and consequently, increased structural loading. In other words, in gusty conditions the glider can experience considerably increased G loading.

G loading also increases in maneuvers due to centrifugal force. In turning flight, the G load increases as the mass and velocity increases, but decreases as the radius increases. Thus a sharper turn increases the stress on the glider considerably. Most gliders can handle the loads of even the sharpest turns, but a pull-out from a dive can create other problems. The important thing to remember is that any condition, or mode of flight, other than following a straight path in calm air, momentarily increases structural stresses.

What factors create forces on the components of a glider?

How do these factors differentially affect the structural loading?

Why is it important for a pilot to understand the structural stability of a glider?