

GRANT ON ASPECT RATIOS AND WING TAPERING

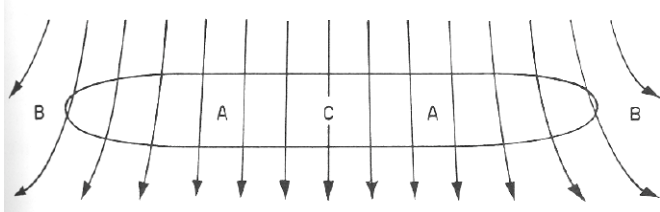
By George White

This is one of a series of articles based upon information contained in Charles H. Grant's 1941 book "Model Airplane Design and Theory of Flight."

As part of Grant's discussion of wing design, he made some interesting points concerning aspect ratios and wing tapering.

First, aspect ratios, i.e. span/chord. He states that the span should be at least six or seven times the chord, and says that within limits, the longer the span compared to the chord, the more efficient the wing. He indicates that building a wing with a span greater than 12 times the chord gains a minimum of efficiency and makes it difficult to build the wing strong and light. Since his book was written in 1941 before the advent of carbon fiber components, this limitation has to be taken with a grain of salt.

The point he is making in espousing a reasonably high aspect ratio is that, as illustrated below, from under every wing some air spills out at the ends. Thus, if the span is small and the chord large, a greater percentage of air escapes off the ends than if the reverse were true. Air spilling at the tips is due to the high pressure under the wing at A and lower pressure at B, the the air naturally moving toward the low pressure area. At the center C, the under-wing lift is greatest.



The following table gives the relative efficiencies with various aspect ratios, that of 6 being considered as 100% efficient.

Aspect ratio 9 = 114% efficient
Aspect ratio 8 = 111% efficient
Aspect ratio 7 = 106% efficient
Aspect ratio 6 = 100% efficient
Aspect ratio 5 = 92% efficient
Aspect ratio 4 = 82% efficient

Grant also makes the point that with a wing with square ends, the four corners produce little lift due to spilling action and the corners cause considerable resistance. Thus, rounding, or "raking" the wing tips reduces weight and resistance.

In a discussion of tapering wings, Grant states that a good rule to follow is to design a tapered wing so that width at the tips is one-half the cord at the center. No difficulty results if less taper is used, but greater taper starts to affect lateral stability.

Lift and efficiency of a tapered wing is 10% to 15% greater than one of uniform chord and equal area.