FLAPS AND AIR BRAKES FOR VARIOUS TAILLESS DESIGNS

There has always been some resistance to using flaps on tailless designs. Why this is so has always puzzled us, as there are any number of flying wings, both full sized and model, which incorporate them. The YB-49 and its predecessor, the XB-35, both utilized flaps to lower landing speeds. The B-2, the "Stealth Bomber," has full camber changing capability through use of flaps controlled by a triple redundant computer system. In the model realm, Gene Dees' Icarosaur pioneered the use of flaps and used the system to great advantage.

Since questions concerning guidelines for size, location, and use of flaps (and air brakes, too) are common, this month's column endeavors to provide the answers.

Flaps on plank designs

It is important to realize a plank design obtains its stability from the reflexed rear portion of the wing, and so any sort of air disturbance over that part of the wing will no doubt influence the stability of the aircraft in some way. (More about this later, when we talk about air brakes.) For now, keep in mind a flap placed on the bottom of a reflexed wing will decrease the stability of the wing because the airflow over the lower part of the reflexed section is disturbed. The majority of the stability provided by that portion of the wing will be derived from the airflow over the upper surface alone.

If you are looking to put flaps on a plank design, keep these guidelines in mind: (1) the flap area needs to be only about 5% of the total wing area, (2) the flaps should be mounted as close as possible to the 40% chord point, as this will reduce any pitching tendency to a minimum, (3) flap deflection needs to be only about 40°, as they are very effective, and (4) it is best if the flaps can be kept away from the control surfaces which influence pitch.

Flaps can be used on launch to get a steeper climb, and the effect is significant. Another use, of course, is to slow the 'wing for landing. Flaps should NOT be used when thermalling! Also, you may need to remember to retract them just before touchdown to prevent stripping the servo gears.

Flaps for swept 'wings

Flaps on swept 'wings are used just as they are on conventional tailed aircraft, and their effects are identical. Flaps can be used to significantly improve launches and slow the 'wing substantialy for landing. Depending on the airfoil(s) used, flaps may be used to advantage in various flight regimes as well.

In looking at a number of swept 'wings with flaps, we find the following similarities: (1) the flaps usually cover about one third of the wingspan, starting at the wing to fuselage junction, (2) the flap chord is about 20% of the wing chord.

In practice we've found flap deflections of about 20^{o} to be very effective during launch. (But make sure they are retracted for the zoom!) Deflections of 75 to 80 degrees or more can be used for landing, and this really slows the 'wing down. As with conventional tailed sailplanes, lowering the flaps has the tendency to pitch the nose up, so some form of elevator compensation is needed. Also, as with their use on planks, you may need to retract the flaps just before touchdown.

Some miscellaneous notes on flaps

If your plank's design has a centrally located elevator, the elevator servo can be mounted in the fuselage along with the rudder servo. A torque tube system to drive the flaps would need only a single additional fuselage mounted servo. On the other hand, outboard elevons should be driven directly by wing mounted servos. Flaps on a swept 'wing are best driven by separate wing mounted servos as well. We have long argued for the mounting of all wing control surface servos in the wings themselves, if possible and advantageous.

As we mentioned above, lowering the flaps on a swept 'wing will cause the nose to pitch up, and some form of compensation will be needed. The new computerized radios are great for mixing channels and making fine adjustments.

Air brakes

Planks, with their lack of sweepback, lend themselves well to air brake installation. An air brake consists of two blades which push up and out of the wing when deployed; one from the upper surface, one from the lower surface. For a plank type 'wing, the blades must rise clear of the wing surface so air can flow relatively freely over both the upper and lower surface of the reflexed trailing edge. For a two meter 'wing, a set of 250 mm air brakes is grossly oversized - better to use a 100mm size, if you can find them. Air brakes are, as their name implies, a method for increasing drag and not for increasing lift. Their usefulness, therefore, is limited.

We have seen only one swept 'wing with air brakes, probably due to the difficulties involved. If the air brakes are mounted parallel to the quarter chord line a large vortex forms at the trailing end, but if mounted at 90^{o} to the centerline they take on the arched quality of the airfoil's upper surface. There are no good solutions to the problems of incorporating them into this planform, and it seems flaps are a far better choice in this application.

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There you have it, the basics of flaps and air brakes on tailless sailplanes! While some experimentation may be necessary, the benefits to be derived from their use are well worth the effort.