

Adverse aileron yaw and its fixes

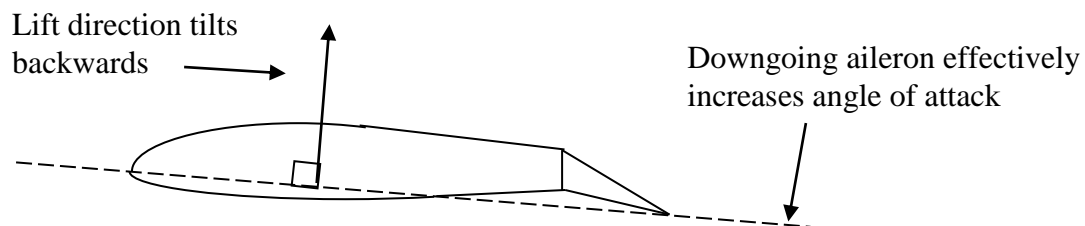
Yaw is rotation of the model in the horizontal plane i.e. the tail moves to one side or the other and is the result, primarily, of rudder input. It is not bank (due to aileron input) or pitch (due to elevator input)

The conventional assumption for aileron input is that it causes the model to bank, enabling elevator to be applied and a turn to take place in the direction of the bank.

On most models under most conditions this takes place. However, on slow flying models, especially ones with high aspect ratio wings, a very important affect also comes into play : “*adverse aileron yaw*”, so called because it is induced by aileron input, not rudder, and tends to yaw the model adversely in a turn i.e. it tries to steer the model out of the turn. This can, under certain conditions, cause the model to behave in a totally unexpected manner.

What causes it ?

Aileron input effectively alters the angle of attack of the wing. Lift tends to be generated in a direction normal, i.e. at right angles, to the angle of attack of the wing, thus :



In the case shown, the downgoing aileron (on the outside of the turn) effectively increases the angle of attack of the outer wing, tilting the lift vector backwards as shown. An upgoing aileron obviously has the opposite effect, reducing the effective angle of attack and tilting the direction of the lift force forwards. In addition to the change in direction of the lift forces, both ailerons also increase the drag on the model when they move since they are effectively small airbrakes.

These two tilted lift forces pull on the wings and effectively twist (or yaw) the model out of the turn i.e. they oppose the normal turning effect of aileron + elevator input. The model finishes up banking one way and yawing the other. To the inexperienced pilot this can appear like a radio problem that is causing loss of control of the model.

On a fast flying model, with small aileron deflections, the adverse yaw is small and doesn't really upset the model. On slow flying models, e.g. biplanes, vintage etc., the aileron inputs tend to be larger and the effect is more pronounced, On slow flying high aspect ratio models, e.g. thermal soarers the effect is even more pronounced because the large wingspan gives these yaw forces a much larger leverage. On many gliders the ailerons, as usually set up, are almost useless at low speeds.

Use of aileron differential

Aileron differential is useful on models susceptible to adverse aileron yaw and absolutely necessary on some. This is achieved by giving the upgoing aileron more throw than the downgoing one. In the case of a “right” turn, the downgoing aileron on the left (outer) wing will be arranged to have typically 50% of the movement of the upgoing aileron on the right (inner) wing. The extra drag due to the larger aileron movement on the right wing helps to pull, and so yaw, the model to the right, opposing the effect of the lift-induced adverse yaw to the left.

In extreme cases it may be necessary to arrange for very little, or even no, down aileron movement, relying on the upgoing (“inside”) aileron to generate both bank and drag to assist the turn.

A word of caution

If the model appears reluctant to respond to aileron input it's very tempting for an inexperienced pilot to apply more aileron. This usually makes any such problem worse. It's a yaw problem, not a bank problem, and the primary yaw control is rudder. A model showing adverse aileron yaw is best corrected by applying rudder in the same direction as the aileron i.e. right bank on aileron together with right yaw using rudder.

Many models such as gliders and slow flying biplanes benefit from having coupled aileron and rudder. In this case it's not mechanical coupling, it's electronic, in the Tx. A percentage of the aileron input (usually less than 100% but may be more) is mixed to the rudder, but not vice versa. It's best to have such mixing switchable since, once the model gets inverted i.e. in a roll, the rudder yaw will assist the (now severe) adverse aileron yaw from the (now) downgoing aileron and make a bad situation much worse. Not advisable.

In the olden days differential was limited, in practice, by the restraints of mechanical linkages and offset servo arms, and the achievement one way mixing by mechanical means was extremely difficult to engineer. Nowadays it is relatively easy to apply extreme differential via EPA (end point adjustment) on computer Txs and programmable mixers take care of aileron to rudder mixing and switching. If you think you have problems with adverse yaw, it's easy to play around with both of these. Give it a go. If you're not sure about it, don't hesitate to ask a Club Instructor or experienced flyer to help set your model up.