AILERON DEFLECTION ANALYSIS

NTSB Accident Number:

ERA18FA088

Date & Location of Accident:

2/26/18
Greenwood, MS

NTSB REQUESTED CONFIDENTIAL:

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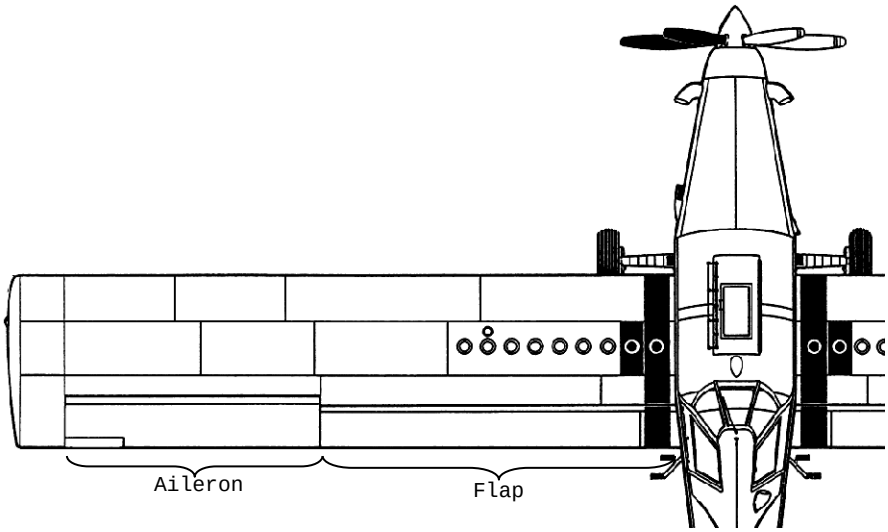
During the course of the on-scene investigation in Greenwood, MS on 2/27/18 through 3/1/18, it was noted that the aircraft ailerons displayed creases and witness marks that could possibly be used to determine aileron positions at the time of impact. This report is intended to provide factual documentation of the results of this effort. The information contained in this report is recorded as a result of measurements taken on an exemplar AT-802A aircraft at the Air Tractor factory on March 28, 2018.

The AT-802A aileron system is a mechanically controlled control system that uses pushrods, bellcranks, and idlers to transmit side-to-side motion of the cockpit control stick to movement of the ailerons. The ailerons are attached to the outboard portion of the wings and are bordered on the outboard end by the wing trailing edge and on the inboard end by the flap. The total design travel for each aileron is 17° up to 13° down.



Location of AT-802A Aileron (Lefthand Shown)

The outboard end of the righthand aileron exhibited a crease that corresponded to contact with the wing trailing edge rib. There were also markings of the aileron counterweight making contact with the lower surface of the wing trailing edge. Both of these are indications that the righthand aileron was deflected upward at the moment that contact was made with the wing trailing edge.

Contact of Righthand Aileron Counterweight with Trailing Edge Skin

The crease in the aileron was represented by a green line on the exemplar AT-802A. The aileron was then deflected to align this green line with the wing trailing edge. This deflection was then measured and found to be 11.4° upward deflection of the aileron.

Crease on Outboard Righthand Aileron

Deflection of Righthand Aileron on Exemplar AT-802A

Likewise, the crease on the inboard end of the righthand aileron was measured and recreated on the exemplar AT-802A by a green line. The aileron was deflected to align this green line with the outboard edge of the flap. This alignment resulted in a deflection of 14.8° upward deflection of the aileron.

Crease on Inboard Righthand Aileron

Deflection of Righthand Aileron on Exemplar AT-802A

Creases were also found on the lefthand aileron of the accident aircraft. The creases on this aileron were not as pronounced as those on the righthand aileron and did not exhibit any paint transfer or scuffing. These creases could have also been made by crushing or bending forces. It was also noted that the outboard wing trailing edge section had separated from the wing and was found between the initial impact and the wing wreckage.

The crease on the outboard end of the lefthand aileron was examined. This crease was represented on the exemplar AT-802A by a red line. This line was aligned with the lefthand wing trailing edge. This alignment corresponded with an 11.3° downward deflection of the aileron.

Crease on Outboard Lefthand Aileron

Deflection of Lefthand Aileron on Exemplar AT-802A

Likewise, the crease on the inboard end of the lefthand aileron was examined. This crease was represented on the exemplar AT-802A by a red line. This line was aligned with the outboard end of the lefthand flap. This alignment corresponded with a 3.7° upward deflection of the aileron.

Crease on Inboard Lefthand Aileron

Deflection of Lefthand Aileron on Exemplar AT-802A

SUMMARY OF AILERON MEASUREMENTS:

To summarize the measurements taken:

Location	Measured Deflection
R/H Outboard	11.4° Upward
R/H Inboard	14.8° Upward
L/H Outboard	11.3° Downward
L/H Inboard	3.7° Upward

It is first noted that the lefthand aileron cannot have a simultaneous upward and downward deflection. This fact, combined with the earlier statements about the unknown cause of the creases, casts doubt on whether either of these values represents a true impact position of the lefthand aileron.

On the exemplar AT-802A, 11.3° downward deflection of the lefthand aileron corresponded with about 12.5° of upward deflection on the righthand aileron.

It should be stressed that none of these measurements can be stated as true positions of the controls at the time of the collision with the tree or at the time of the impact with the ground. The aileron and flap control surfaces all showed significant amounts of the deformation that may or may not have happened before the creases were created. Also, the flexibility of the control system components, flexibility of the wing structure, and any variations in aileron or flap rigging could cause variations in the measurements that could not be accounted for.

The evidence on the right wing was conclusive that the aileron was deflected upward by some amount at the time that the creases were created on the aileron. With the information presented in this report, it is likely that the ailerons were in a position consistent with a righthand rolling input at the time of impact.

ESTIMATION OF MAXIMUM ROLL RATE:

In an effort to estimate the maximum roll rate of an AT-802A, data from previous Air Tractor roll rate test results were reviewed. These tests showed that an AT-802 was capable of rolling 29 degrees per second at 90 MPH. The conditions of this test were 9300 lbs with an engine torque of 2300 ft-lbs and with the propeller turning at 1650 RPM. The wings and ailerons of the AT-802A are the same as the AT-802.

With all other items being assumed equal, the roll rate can be estimated to be proportional to the dynamic pressure of the free stream air which is a function of velocity squared, V^2. Therefore, the following formula can be used to calculate the roll rate at different airspeeds:

$$\text{Roll Rate} = 29.0 * (V^2 / 90^2)$$

This formula can be used to complete the following table:

Indicated Airspeed (MPH)	Estimated Maximum Roll Rate (°/s)
80	23
90	29
100	36
110	43
120	52
130	61
140	70
150	81
160	92
170	103
180	116
190	129

It should be noted that these values are calculated for estimation purposes only and that multiple assumptions have been made to arrive at these values. It should also be noted that aircraft roll rate is aerodynamically damped at higher roll rates and the actual roll rates may not be as high as calculated in this table. Further, these estimates assume a controlled steady state maneuver and do not predict what the roll rate may be for an aggressive maneuver such as a snap roll.