November 1974 B74-10187

NASA TECH BRIEF

Langley Research Center

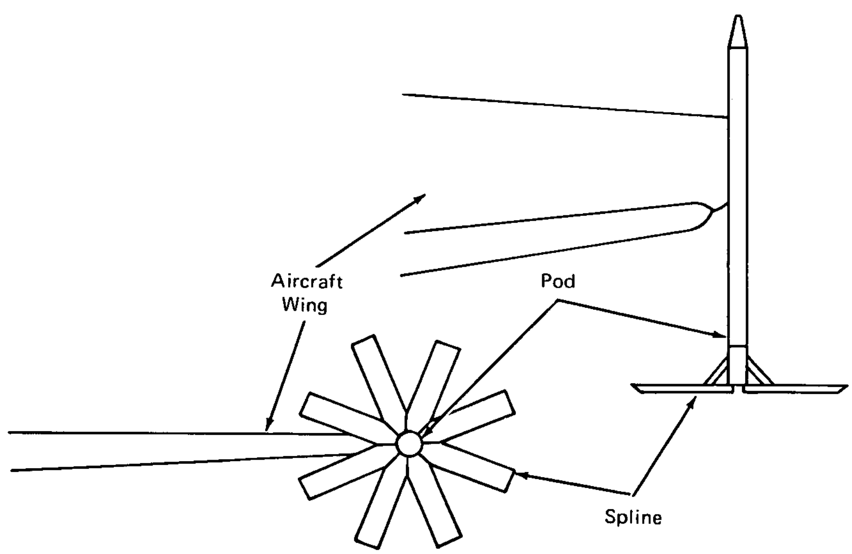
Flight Tests of Vortex-Attenuating Splines

Visual data on the formation and motion of a lift-induced wingtip vortex were obtained by a recently-developed, stationary, airflow visualization method. In studying these visual data, it became apparent that the vortex cannot be eliminated by merely reshaping the wingtip. A change in tip configuration may have a decided effect on the near-field vortex, resulting in an aerodynamic advantage through a reduction in induced drag. However, this configuration change will very likely have only a small effect on the far-field flow and is thereby considered no solution to the vortex persistence problem.

It was proposed that an unfavorable or positive pressure gradient applied just downstream of the wingtip might force the vortex to dissipate. This has been done by employing a decelerating chute at each wingtip. Tests have shown that the vortex was virtually eliminated in this manner in both the near and far fields. The success of this approach was believed to be due to the shearing stresses set up between the rotational vortex flow and the linear flow of the mass of air forced into each vortex core by the decelerating chutes.

As a more practical application of this idea, a number of splines were probe mounted just downstream of each wingtip with the same results as those obtained by the decelerating chute. The spline configuration has the advantage that it may be retracted during cruise flight and deployed during landing and takeoff.

Flight tests have been conducted to evaluate the effectiveness of a wingtip vortex-attenuating device (spline), and they revealed a significant reduction in the vortex-induced roll acceleration experienced by a following aircraft. During the tests, vortex penetrations were made by a PA-28 behind a C-54 aircraft with and without attached wingtip splines. The resultant rolling acceleration was measured and related to the roll



Wingtip Vortex-Attenuating Device (Spline)

(continued overleaf)

acceleration capability of the PA-28 aircraft. Tests were conducted with separation distances ranging from 5 to less than 1 nautical miles, and the splines reduced the distance at which the PA-28 roll control became ineffective from 2.5 to 0.6 nautical miles. This was accomplished with no noticeable changes in the handling qualities of the C-54 due to the splines and no detectable aerodynamic noise increase, although increased power settings for landing approach increased the overall sound pressure level approximately 4 dB. The illustration shows the pod-and-spline assembly installed on the right wingtip of the aircraft.

Because of the tapered wing of the C-54 aircraft, the most efficient position for the splines would be at between 80 and 90 percent of the semispan. This has been determined from the visual results of a test performed using a C-54 model wing. Due to the structure of the C-54 wing and to the fact that the aileron extends to the tip of the wing, it was necessary to locate the splines at the very tip of the wing. Splines 72 and 90 inches (183 and 229 cm) in diameter were tested mounted 82 inches (208 cm) aft of the wingtip. The splines were not retractable but were attached by explosive bolts which, in an emergency, could have been activated from the cockpit. A vortex visualization system was also installed.

On a typical penetration flight, the two aircraft would rendezvous and the desired airspeed, heading, and configuration would be established. At that time, the PA-28 special equipment would be turned on and the C-54 would begin to emit a vortex smoke trail from the right wingtip. As the C-54 maintained a constant heading, airspeed, and altitude, the PA-28 would orbit to obtain the desired separation distance and then would approach the vortex trail along a parallel course. Once the vortex had been penetrated, two techniques were used to collect data on vortex-induced roll acceleration: (1) The pilot would attempt to hold the ailerons neutral, and the aircraft was allowed to roll until thrown out of the vortex; or (2) the pilot used the ailerons, to collect data on roll control effectiveness, and tried to maintain a wing-level attitude while in the vortex.

Note:

Requests for further information may be directed to:

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Patent status:

Inquiries concerning rights for the commercial use of this invention should be addressed to:

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