Roll performances assessment of a light aircraft: flight tests and flight simulation

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The present paper deals with the assessment of roll performances of a light aircraft through several flight tests and flight simulations. The general problem of a reliable evaluation of aircraft roll performances is first discussed, including the estimation of the aerodynamic derivatives that mainly influences the airplane rolling characteristics. Next, the results of extensive flight test activities on a two-seats Tecnam P92 light aircraft are presented. The analysis of many roll maneuvers carried out at different flight speeds and with different aileron deflections has shown interesting values of roll performances for this non-aerobatic aircraft and has been extremely useful to derive the aileron efficiency factor in non-linear conditions (high aileron deflections). Flight data have been used to extract the main aerodynamic derivatives involved and to implement an accurate flight simulation model of the aircraft. Both 1-DoF and 6-DoF Flight simulations have been used in the first part of this research to select an appropriate matrix of test conditions. Finally, when the key lateral aerodynamic derivatives were estimated from flight experiments, the resulting flight simulations have shown a very good agreement with measured time histories.

Nomenclature

AEI	=	aileron effectiveness index
a_z	=	normal acceleration
b	=	wing span
CoG	=	Aircraft Center of Gravity
C_l ,C_m ,C_n	=	rolling-, pitching-, and yawing-moment coefficients
$C_{l_{\delta_A}}$	=	aileron control power derivative, $\partial C_l/\partial \delta_A$
$C_{l_{\delta_R}}$	=	rolling moment coefficient derivative w.r.t. rudder deflection, $\partial C_l/\partial \delta_R$
C_{l_p}	=	roll damping aerodynamic derivative, $\partial C_l/\partial(pb/2V)$
c	=	chord
Hp	=	pressure altitude
l	=	dimensional rolling moment
ℓ	=	local airfoil lift (lift per unit span)
MAC	=	mean aerodynamic chord
q	=	dynamic pressure
S	=	wing reference area
S/L	=	sea level
t	=	time
$\dot{f}$	=	generic quantity f derived w.r.t. time, $\mathrm{d}f / \mathrm{d}t$
V	=	flight speed

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