Trevor Boundy <trevor@boundy39.com>

4 Sweeper IV - Longitudinal Stability Predictions

1 message

Tandy Walker <rdb435021@icloud.com> Wed, N
To: Tandy Walker <rdb435021@icloud.com>

Report No. 4

Sweeper IV

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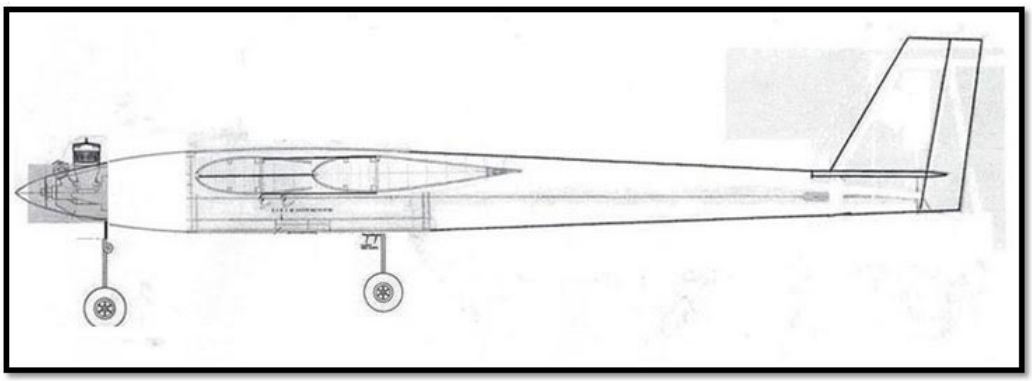
There was a downwash issue raised with the Sweeper VI's wing and horizontal tail being in the same plane as shown below.



However, Alfredo Herbon's 1972 design that he called "Alviju I" shown below had wing and stabilizer placed in the same plane and he said it was a good flying model configuration in all aspects. Therefore, I will stay with the Sweeper VI's wing and horizontal tail being in the same plane

The Sweeper IV planform sketch and wing design metrics shown below were sent to Alfredo Herbon to conduct a longitudinal stability analysis.

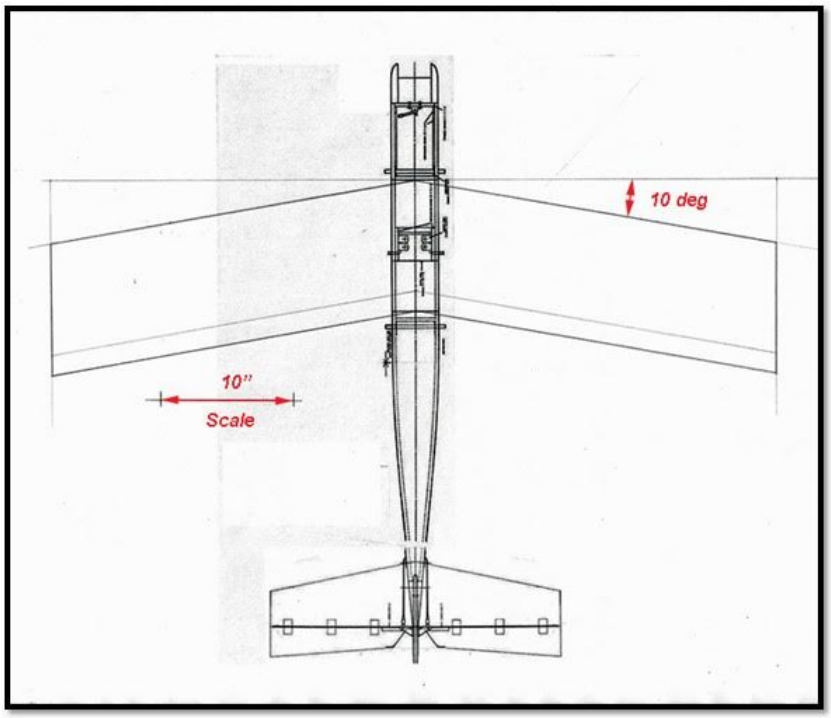
Sweep-Back Angle: 10 deg.

Span: 55.0 in. *(includes both the 1/4" wing tips)*

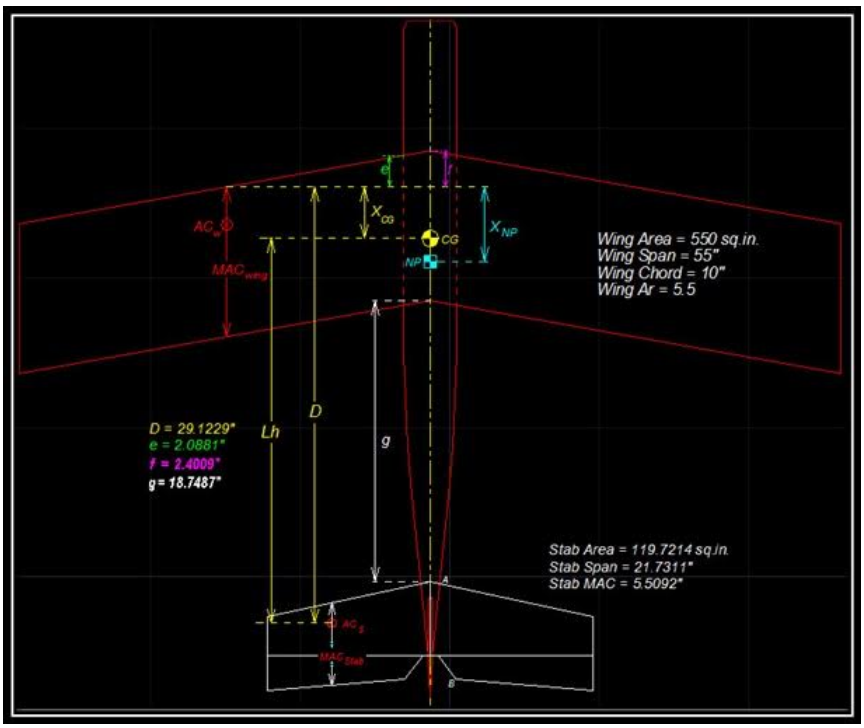
Chord: 10.0 in. *(includes 1.5" strip ailerons)*

Area: 550 sq. in.

Aspect Ratio: 5.5



Alfredo formalized my sketch by redrawing it in his ACAD program using the 10" scale reference. He made the corrections to adjust the ACAD drawing according basic dimensions for the wing (10° swept-back, wing area, wing span and wing chord). For stabilizer, he used the sketch lines and position respecting to wing. Then the LE and TE lines adjusted exactly to 12° and 5° respectively, departing from points A and B as shown below. Once the ACAD planform was complete, Alfredo measured all of the various dimensions and areas shown on the drawing below.



Now the measure of longitudinal stability is called Static Margin, which is a function of the planform's Neutral Point (NP). The expression is SM = (CG - NP)/MAC and is expressed as a percentage of the Mean Aerodynamic Chord (MAC).The generally acceptable range for SM is somewhere between 10% and 15%.

Since the design of the Sweeper IV is meant to be an aerobatic-sport configuration, Alfredo provided the following background information on this type of a model. He said an article detailing the trimming procedure for an R/C stunt model was published in the March 1971 issue of the Model Airplane News magazine by Jim Kirkland (one of the top level R/C aerobatic competitors in the US during late 60's early 70's). He concluded that 36% was the target center of gravity location for a fine tuned R/C stunt plane. Alfredo said that he and his brother Nuno had used the 36% CG location in several of their R/C aerobatic models, which proved to work out great.

Some time ago Alfredo set up an Excel spread sheet to calculate longitudinal stability based on algorithms provided by Dr. Sergio Montes. The last iteration in the spread sheet below shows that a Sweeper IV's center of gravity of 36% MAC provides a static margin 12.46% MAC. It is interesting to note that this static margin is approximately half way between the acceptable range of 10% to 15%.

Neutral Point and Static Margin According Blain Rawdon and Mark Drela Reccomendations - Ref.: "Lab 8 Notes" and "Basic sizing checks for homebrew R/C gliders"

Wing Span bw (in)	Wing Area S (in)2	Average Wing MAC MAC wing (in)	Wing Aspect ratio AR (in)	Stab Span bh (in)	Stab Area Sh (in)2	Average Stab MAC MAC stab (in)	Stab Aspect Ratio Arh	Stab Arm Lh (in)	Distance D (in)	Tail Volume Vh	Neutral Point Location Xnp		CG Location Xcg		Stability Margin
											MAC fract.	(in)	MAC fraction	(in)	(%)
55.000	550.000	10.0000	5.500	21.731	119.721	5.509	3.944	25.5229	29.1229	0.556	0.484596	4.8460	0.36000	3.6000	12.4595

Iterate on Lh to find the 36% CG ~ 0.36 MAC

The geometry in the ACAD planform above can now be used to calculate the CG's location on the fuselage's center line: CG = (2.40 + 0.36*10) = 6.00" aft of the wing's LE apex point.

At this point, there is now enough information to develop the necessary drawings to build the Sweeper IV, with the exception of the nose length distance from the wing's LE apex point forward to the prop plane. This will have to be determined later with some preliminary weight and balance calculations……Tandy