MAAA Instructor Course

Determination of Centre of Gravity

INTRODUCTION

You may be scaling down from full size to build a scale model or building from a plan that doesn't show the centre of gravity or perhaps you have purchased a second hand model and don't know where the centre of gravity should be located. If you apply the following formula it will give you a good starting point to balance your plane for the initial flight that should give good model behaviour.

WHERE TO PUT THE C.G.

The Formulae
We need to apply the following formulae.

$$\text{GC Position} = \frac{\text{Average Chord}}{6} + \frac{3}{8} \times \frac{\text{Tail Area}}{\text{Wing Area}} \times \text{Tail Moment Arm}$$

These formulae can be applied to monoplane, biplane and delta wing aircraft. The first part of the formulae takes into consideration the wing of the aircraft and the second part the affect of the tailplane and its distance from the wing. You start off with $1/6^{TH}$ of the Average Chord and then the larger the Tail Area with respect to the Wing Area and the longer the Tail Moment arm the further back will be the centre of gravity.

On a delta wing aircraft there is no tailplane so both the Tail Area and Tail Moment equals zero, so the formulae then becomes.

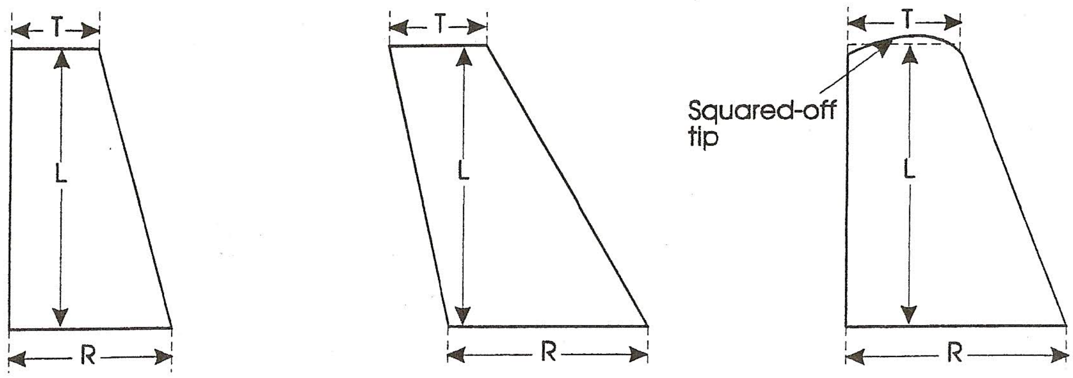
$$\text{CG Position} = \frac{\text{Average Chord}}{6}$$

The CG position is calculated from the leading edge of the average chord and then transferred across to the root chord.

That leaves as with working out the values for the following components: -

- Surface Area for the tail plane and wing
- Average Chord
- Tail Moment

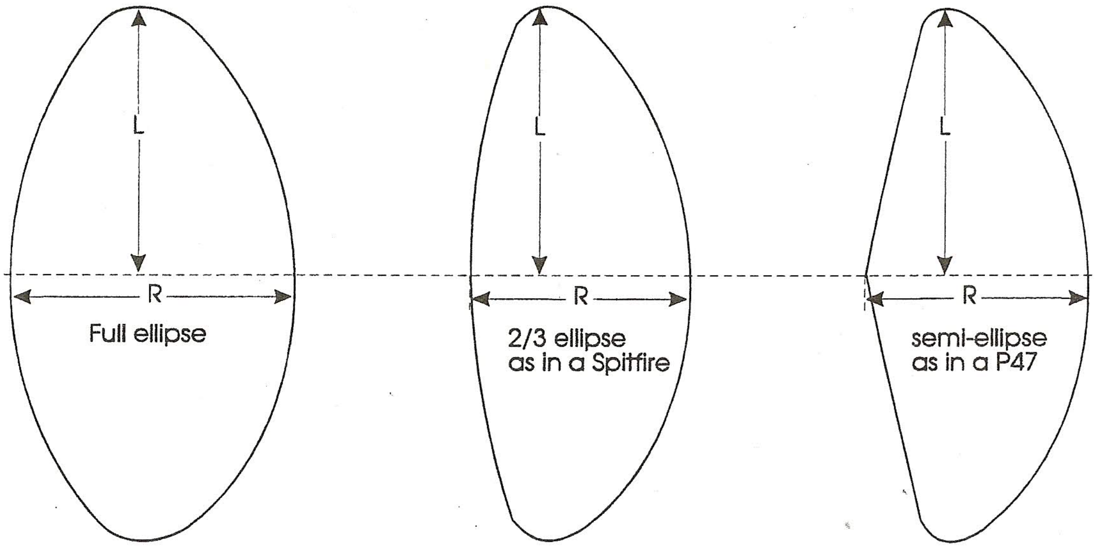
Calculation of surface area



For areas of straight-taper wings

Wing Area = (R + T) x L

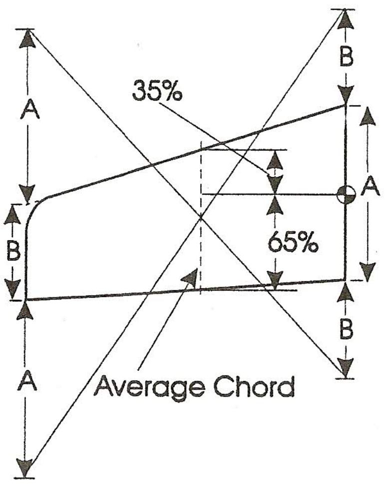
Where L = the length of the semi-span

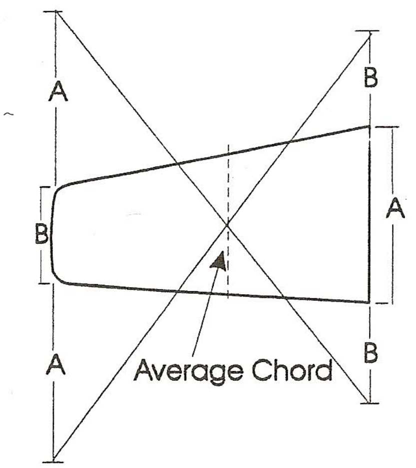


Area for both full and 2/3 ellipses = $(p \times R \times L) / 2$ Where ($p = 22 / 7$)

Working out the Average Chord

Finding the position of the average chord on swept or delta wings. A simple method is shown in the drawing below.





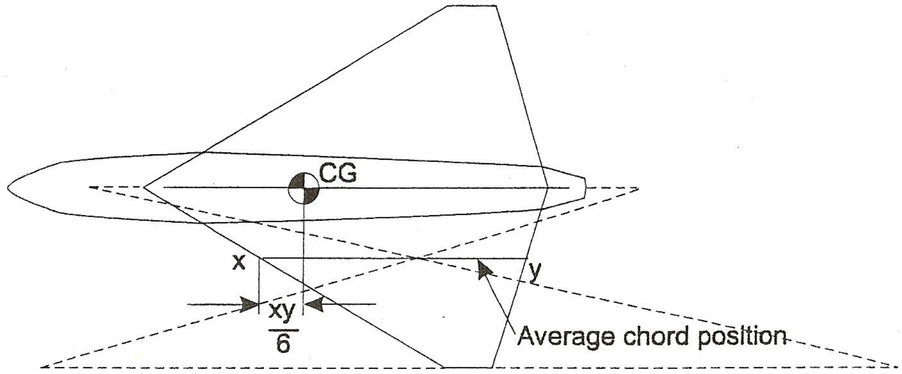
NOTE: This works for all straight taper and parallel chord wings

The best procedure is to trace the wing plan of the 3-view. Then extend the L.E. and T.E to the centre-line of the plane. Also square off the tips. Next, extend the opposite chord lengths as indicated; *ie.* extend **B** by chord lengths **A**, and **A** by lengths **B.**

Diagonal lines then join the four extreme points. Where these lines intersect, will be found the average chord. Transfer the average chord line back onto the 3-view. If the CG were to be at 35%, then we would mark it 35% back from the L.E. along the average chord line.

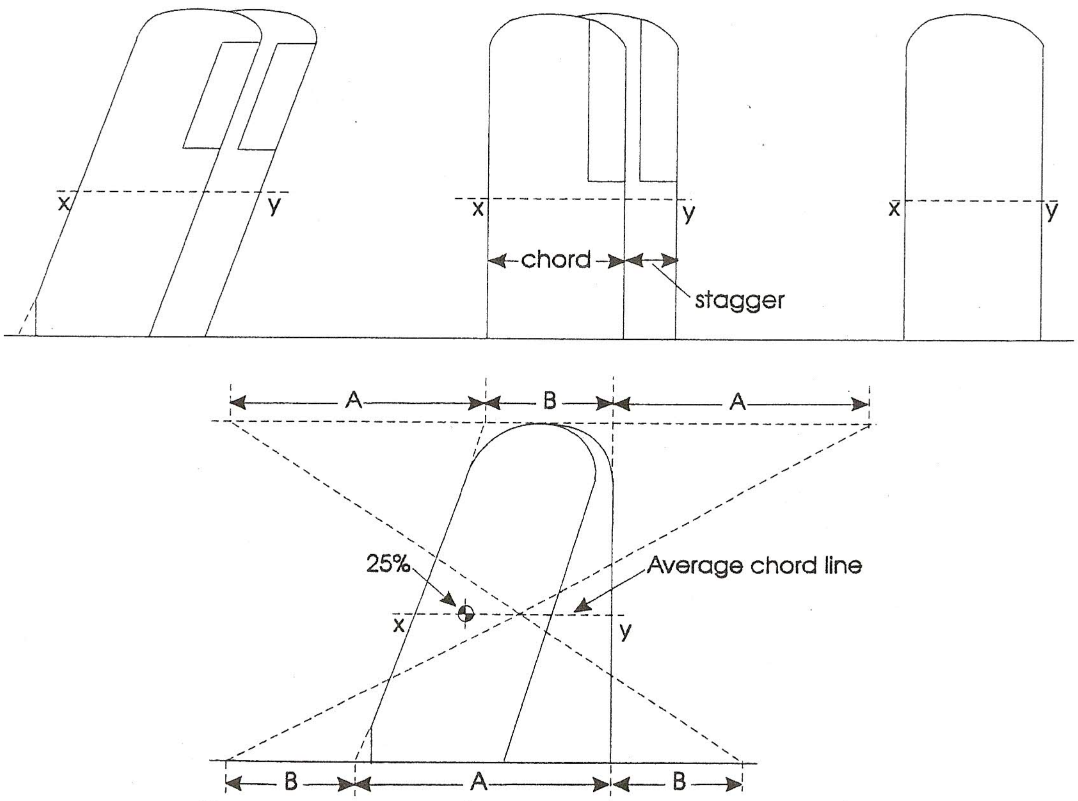
Delta Wing Aircraft

For a Delta Wing Aircraft the average chord position is determined the same way and as previously indicated the formula for the CG position is reduced to: -



$$\text{GC Position} = \frac{\text{Average Chord}}{6}$$

Average chord positions for biplane layouts

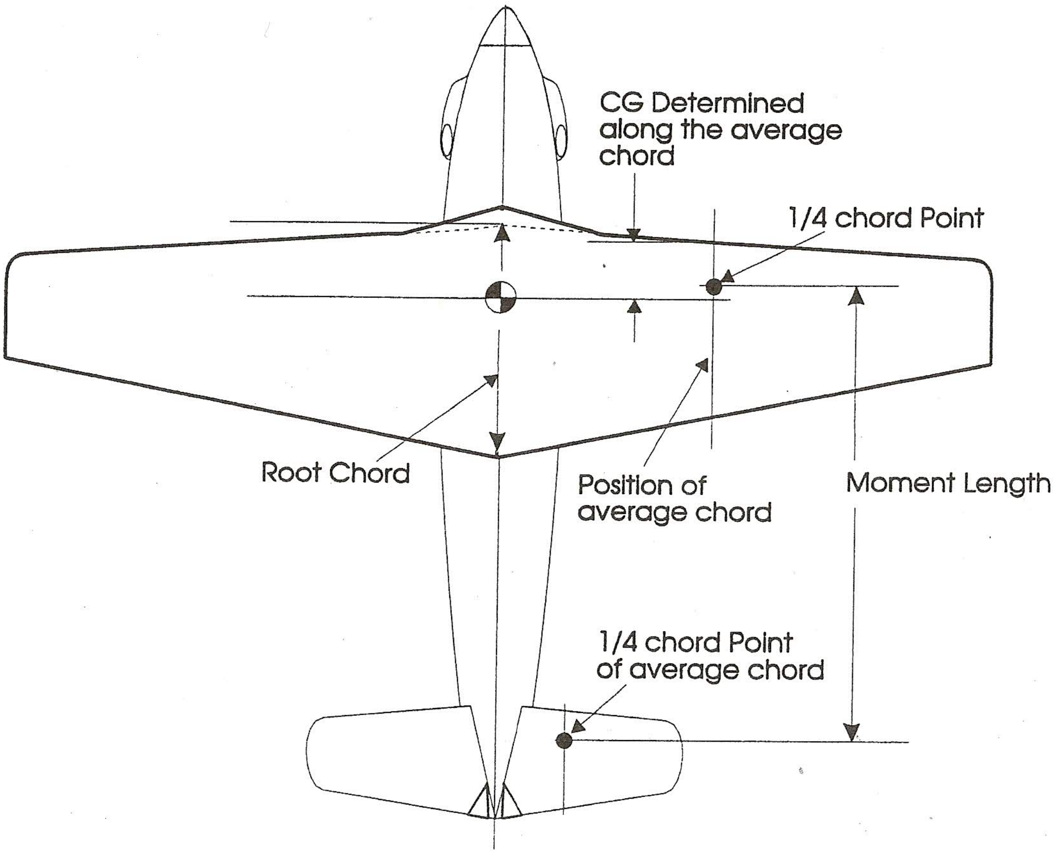


The average chord is represented by x - y in each case

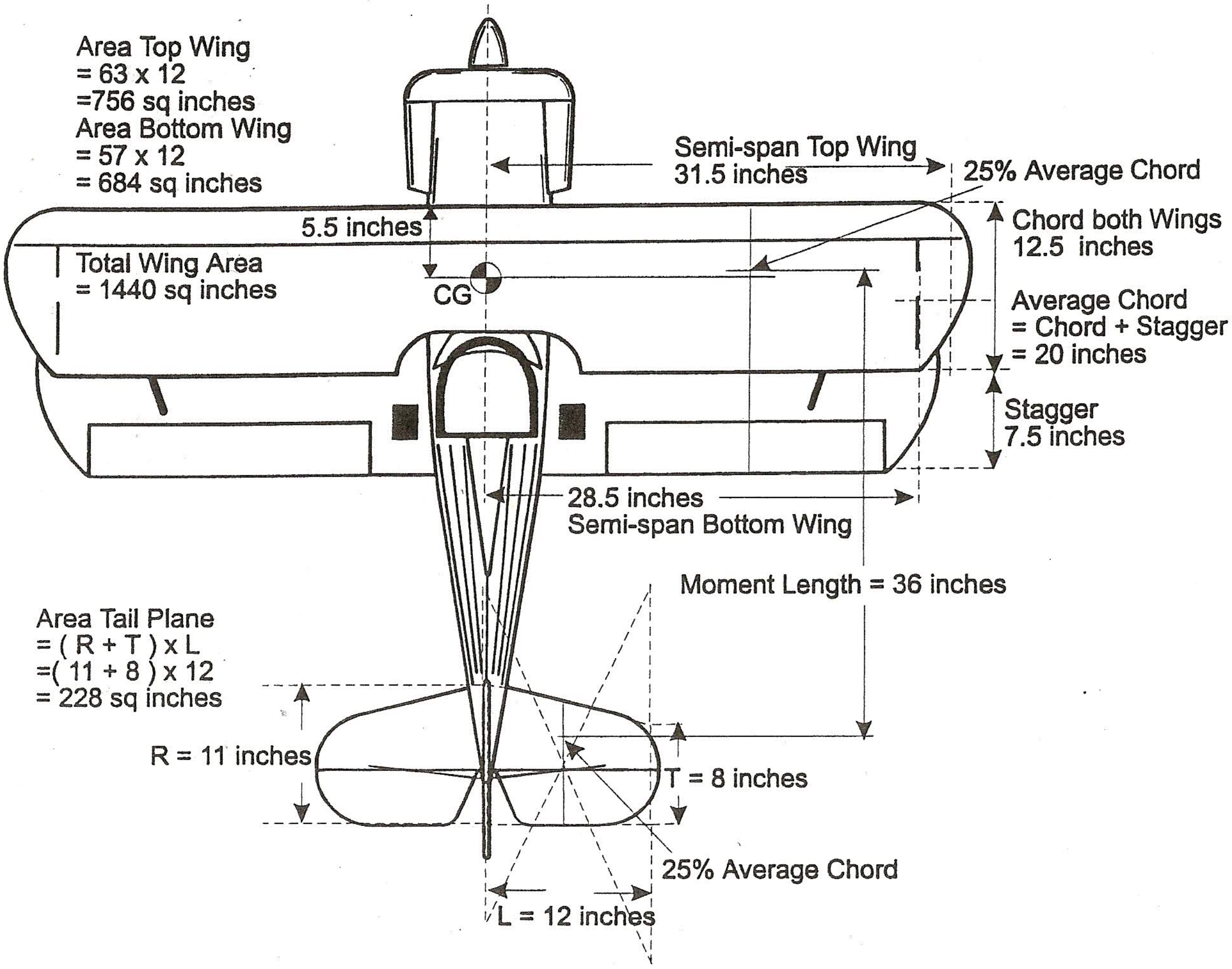
In the case of straight winged biplanes with equal chords on upper and lower wings, average chord xy = chord + stagger.

The Tail Moment

The tail moment arm is defined as the distance between the 25% points on the average chord lines of wing and tail. So, on the plan view, locate the average chord lines on wing and tail. Mark the quarter-chord points, and measure the distance between them. The drawing below shows a plan view of an aeroplane where we have located the average chord, having "squared-off " the tail to do so (pure guesswork here). After marking the ¼ - chord points, the distance between them is the tail moment.



EXAMPLE



$$\text{GC Position} = \frac{\text{Average Chord}}{6} + \frac{3}{8} \times \frac{\text{Tail Area}}{\text{Wing Area}} \times \text{Tail Moment Arm}$$

$$= \frac{20}{6} + \frac{3}{8} \times \frac{228}{1440} \times 36 = 5.5 \text{ inches}$$

This works out at 27.5 % of the average chord, this happens to be 2 inches in front of the leading edge of the bottom wing.