Glider Design! – Design Hints & Tips

Building A Hand Launched Glider (HLG) or 'Chuckie'

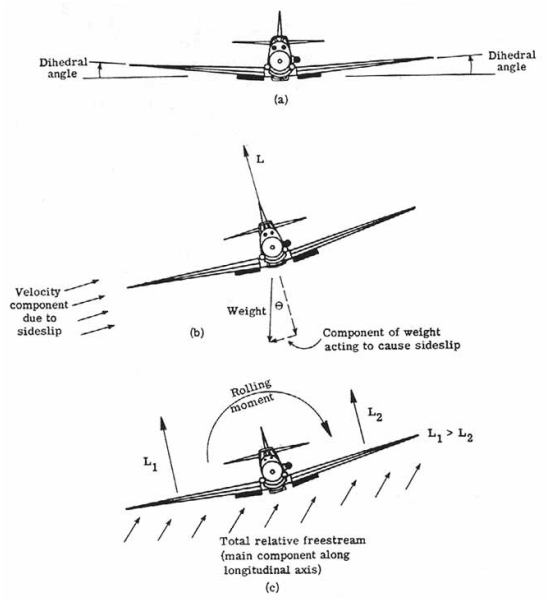
General Design Tips

In order to help you design and build a more efficient (better flying) glider you will find the following tips useful.

Dihedral

The purpose of building in dihedral on a wing is to improve the lateral (roll) stability of an airplane.

The dihedral angle is the angle that each wing of an airplane makes with the horizontal



If a disturbance causes one wing to drop, the unbalanced force produces a sideslip in the direction of the down going wing.

This will, in effect, cause a flow of air in the opposite direction to the slip. This flow of air will strike the lower wing at a greater angle of attack than it strikes the upper wing.

The lower wing will thus receive more lift and the airplane will roll back into its proper position.

A dihedral angle of 5º will provide your glider with sufficient lateral stability.

An angle of 5º equates to a height at the wingtip of 2.5 cm for every 30 cm of wingspan.

You will be shown how to build dihedral into your Main Wing without having to cut or break the wing.

Wing Taper

Compared to a simple rectangular wing, using a wing with taper on your glider can decrease the amount of induced drag that develops at its wingtips.

Reduced drag results in longer flight time for your glider. To further reduce induced drag the corners of the wing tips can be rounded off.

In addition, certain flying characteristics can be improved or compromised by how wings are tapered.

The total amount of taper angle should not exceed 10º.

There are three main types of wing tapering. Leading edge taper, trailing edge taper and middle taper.

The diagrams on the next page illustrate these three types of taper and the effect that they will have on your glider.

Leading Edge Taper

This type of taper will make the glider easier to roll and more manoeuvrable. However, it will be less stable and less likely to stay on a straight course.

Trailing Edge Taper

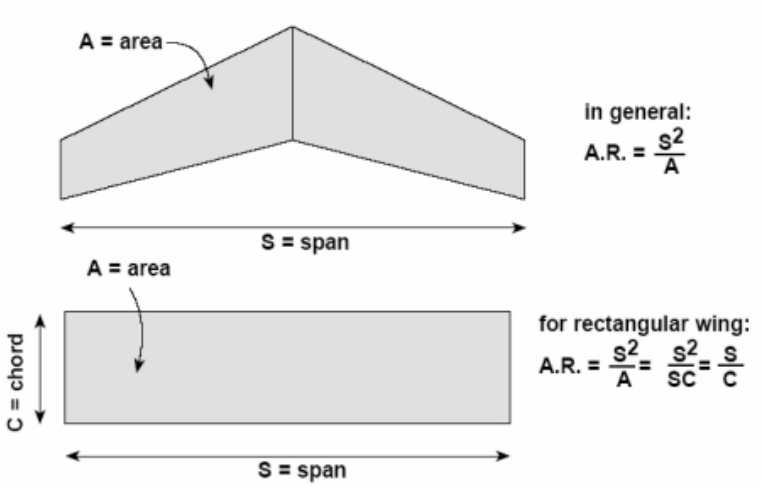
This type of taper will make the glider more stable and give it straighter tracking but make it less manoeuvrable.

Middle Taper

This type of taper often results in the best balance of stability and manoeuvrability for overall performance.

Aspect Ratio

The aspect ratio (AR) of a wing is defined to be the square of the span (s), divided by the wing area (A). Aspect ratio is a measure of how long and slender a wing is from tip to tip. For a rectangular wing, this reduces to the ratio of the span to the chord length (c):

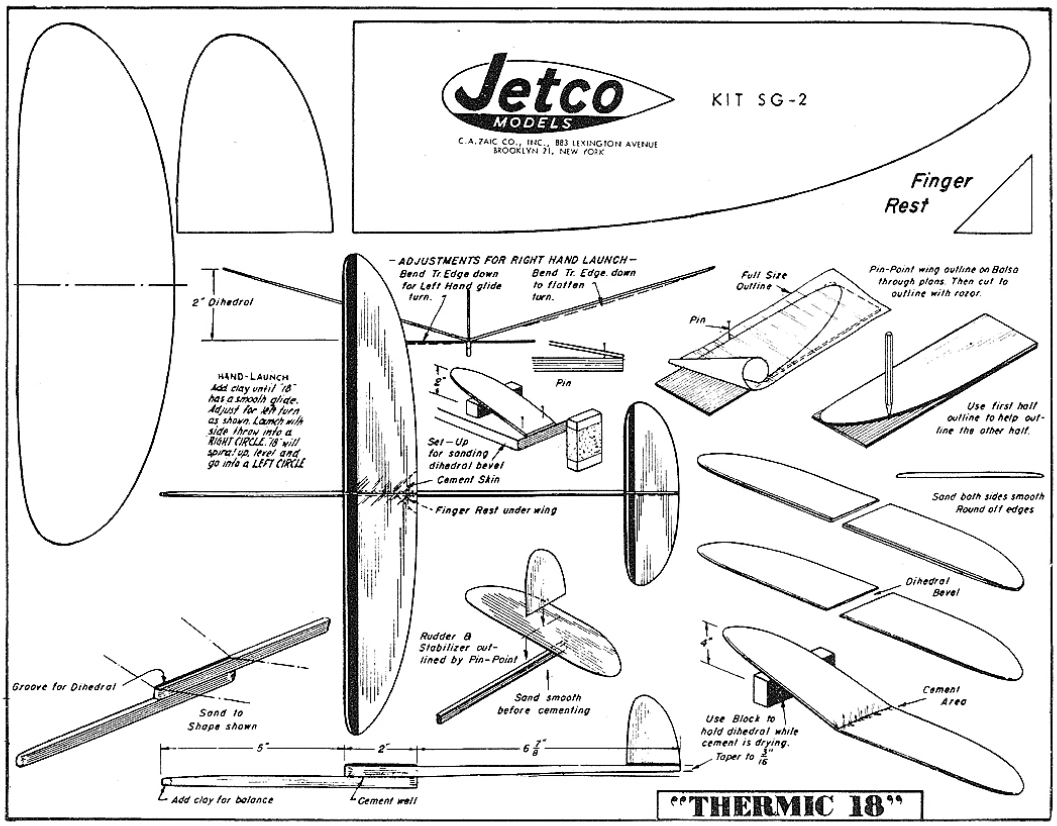


High aspect ratio wings have long spans (like high performance gliders), while low aspect ratio wings have either short spans or thick chords (like the Space Shuttle). Gliders have a high aspect ratio because the drag of the aircraft depends on this parameter. A higher aspect ratio gives a lower drag, a higher lift to drag ratio, and a better glide angle.

When designing your glider you should aim for its aspect ratio to be: $4.5 \leq A.R. \leq 7.5$. If the A.R. is greater than 7.5 then the force applied to your glider whilst launching it might result in the wing breaking off!

In preparing these notes the following sources were referenced.

Designing Model Gliders by Frank Zaic, by Model Aeronautic Publications, 1944
http://www.f4bscale.worldonline.co.uk/hand.htm
http://www.gryffinaero.com/models/ffpages/tips/hlgtips.html
http://www.modelresearchlabs.com/hand_launch_glider_airfoils.htm
http://www.seeds2lrn.com/airIndex.html#gliders
http://resources.yesican-science.ca/100_years/unit1_flight1g06.html



Glider Design! – Tutorial

With these ideas in mind you are ready to start designing your own hand launched glider (HLG) or "chuckie" using the computer program Glider Design.

Balsa Wood

You will be provided with the following pieces of balsa wood with which to construct your glider.

- 1.5 mm x 75 mm x 915 mm ***or*** 2.0 mm x 75 mm x 915 mm sheet balsa.
  Your wing, stabiliser and rudder are all to be made from this sheet.
- 6.5 mm x 6.5 mm x 45 mm balsa stick.
  Your fuselage will be made from this.

Glider Design! – Specifications

After the *Glider Design!* program has determined that your glider will fly, complete these details from each of the individual screens.

Screen	***Measurement***	***Value Trial 1***	***Value Trial 2***	***Value Final***
Fuselage	Length			
	Position of wing			
	Position of Stabiliser			
	Position of Vertical Tail			
	Nose Mass			
	Throwing Velocity			
Main Wing	Half wing Span			
	Root Chord			
	Tip Chord			
	Tip Sweep Distance			
Stabiliser	Half Stabiliser Span			
	Root chord			
	Tip Chord			
	Tip Sweep Distance			
Vertical Tail	Vertical Tail Height			
	Root Chord			
	Tip Chord			
	Tip Sweep Distance			
Analyse Design Compute	Flight Angle of Attack			
	Stabiliser Incidence angle			
	Main Wing Aspect Ratio			

<u>Before</u> cutting out any balsa wood answer the questions on the next page.

Question 1

What is the maximum allowable length of fuselage wood? .....

Is your measurement equal to, or less than this value? Yes | No

Question 2

What is the maximum allowable length of wing wood? .....

Calculate the following total: $2\times Half\ Wing\ Span + 2\times Half\ Stabiliser\ Span + Vertical\ Tail$.

Is the value of your calculation equal to, or less than the maximum allowable length of wing wood?

Yes | No

Question 3

Are the wings in front of the stabiliser? Yes | No

Question 4

Is the stabiliser angle within $\pm 5^o$? Yes | No

Question 5

Is the main wing angle of attack within $0^o \leq \theta \leq 10^o$? Yes | No

- If your answers to each of the five questions was yes, and you are satisfied with your design then it is time to draw a plan for your glider.

  Using the sample plans on the following pages as a guide, carefully draw using a scale of 1:1 the plans for your glider onto one or more sheets of A4 paper. You will need a plan for: Half Wing Span
  Stabiliser
  Vertical Tail
  Fuselage

  Include all of the relevant measurements on your plans.

- Next you will need to accurately transfer/copy your plans onto your balsa sheets. This can best be done using a ruler and a felt tipped pen/texta.

- Do not cut anything until after each part has been copied onto your balsa sheets.

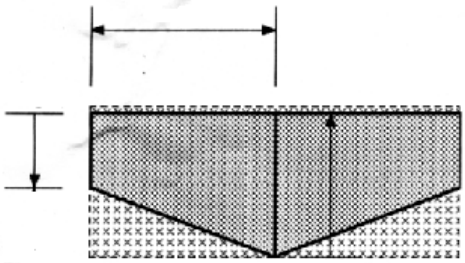
- The main wing is to be cut out as a single piece. The stabiliser is to be cut out as a single piece.

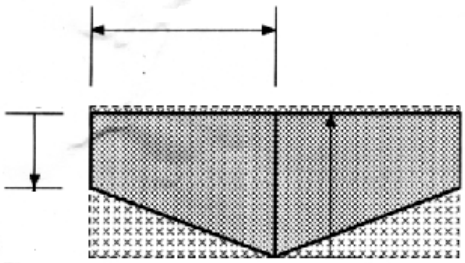
- When you use the glue to put the pieces of the glider together, make certain that the pins hold the pieces tight and there is no gap. If not, the glue will dry and the wings etc. will not be attached.

Main Wing and Stabilizer Plans (leading edge to the top of the page).

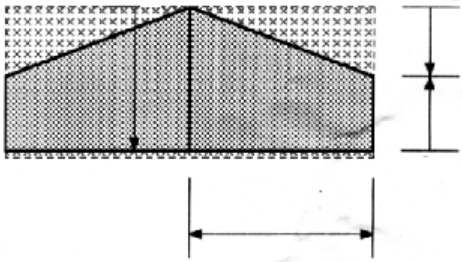
The first 2 plans are repeated since you may have decided to use these plans for both the wing and stabilizer.

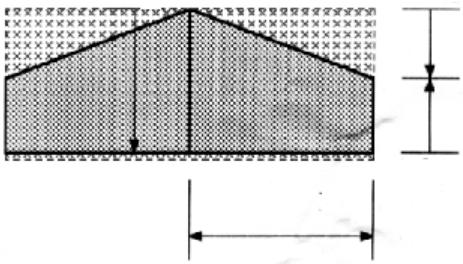
Straight Leading Edge



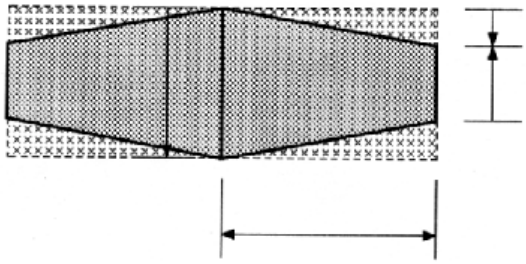


Straight Trailing Edge

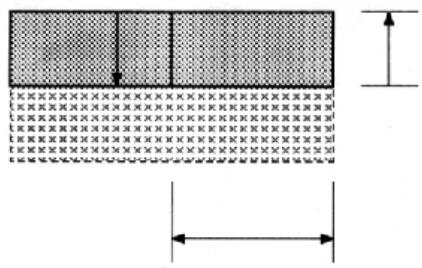




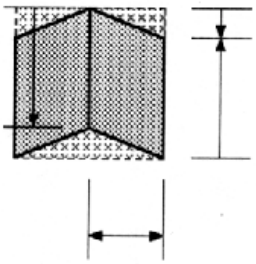
Centred Wing

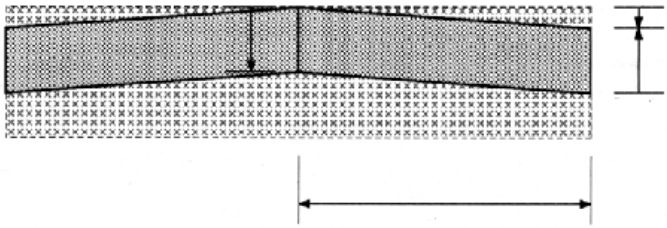


Rectangular Wing

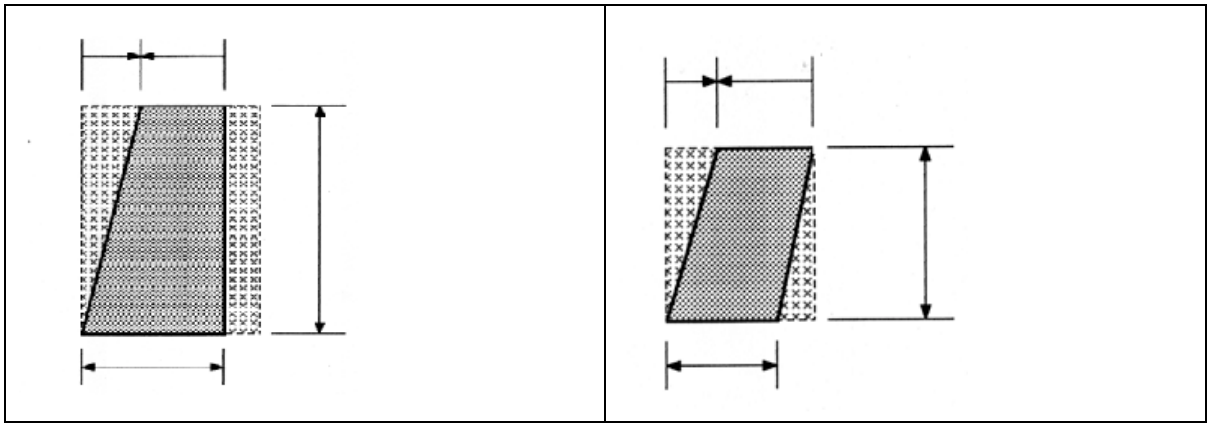


These plans need the root chord to be less than the width of the wood otherwise they will not fit when cut.





Vertical Tail Plans



Fuselage Plans (top view)