SINGLE SITTER BIRD GLIDER

Atul Choudhary[1], Sandesh Raikwad[2], Chinmay Purohit[3], Kailash Salunkhe[4], Rushikesh Sawant[5]

[1]Assistant Professor, Department of Mechanical Engineering, ARMIET, Thane, M.H.,

[2345]UG Student, Department of Mechanical Engineering, ARMIET, Thane, M.H.,

ABSTRACT

In this Research Paper we made a single sitter glider which has cloth wings and it runs on IC engine.

During flight the glider experience 3 types of forces 'Lift, Drag and Weight'. So in order to fly glider must produce lift oppose to its weight. When the glider is in motion it generates Drag. The glider quickly slows down until it can no longer generate lift to oppose the weight and it falls. In our project the IC engine is use to produce the thrust against the weight of glider so it can lift.

The main component of glider is body which we made of 6063 aluminium alloy which is a Al and Si 6 series alloy, the wings which are manufacture by light weight airfoils Al alloy material which consist slots and fabricated with Nylon 66 cloth. Wings are a type of fin that produces lift, while moving through air or some Fluid. The wings has streamline cross-section, which is aerodynamic. The aerodynamic forces act on wings during flight. A wing's aerodynamic efficiency is expressed as its lift-to-drag ratio. The lift a wing generates at a given speed and angle of attack can be one to two orders of magnitude greater than the total drag on the wing.

The main mechanical component use in our project is 4-stroke petrol engine which is connected propeller fan use to produce thrust.

Keyword- I.C Engine, Propeller, Aerofoil, Lift, Drag, Thrust, Struts, Parachute Fabric.

INTRODUCTION

A glider is a heavier compare to aircraft and it is supported in flight by the dynamic reaction of the air against its lifting surfaces. The glider flight does not depend on an engine. Most gliders do not have an engine, but some have small engines for extending their flight when necessary with some being powerful enough to take-off.

There is a wide variety of types in the construction of glider's wings, aerodynamic efficiency, the location of the pilot, controls and intended purpose. In most exploit climate changes, to maintain or gain height. Gliders are used for the air sports such as gliding, hang gliding and paragliding. However some spacecraft have been designed to descend as gliders. In the past military gliders have been used in warfare. Some simple types of glider are toys such as the paper plane and balsa wood glider. In flight, a glider has three forces acting on it as compared to powered aircraft where four forces are acting on it. Both aircraft are subjected to the forces of lift, drag, and weight. The powered aircraft use an engine to generate thrust, while the glider has no engine to produce thrust.

In order to fly, glider must generate lift to oppose its weight. The motion of a glider generates drag in air. In a mechanized aircraft, the thrust from the engine opposes drag. But a glider has no engine to generate thrust, hence the drag is unopposed. A glider quickly slows down until it can no longer generate enough lift to oppose its weight, and it then falls to ground, the aircraft is given an initial velocity by throwing the aircraft. Some larger balsa gliders employ a catapult made from rubber bands and a tow line to provide velocity and some initial altitude. Hang-glider pilots often run and jump off the hill or cliff to get going. Some hang-gliders and most sailplanes are towed aloft by a powered aircraft and then cut loose to begin the glide.

The mechanized aircraft that pulls the glider aloft gives the glider a certain amount of potential energy. The glider can trade the potential energy difference from a higher altitude to a lower altitude to produce kinetic energy, which means velocity. Gliders are always declining relative to the air in which they are flying.

EXPERIMENT

1.1 Material Used:

1.1.1 Aluminium 6063:

It is similar to the British aluminium alloy HE9. The 6063 in an aluminium alloy with alloying element magnesium and silicon. The standard controlling of its composition is maintained by, "Aluminium Association".

The aluminium 6063 is heat treated hence has good mechanical properties and easily weldable. It is commonly used in aluminium extrusion. It allows the complex shape to be formed with a good surface finish, which is fit for anodizing.
The 6063 alloy is popular for the architectural application like windows frame, door frame, roof and sign frame. For higher strength application 6061 and 6082 alloys are used.

Fig 1.1.1 Aluminium Pipes (6063):

Chemical composition

- Silicon - 0.2% to 0.6% by weight
- Iron - maximum 0.35%
- Copper - maximum 0.10%
- Manganese - maximum 0.10%
- Magnesium - 0.45% to 0.9%
- Chromium - maximum 0.10%
- Zinc - maximum 0.10%
- Titanium - maximum 0.10%
- Remaining is Aluminium.

Aluminium 6063	
Physical properties	
Density (ρ)	2.69 g/cm^3
Mechanical properties	
Young's modulus (E)	68.3 GPa (9,910 ksi)
Tensile strength (σ_t)	145–186 MPa
Elongation (ε) at break	18-33%
Poisson's ratio (ν)	0.3
Thermal properties	
Melting temperature (T_m)	615 °C (1,139 °F)
Thermal conductivity (k)	201-218 W/m*K
Linear thermal expansion coefficient (α)	2.34*10^{-5} K^{-1}
Specific heat capacity (c)	900 J/kg*K
Electrical properties	
Volume resistivity (ρ)	30-35 n Ohm*m

We use aluminium 6063 alloy because of its light in weight. 6063 alloy is heat treated hence has good Strength. It is good architectural material hence used. The fabrication of 6063 alloy is easy compare to other air craft material.

Material used:

Material Dimension	Quantity
2 inch.	2
1.5 inch.	3
1.25 inch	3
1 inch.	1
0.75 inch.	2

1.1.2 Mild Steel:

Steel is an alloy of iron and carbon. It possess very high tensile strength and allows to make complicated structure or component with good surface finish. It has good mechanical and physical properties such as toughness, hardness, stiffness, density, thermal conductivity etc.

Iron is the base metal of steel, and has two crystalline forms, Body-Centre Cubic and Face-Centred Cubic depending on temperature. In the BCC, there is an iron atom in the centre of each cube, and in the FCC, there is one at the centre of each six faces of the cube. It is the reaction between the allotropes and alloying elements, mainly carbon that gives steel and cast iron their range of rare properties.

In the typical steel alloys carbon may contribute up to 2.14% of its weight. The quantity of carbon and many other alloying elements, and controlling their chemical and physical properties help in making of final steel, slows the movement of dislocations that make iron ductile, thus controls and improve its qualities. It include hardness, quenching, annealing, tempering behaviour, yield strength, and tensile strength of the steel. The increase in steel's strength compared to pure iron is possible only by reducing its ductility.

Fig 1.1.2 Mild Steel:

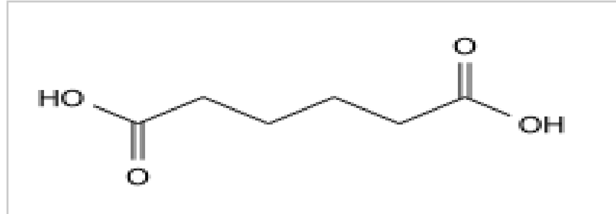
Material used :

Material Dimension	Quantity
2 inch.	2
1.5 inch.	2
0.75 inch.	1

1.1.3 Parachute Fabric (Nylon 66):

Nylon 66 is a type of polyamide, has high mechanical strength, rigidity, stability under heat and chemical resistance. Nylon 66 has more compact molecular structure and excellent abrasion resistance.It possess density of 1.14 gm/c.c.

Synthesis and manufacturing



Nylon 66 is composition of polycondensation of hexa-methylene diamine and adipic acid at equivalent amount of hexa-methylene diamine and adipic acid are combined with water in a reactor. This is crystallized to make nylon salt, ammonium/carboxylate mixture. The nylon salt goes into a reaction vessel where polymerization process takes place either in batches or continuously.

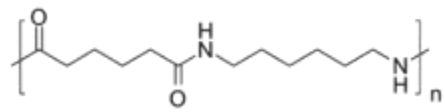
$NHOOC\text{-}(CH_2)_4\text{-}COOH + n\ H_2N\text{-}(CH_2)_6\text{-}NH_2 \rightarrow [\text{-}OC\text{-}(CH_2)_4\text{-}CO\text{-}NH\text{-}(CH_2)_6\text{-}NH\text{-}]_n + (2n-1)\ H_2O$

Removing water from reaction of polymerization through the formation of amide bonds to from the acid and amine functions. Thus molten nylon 66 is formed. It can either be extruded and granulated at this point or directly spun into fibres by extrusion through a spinneret and cool to form filaments.

Fig 1.1.3 Nylon 66:

We use nylon 66 as parachute fabric because of its high strength per square yard.

Properties of Nylon 66

Nylon 66

Names

IUPAC name Poly[imino(1,6-dioxohexamethylene) iminohexamethylene]	
Other names Poly(hexa-methylene adipamide) ,Poly(*N*,*N*'-hexamethyleneadipinediamide), Maranyl, Ultramid, Zytel, Akromid, Durethan, Frianyl, Vydyne	
Identifiers	
CAS Number	32131-17-2
ChemSpider	none
ECHA InfoCard	100.130.739
PubChem CID	24866842
Properties	
Chemical formula	$(C_{12}H_{22}N_2O_2)_n$
Density	1.314 g/mL (Zytel)
Melting point	507 °F (264 °C)

Material Specification:

Material Dimension	Quantity
20*1 meter	1

1.2 S.I Engine:

A spark ignition engine is an internal combustion engine with spark ignition, design to run on petrol as main fuel. The engine works on four strokes such as Suction, Compression, Power and Exhaust.

In most petrol engine, the charge that is air and fuel is usually mixes in compression stroke. But now a days some modern engine is use with direct petrol injection with the aid of electronic sensors.

Except in small engines where the complication of electronics does not justify the added engine efficiency. The process varies from a diesel engine in the method of mixing the fuel and air, and in using spark plugs to initiate the combustion process. In a diesel engine, only air is compressed (and therefore heated), and the fuel is injected into very hot air at the end of the compression stroke, and self-ignites.

We use S I engine instead of air craft engine because of its light weight. Petrol engines are mechanically designed with different timing than diesels, so to auto-ignite a petrol engine causes the expansion of gas inside the cylinder to reach its greatest point before the cylinder has reached the "top dead centre" (T.D.C) position. Spark plugs are typically set statically or at idle at a minimum of 10 degrees or so of crankshaft rotation before the piston reaches T.D.C, but at much higher values at higher engine speeds to allow time for the charge to essentially complete combustion before too much expansion has occurred gas expansion occurring with the piston moving down in the power stroke. Higher octane petrol burns slower, therefore it has a lower propensity to auto-ignite and its rate of expansion is lower. Engine designed to run high-octane fuel can achieve higher compression ratios.

Most modern automobile petrol engines generally have a compression ratio of 10.0:1 to 13.5:1.Engines with a knock sensor can and usually have C.R higher than 11.1:1 and approaches 14.0:1 (for high octane fuel and usually with direct fuel injection) and engines without a knock sensor generally have C.R of 8.0:1 to 10.5:1.

We use 4-stroke petrol engine to produce thrust which help to lift glider. We attached lever mechanism for throttling of engine.

We are extending Engine output Shaft to attach the propeller.

We are removing the gear box from engine, so we get full throttling and easy control.

Fig1.2 S.I. Engine

1.3 Wooden Propeller:

An aircraft propeller is attached to output drive of an engine and convert its rotary motion to whirling stream, which pushes the propeller forward and backword. The assembly of propeller include hub which is attached to several radial air foil blades. Such assembly rotates about an axis the blade pitch is fixed or manually variable for set position or automatic variable for constant speed.

The propeller attaches to the power source's driveshaft either directly or through reduction gearing. A propeller are made from wood, metal or composites. The propeller are used at subsonic speed around 770 km/h. if the speed is increased the blade tip speed reaches the speed of sound, and this causes high drag and noise.

A propeller efficiency of about 73.5%. The efficiency of the propeller is determine by the angle of attack. This is defined as $\alpha = \Phi - \theta$, where θ is the helix angle and Φ is the blade pitch angle. A small pitch and helix angles gives high performance against resistance but provide little thrust. While larger angles have the opposite effect. The best helix angle is when the blade is acting as a wing producing much more lift than drag. However, 'lift-and-drag' is only one way to express the aerodynamic force on the blades. To explain aircraft and engine performance the same force is expressed slightly differently in terms of thrust and torque since the required output of the propeller is thrust. Thrust and torque are the basis of the definition for the efficiency of the propeller as shown below. The advance ratio of a propeller is similar to the angle of attack of a wing.

Fig 1.3 Wooden Propeller.

1.4 Concept of Flying:

Essentially there are 4 aerodynamic forces that act on glider during flight are-

1) Lift: upward force (generated by wing)
2) Gravity: downward force (due to its weight)
3) Thrust: forward force (power of the Engine)
4) Drag: backward force (resistance of air).

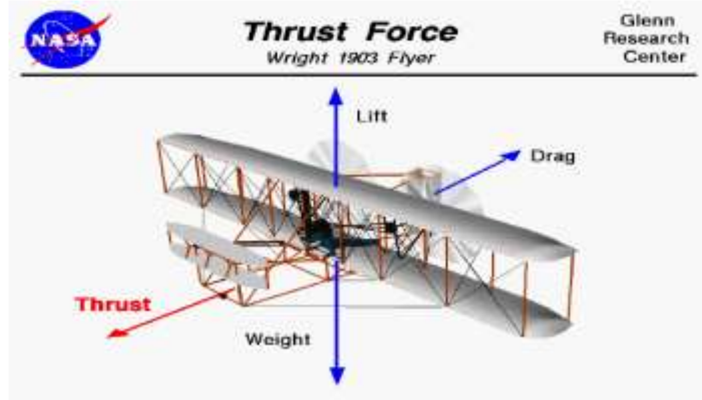


Fig1.4 Forces on glider:

Calculation

1. **Torque calculation:**

As per ratio of rpm and torque we can find the required torque of lifting our glider.

we know,

$$\frac{N1}{N2} = \frac{T2}{T1}$$

we know,

N_1 = engine actual rpm
N_2 = required rpm
T_2 = required torque in N.m
T_1 = actual torque in N.m

$$\frac{8000}{3000} = \frac{T2}{20}$$

$$T_2 = 8000 \times 20/3000$$

$$\mathbf{T_2 = 54 N.m}$$

2. Weight calculation:

Total weight of glider is given by,

$$W = W_1 + W_2 + W_3$$

W1 = weight of wings,
W2 = weight of base (including engine and propeller),
W3 = weight of pilot.

$$W = 40+70+60$$

$$\mathbf{W = 170\ Kg.}$$

3. For balancing,

We use symmetry theorem for balancing of wings.

2. Component of Glider

2.1 Base (Fuselage):

It is main part of whole glider assembly as comparing with convectional aircraft. The fuselage or base carries pilot, passenger, crew and controlling unit of glider.

The base is attached where camber is maximum, middle portion of glider where wings are attached.

We use 12feet long MS square pipes for base, by using Arc welding the cross section of base is trapezoidal so air resistance at front is less, the pilot seat is attached to the base.

Fig 2.1: Base

2.2 Aerodynamic wings:

Wings are most essential part of the glider, it helps glider to lift. When air is passed over wings due to its difference in curvature of upper and lower part lift is generated.

The wings are made from an aluminium strips with 3mm in thickness and 12feet long. By giving shape on the wooden mould. To withstand the high resistance of air we make a torsion box in wings with help of wooden ply.

Fig 2.2: Wings

2.3 Tail:

The 'Tail' is situated on the back side of a glider, also known as a stabilizer. It contains two component vertical component are known as 'Rudder' and horizontal component known as 'Elevator'. The rudder is used to turn glider to left or right. While the elevator is used during take-off and landing of the glider.

The rudder and elevator also provide vertical and horizontal stability to glider in mid-air.

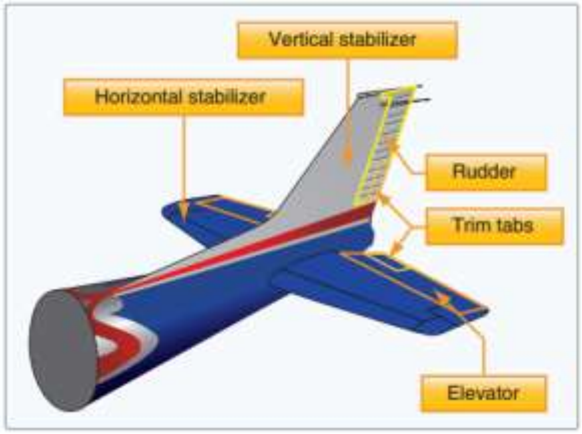


Fig 2.3: Tail

3. Welding process:

3.1 Gas Welding:

As we know the aluminium can only be weld by gas welding. Here we use oxy-carbide gas welding for making of wings structure and supports.

The various components of gas welding are:

- Oxygen tank
- Carbide tank
- Filler rod
- Torch

Fig 3.1.1 Gas welding

Fig 3.1.2 Oxygen tank

The oxygen tank provide oxygen to torch where oxy flame is produce the carbide is provided to torch by pipe arrangement. The filler rod is placed on metal due to high temperature generate which melts filler rod is melt and its get weld.

Fig 3.1.3 Carbide tank

3.2 Arc Welding:

The arc welding is used for joining of MS pipes, working on body or fuselage.

The base has to carry pilot seat, engine propeller assembly and handling assembly of glider. The whole assembly weight is situated on base of glider hence it should withstand. The arc welding is most preferable for making fuselage.

4. Fuel tank

Hero Karizma R version has 15litres Fuel capacity. A fuel tank (or petrol tank) shown in fig.7.1 is a safe container for flammable fluids. Though any storage tank for fuel may be so called, the term is typically applied to part of an engine system in which the fuel is stored and propelled (fuel pump) or released into an engine.

Fig 4.1: Fuel tank of glider.

5. Seating Arrangements

The seating arrangement of pilot is fixed to fuselage by arc welding.

Fig 5.1 Pilot seat

6. Battery

• The revolutionary Gas Recombination system eliminates water loss making the battery completely maintenance-free as shown in **fig.**

• The spill-proof design guards against the possibility of leakage, even if mounted in a tilted or inclined position in fig. 10.1.

• The advanced Lead-Calcium technology leads to low self-discharge.

• Unique Flame Arrestor ensures greater safety.

• The AGM construction gives superior cranking power and better resistance to vibration and hence makes this battery the most reliable in the market today.

• The permanently sealed VRLA battery comes factory-charged.

• It needs no refilling, electrolyte or water.

Fig 6.1: battery for engine

COST TABLE

Sr. No.	Material	Cost
1	Aluminium Pipes	15000
2	Aluminium Strips	1500
3	M.S. Pipes	1500
4	Engine	30000
5	Parachute Fabric	15000
6	Wooden Propeller	10000
7	Wheels	2000
8	Pulleys	500
9	Brake Wire	500
10	**Total**	**76,000/-**

CONCLUSION

1. The glider is used from the 19th century but they are much expensive, hence we are used 6063 aluminium alloy which is light and low-cost aluminium alloy.

2. The transportation of glider is easy because it has temporary joints. It can be assembled and disassemble very easily.

3. We use 4-stroke petrol engine for propulsion which is cheaper than actual Para motor engine used in the glider.

4. We used rudder for left and right movement of glider and elevator for up and down motion. We are using the wing for lift, no ailerons for movement.

5. The movement of the glider is easy compared to aircraft because of using pulleys and brake wire.

6. It is economical compared to actual glider engine which consumes more fuel.

ENGINE, POWER & TORQUE

Maximum Power	20 BHP	8000 RPM
Maximum Torque	19.70NM	6500 RPM
Bore	65.5 MM	

FUTURE SCOPE

1. Nowadays not much people are knows with this concept of the glider. There is some main reason which leads to the scope for the glider.

2. It can use for the military application, sports and various field.

3. It is used in the field of surveying and inspection of the larger area.

4. In near future, we can put am manufacturing firm for making low cost hang glider, paraglider etc.

5. It required less runway hence can be used for traveling, private flying experience, and transport.

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