SIMULATION OF RATE OF CLIMB FOR A SINGLE SEATER HOME BASED AIRCRAFT

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Abstract— **The rate of climb (RoC) is an aircraft's vertical speed - the rate of change in altitude. The rate of climb in an aircraft is indicated with a vertical speed indicator (VSI) or instantaneous vertical speed indicator (IVSI). The rate of decrease in altitude is referred to as the rate of descent or sink rate. A decrease in altitude corresponds with a negative rate of climb. The objective of this research is to simulate the rate of climb of a single seater home based aircraft using "C".**

Keywords- Simulation; rate of climb; aircraft; C; software.

INTRODUCTION

Aircraft Design

Three major types of airplane designs are

1. Conceptual design
2. Preliminary design
3. Detailed design

1.1 Conceptual design

It depends on what are the major factors for designing the aircraft.

1.1.1 Power plant Location

The Power plant location is either padded (or) Buried type engines are more preferred. Rear location is preferred for low drag, reduced shock & to the whole thrust.

1.1.2 Selection of Engine

The engine should be selected according to the power required.

1.1.3 Wing selection

The selection of wing depends upon the selection of

(1) Low wing
(2) Mid wing
(3) High wing

1.2. Preliminary design

Preliminary is based on Loitering. 'U' is the mathematical method of skinning the aircraft, the aircraft look like a masked body. Preliminary design is done with help of C SOFTWARE.

1.3. Detailed design

In the detailed design considers each & every rivets, bolts, paints etc. In this design the connection & allocations are made.

RATE OF CLIMB:

At steady state condition of flight for increase in power of engine there will have a corresponding increase of lift, if the elevators are operated suitably this increase in power can be used for the climbing flight with the nose up.

For such a flight L=W sinθ. The vertical velocity component Vsinθ is called rate of climb. In a climbing flight power is required for both of the following

1. To pull the aircraft weight up
2. To overcome the drag force,

$$\text{Rate of climb} = \left[\left(\text{T - W} \right) / \text{W} \right] \text{V}$$

=Excess power/W

This relation is true for small angles of climb. (Say $\theta<20^0$) Therefore, from the engine selection, the thrust available F=3235N

The thrust required at the altitude $= F \times \left(\frac{20-h}{20+h}\right)^{1.15}$

At altitude h=0, (sea level)

$$F_{required} = F\left(\frac{20}{20}\right)^{1.15}$$

$$F_{required} = 3235N$$

At h=1000m,

$$F_{required} = 3235\left(\frac{20-1}{20+1}\right)^{1.15}$$

$$F_{required} = 2.883N$$

At h=2000m,

$$F_{required} = 3235\left(\frac{20-2}{20+2}\right)^{1.15}$$

$$F_{required} = 2568N$$

At h=3000m,

$$F_{required} = 3235\left(\frac{20-3}{20+3}\right)^{1.15}$$

$$F_{required} = 2285N$$

At h=4000m,

$$F_{required} = 3235\left(\frac{20-4}{20+4}\right)^{1.15}$$

$$F_{required} = 2029N$$

Table – 1 at h=0, (sea level),

S.NO.	V(m/sec)	D(KN)	T(KN)	ROC
1	20	1.688	3.235	0.245
2	40	0.826	3.325	0.752
3	60	0.864	3.325	1.128
4	83.33	1.114	3.325	1.4016

Table – 2 at h=1000m,

S.NO.	V(m/sec)	D(KN)	T(KN)	ROC
1	20	1.835	2.883	0.1662
2	40	0.826	2.883	0.6525
3	60	0.826	2.883	0.9606
4	83.33	1.114	2.883	1.169

Table – 3 at h=2000m,

S.NO.	V(m/sec)	D(KN)	T(KN)	ROC
1	20	2.024	2.568	0.08628
2	40	0.867	2.568	0.5395
3	60	0.869	2.568	0.8084
4	83.33	1.082	2.568	0.9819

Table – 4 at h=3000m,

S.NO.	V(m/sec)	D(KN)	T(KN)	ROC
1	20	2.22	2.285	0.0103
2	40	0.909	2.285	0.4364
3	60	0.878	2.285	0.6694
4	83.33	1.078	2.285	0.7976

Table – 5 at h=4000m,

S.NO.	V(m/sec)	D(KN)	T(KN)	ROC
1	20	2.441	2.029	-0.06534
2	40	0.957	2.029	0.34
3	60	0.884	2.029	0.5448
4	83.33	1.069	2.029	0.6343

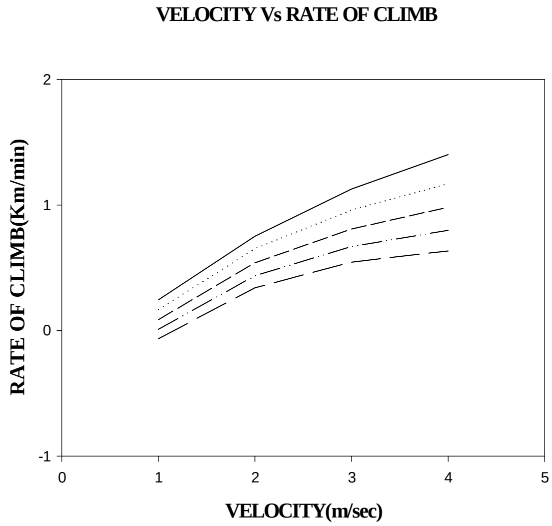

Fig.1. **Variation of ROC with respect to velocity**

Fig – 1 is drawn in between velocity and rate of climb. From the above graph we understand that

1. For steady climbing flight, lift and coefficient of lift are smaller than that in a steady level flight. Hence induced drag also smaller.

2. Consequently total drag for climbing flight becomes smaller than total drag for level flight at same velocity.

3. Hence a plot of drag power (i.e., drag x velocity) against velocity of flight for climbing flight will be totally different from same plot for level flight, as the drag is smaller during climbing than level flight at same flight velocity

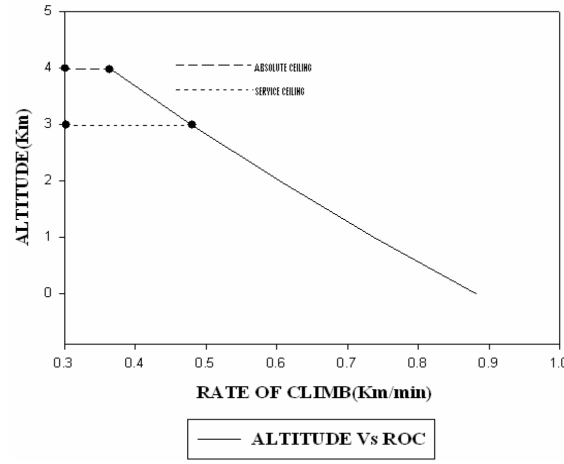

Fig.2. **Variation of ROC with respect to altitude**

Fig – 2 is drawn in between altitude and rate of climb from this above graph we should understand that rate of climb decreases with increase in altitude.

A. Absolute ceiling is termed as generally used to indicate the maximum height to which airplane can reach. At that altitude the power available and power required will be equal.

B. The service ceiling can be defined as the altitude at which the rate of climb is 100 units/units time.

C. The maximum rate of climb will not occur at maximum angle of climb.

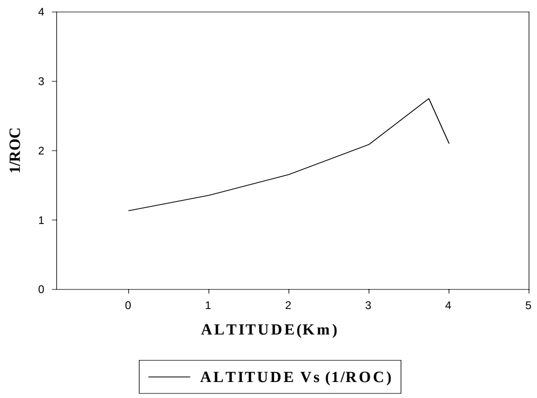

Fig.3 **Variation of 1 / ROC with respect to velocity**

Fig – 3 is drawn in between the 1/ROC and altitude. From this above graph we should understand that as altitude increases the 1/ROC value increases up to 3000m and after this altitude the value of 1/ROC value starts to decreases.

CONCLUSION

Thus by simulation we had determined the rate of climb of a single seater home based aircraft and found that as rate of climb increases with increase in velocity, rate of climb decreases with increase in altitude and as altitude increases the 1/ROC value increases up to 3000m and after this altitude the value of 1/ROC value starts to decreases.

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Dr. M.Venkatesan received the Ph.D Award from the International University of Contemporary Studies, Washington DC in 2009, Masters in Thermal Engineering (2001) and Bachelor Degree in Mechanical Engineering (1997) from University of Madras. He is currently working as Assistant Professor in Mekelle University – Ethiopia and he has also served as Vice Principal (Academics) in PMR Engineering College, Chennai, TamilNadu, India. He has more than 14+ years of experience in Teaching, Research and Administration at National and International Level. His fields of interests are various, viz., Alternative fuels, Heat Transfer, Aeronautics, Design, and Supply chain Management. He has more than 10 publications to his credit both in National and International Journals and conferences and has authored 5 books on Engineering viz., Engineering Mechanics, Aero Engineering Thermodynamics, Fluid Mechanics and Fluid Machinery, Engineering Graphics and Workshop Practice as per Anna University Chennai regulation. He has dedicated his whole soul and life to research and education and he has been serving as Editorial Board Member, Advisory Board Member and Editor-in-Chief for various International Journals.