



GLOBAL JOURNAL OF RESEARCHES IN ENGINEERING
AUTOMOTIVE ENGINEERING
Volume 13 Issue 2 Version 1.0 Year 2013
Type: Double Blind Peer Reviewed International Research Journal
Publisher: Global Journals Inc. (USA)
Online ISSN: 2249-4596 & Print ISSN: 0975-5861

Simulation of Rate of Climb for a Single Seater Home based Aircraft

By Dr. Meyyappan Venkatesan

Mekelle University, Ethiopia

Abstract- The rate of climb (RoC) is an aircraft's vertical speed - the rate of change in altitude (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".

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GJRE-B Classification : *FOR Code: 880399*



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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".

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I. INTRODUCTION

a) Aircraft Design

Three major types of airplane designs are

- Conceptual design
- Preliminary design
- Detailed design

b) Conceptual Design

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

i. 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.

ii. Selection of Engine

The engine should be selected according to the power required.

iii. Wing Selection

The selection of wing depends upon the selection of

- Low wing
- Mid wing
- High wing

c) 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.

d) Detailed Design

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

II. RATE OF CLIMB

At steady state condition of flight for increase in power of engine there will have a corresponding

Author: Assistant Professor, Mechanical Engineering, Mekelle University, Ethiopia. e-mail: Kmv1975@gmail.com

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 $L=W \sin\theta$. The vertical velocity component $V\sin\theta$ is called rate of climb. In a climbing flight power is required for both of the following

- To pull the aircraft weight up
- To overcome the drag force,

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

$$= \text{Excess power}/W$$

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

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

At altitude $h=0$, (sea level)

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

$$F_{\text{required}} = 3235N$$

At $h=1000m$,

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

$$F_{\text{required}} = 2.883N$$

At $h=2000m$,

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

$$F_{\text{required}} = 2568N$$

At $h=3000m$,

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

$$F_{\text{required}} = 2285N$$

At $h=4000m$,

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

$$F_{\text{required}} = 2029N$$

Table 1 : at h=0, (sea level)

S.NO.	V(m/sec)	D(KN)	T(KN)	$ROC = \frac{(T - D) \times 60 \times V}{W_o \times 9.81} \text{ (Km/min)}$
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)	$ROC = \frac{(T - D) \times 60 \times V}{W_o \times 9.81} \text{ (Km/min)}$
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)	$ROC = \frac{(T - D) \times 60 \times V}{W_o \times 9.81} \text{ (Km/min)}$
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)	$ROC = \frac{(T - D) \times 60 \times V}{W_o \times 9.81} \text{ (Km/min)}$
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)	$ROC = \frac{(T - D) \times 60 \times V}{W_o \times 9.81} \text{ (Km/min)}$
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

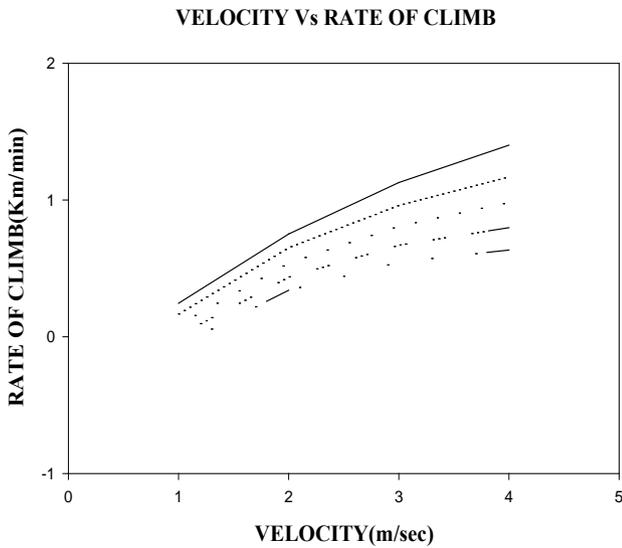


Figure 1 : Variation of ROC with respect to velocity

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

- For steady climbing flight, lift and coefficient of lift are smaller than that in a steady level flight. Hence induced drag also smaller.
- Consequently total drag for climbing flight becomes smaller than total drag for level flight at same velocity.
- 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.

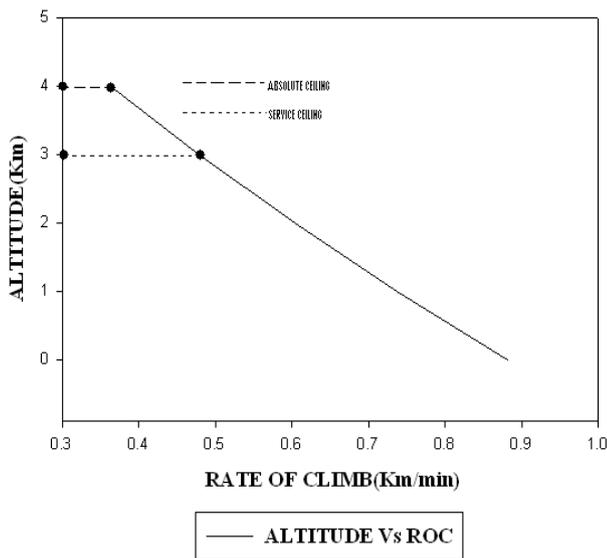


Figure 2 : Variation of ROC with respect to altitude

The above graph 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.

- 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.
- The service ceiling can be defined as the altitude at which the rate of climb is 100 units/units time.
- The maximum rate of climb will not occur at maximum angle of climb.

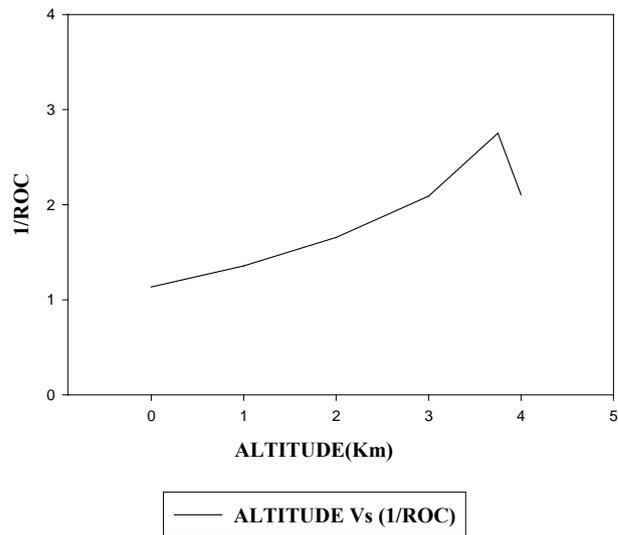


Figure 3 : Variation of 1 / ROC with respect to velocity

The above graph 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.

III. CONCLUSION

Thus by simulation we had determined the rate of climb, take – off and landing distance 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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