

A NASA X-45 hypersonic aircraft is shown in flight against a blue sky with light clouds. The aircraft is white with a dark blue stripe along the fuselage and a NASA logo on the tail. The registration number N932NA is visible on the side of the fuselage. The aircraft is angled upwards, suggesting a climb.

Climbing and descending flight- Introduction

Introduction to Aeronautical Engineering

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Steep climb



Fast climb



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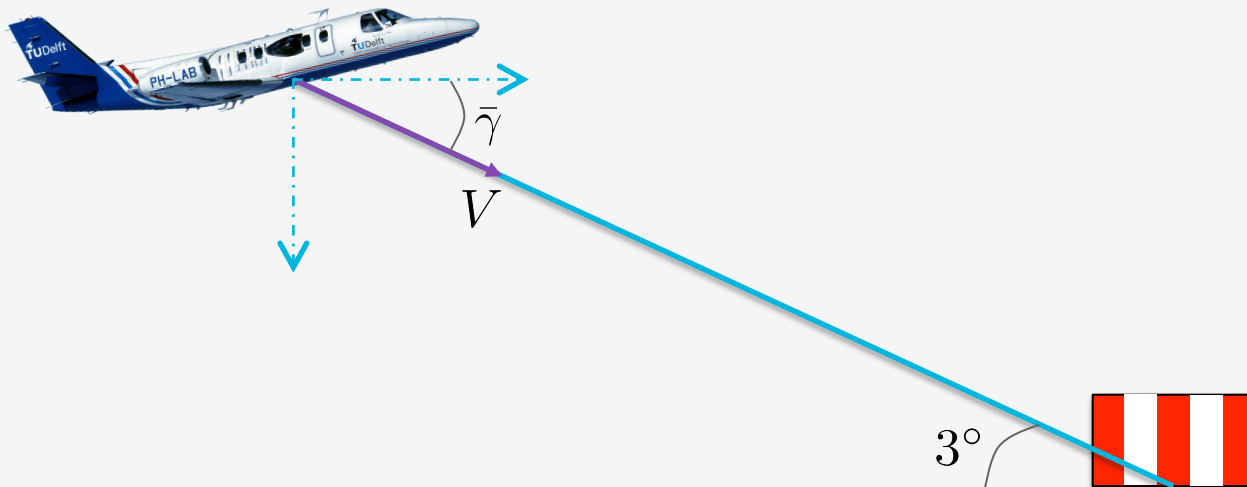
Glide distance



Minimum rate of descent



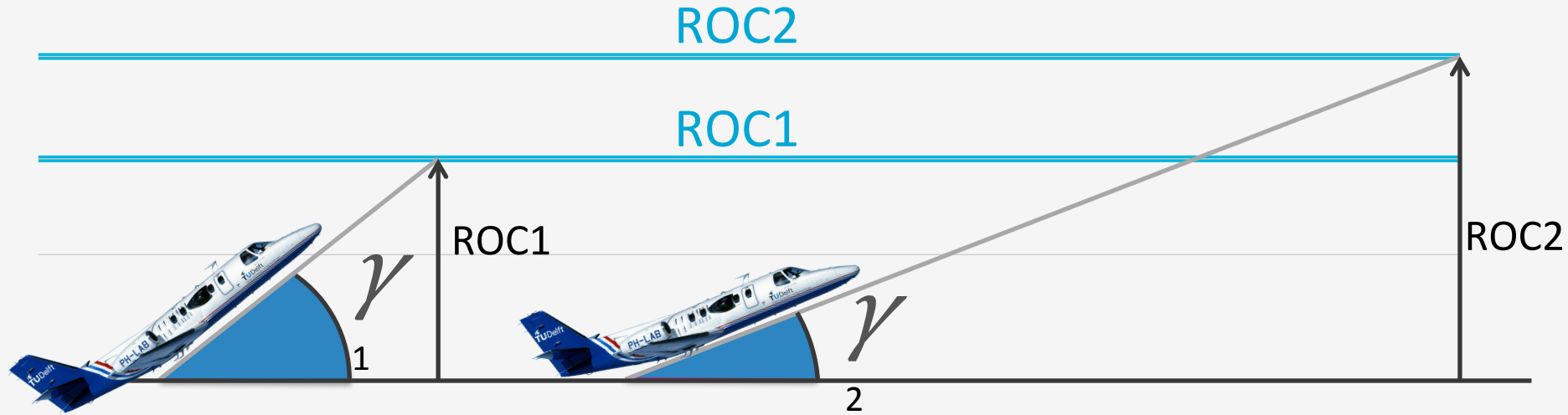
Glideslope



Glideslope (2)

- Fuel required
- Time
- Optimal airspeed

Rate of Climb (ROC) vs. flight path angle (γ)



$$\gamma_1 > \gamma_2$$

BUT

$$ROC1 < ROC2$$

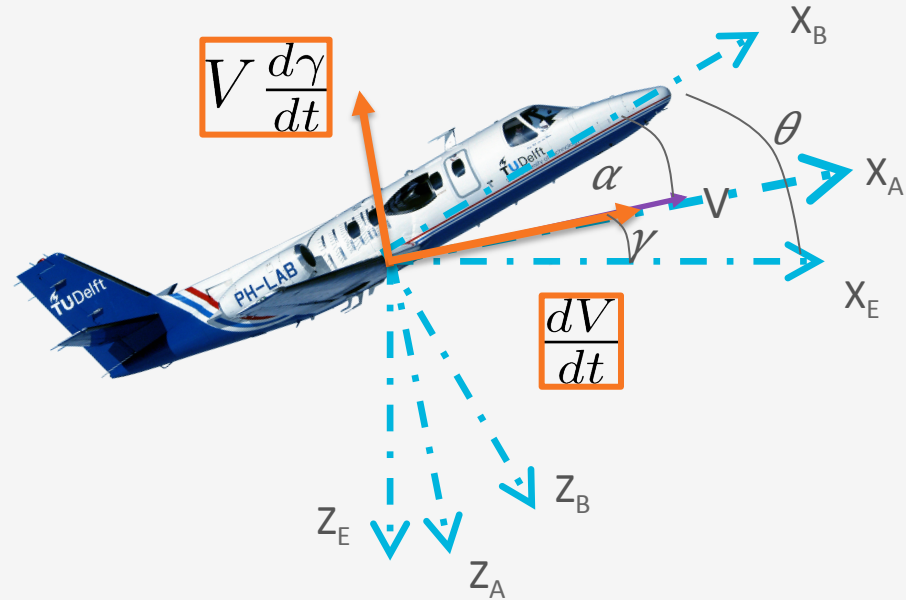
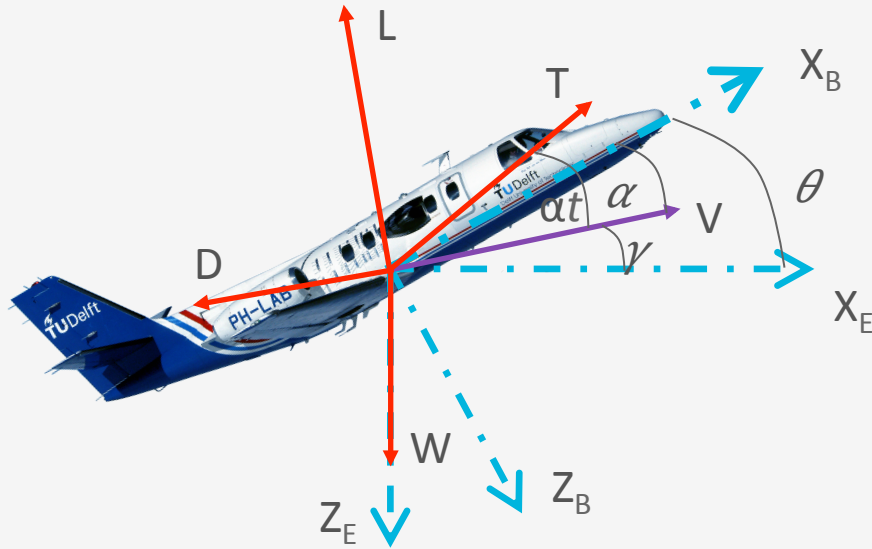
Importance of climb angle



Importance of rate of climb



Free-body & kinetic diagram



Equations of Motion

$$\sum F_{\parallel V} : \frac{W}{g} \frac{dV}{dt} = T \cos \alpha_t - D - W \sin \gamma$$

$$\sum F_{\perp V} : \frac{W}{g} V \frac{d\gamma}{dt} = L - W \cos \gamma + T \sin \alpha_t$$

Equations of Motion

$$L = W$$

$$\sin \gamma = \frac{T-D}{W}$$

$$V \sin \gamma = \frac{P_a - P_r}{W} = \text{ROC}$$

A NASA X-45 hypersonic aircraft is shown in a steep climb against a clear blue sky. The aircraft is white with a blue stripe along the fuselage and a NASA logo on the tail. The registration number N932NA is visible on the side of the fuselage. A semi-transparent dark blue rectangle is overlaid on the image, containing the title text.

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