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Wing-Tail Contribution Formulas

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List of 15 Wing-Tail Contribution Formulas

Wing-Tail Contribution

1) Angle of Attack at Tail

Open Calculator

fx $\alpha_t = \alpha_w - i_w - \varepsilon + i_t$

ex $0.77\text{rad} = 0.083\text{rad} - 0.078\text{rad} - 0.095\text{rad} + 0.86\text{rad}$

2) Angle of Attack of Wing

Open Calculator

fx $\alpha_w = \alpha_t + i_w + \varepsilon - i_t$

ex $0.083\text{rad} = 0.77\text{rad} + 0.078\text{rad} + 0.095\text{rad} - 0.86\text{rad}$

3) Angle of incidence of tail

Open Calculator

fx $i_t = \alpha_t - \alpha_w + i_w + \varepsilon$

ex $0.86\text{rad} = 0.77\text{rad} - 0.083\text{rad} + 0.078\text{rad} + 0.095\text{rad}$

4) Angle of incidence of wing

Open Calculator

fx $i_w = \alpha_w - \alpha_t - \varepsilon + i_t$

ex $0.078\text{rad} = 0.083\text{rad} - 0.77\text{rad} - 0.095\text{rad} + 0.86\text{rad}$

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5) Downwash angle

Open Calculator

$$\varepsilon = \alpha_w - i_w - \alpha_t + i_t$$

$$0.095\text{rad} = 0.083\text{rad} - 0.078\text{rad} - 0.77\text{rad} + 0.86\text{rad}$$

6) Lift due to Tail only

Open Calculator

$$L_t = F_L - L_w$$

$$273.04\text{N} = 1073.04\text{N} - 800\text{N}$$

7) Lift due to Wing only

Open Calculator

$$L_w = F_L - L_t$$

$$800\text{N} = 1073.04\text{N} - 273.04\text{N}$$

8) Tail area for given tail efficiency

Open Calculator

$$S_t = S \cdot \frac{C_L - CW_{lift}}{CT_{lift} \cdot \eta}$$

$$1.803768\text{m}^2 = 5.08\text{m}^2 \cdot \frac{1.108 - 1.01}{0.3 \cdot 0.92}$$

9) Tail Efficiency for given lift coefficients

Open Calculator

$$\eta = S \cdot \frac{C_L - CW_{lift}}{CT_{lift} \cdot S_t}$$

$$0.921926 = 5.08\text{m}^2 \cdot \frac{1.108 - 1.01}{0.3 \cdot 1.8\text{m}^2}$$

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10) Tail Lift Coefficient for given Pitching Moment

Open Calculator

$$\mathrm{CT_{lift}} = -2 \cdot \frac{\mathrm{M_t}}{\boldsymbol{l_t} \cdot \rho_\infty \cdot \mathrm{V_{tail}^2} \cdot \mathrm{S_t}}$$

$$0.3 = -2 \cdot \frac{\text{-218.6644N*m}}{0.801511\text{m} \cdot 1.225\text{kg/m}^3 \cdot (28.72\text{m/s})^2 \cdot 1.8\text{m}^2}$$

11) Tail Lift Coefficient for given Pitching Moment Coefficient

Open Calculator

$$\mathrm{CT_{lift}} = -\left(\mathrm{Cm_t} \cdot \mathrm{S} \cdot \frac{\mathrm{c_{ma}}}{\eta \cdot \mathrm{S_t} \cdot \boldsymbol{l_t}}\right)$$

$$0.29853 = -\left(\text{-0.39} \cdot 5.08\text{m}^2 \cdot \frac{0.2\text{m}}{0.92 \cdot 1.8\text{m}^2 \cdot 0.801511\text{m}}\right)$$

12) Tail Lift Coefficient of Wing-Tail Combination

Open Calculator

$$\mathrm{CT_{lift}} = \mathrm{S} \cdot \frac{\mathrm{C_L} - \mathrm{CW_{lift}}}{\eta \cdot \mathrm{S_t}}$$

$$0.300628 = 5.08\text{m}^2 \cdot \frac{1.108 - 1.01}{0.92 \cdot 1.8\text{m}^2}$$

13) Total Lift Coefficient of Wing-Tail Combination

Open Calculator

$$\mathrm{C_L} = \mathrm{CW_{lift}} + \left(\eta \cdot \mathrm{S_t} \cdot \frac{\mathrm{CT_{lift}}}{\mathrm{S}}\right)$$

$$1.107795 = 1.01 + \left(0.92 \cdot 1.8\text{m}^2 \cdot \frac{0.3}{5.08\text{m}^2}\right)$$

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14) Total Lift of Wing-Tail Combination

Open Calculator

fx $$F_L = L_w + L_t$$

ex $$1073.04\text{N} = 800\text{N} + 273.04\text{N}$$

15) Wing Lift Coefficient of wing-tail combination

Open Calculator

fx $$CW_{lift} = C_L - \left(\eta \cdot S_t \cdot \frac{CT_{lift}}{S}\right)$$

ex $$1.010205 = 1.108 - \left(0.92 \cdot 1.8\text{m}^2 \cdot \frac{0.3}{5.08\text{m}^2}\right)$$

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Variables Used

- C_L Lift Coefficient
- c_{ma} Mean Aerodynamic Chord *(Meter)*
- Cm_t Tail Pitching Moment Coefficient
- CT_{lift} Tail Lift Coefficient
- CW_{lift} Wing Lift Coefficient
- F_L Lift Force *(Newton)*
- L_t Lift due to Tail *(Newton)*
- L_w Lift due to Wing *(Newton)*
- M_t Pitching Moment due to Tail *(Newton Meter)*
- S Reference Area *(Square Meter)*
- S_t Horizontal Tail Area *(Square Meter)*
- V_{tail} Velocity Tail *(Meter per Second)*
- α_t Horizontal Tail Angle of Attack *(Radian)*
- α_w Wing Angle of Attack *(Radian)*
- ε Downwash Angle *(Radian)*
- η Tail Efficiency
- ρ_∞ Freestream Density *(Kilogram per Cubic Meter)*
- i_t Tail Incidence Angle *(Radian)*
- i_w Wing Incidence Angle *(Radian)*
- l_t Horizontal Tail Moment Arm *(Meter)*

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Constants, Functions, Measurements used

- Measurement: **Length** in Meter (m)
  Length Unit Conversion
- Measurement: **Area** in Square Meter (m²)
  Area Unit Conversion
- Measurement: **Speed** in Meter per Second (m/s)
  Speed Unit Conversion
- Measurement: **Force** in Newton (N)
  Force Unit Conversion
- Measurement: **Angle** in Radian (rad)
  Angle Unit Conversion
- Measurement: **Density** in Kilogram per Cubic Meter (kg/m³)
  Density Unit Conversion
- Measurement: **Moment of Force** in Newton Meter (N*m)
  Moment of Force Unit Conversion

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Check other formula lists

- **Tail Contribution Formulas**
- **Wing-Tail Contribution Formulas**

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