



# Vertical Tail Contribution Formulas

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## **List of 24 Vertical Tail Contribution Formulas**

## **Vertical Tail Contribution**

1) Moment Produced by Vertical Tail for given Lift Curve Slope

$$\mathbf{K} \left[ \mathbf{N}_{\mathrm{v}} = oldsymbol{l}_{\mathrm{v}} \cdot \mathbf{C}_{\mathrm{v}} \cdot (eta + \sigma) \cdot \mathbf{Q}_{\mathrm{v}} \cdot \mathbf{S}_{\mathrm{v}} 
ight]$$

Open Calculator 🗗

 $\mathbf{ex} = 5.4054 \mathrm{N^*m} = 1.2 \mathrm{m} \cdot 0.7 \mathrm{rad^{-1}} \cdot (0.05 \mathrm{rad} + 0.067 \mathrm{rad}) \cdot 11 \mathrm{Pa} \cdot 5 \mathrm{m^2}$ 

2) Moment Produced by Vertical Tail for given Moment Coefficient

$$N_{v} = C_{n} \cdot Q_{w} \cdot b \cdot S$$

Open Calculator

 $= 5.398008N*m = 1.4 \cdot 0.66Pa \cdot 1.15m \cdot 5.08m^{2}$ 

3) Moment Produced by Vertical Tail for given Side Force

$$\mathbf{f} \mathbf{x} egin{bmatrix} \mathbf{N}_{\mathrm{v}} = -(oldsymbol{l}_{\mathrm{v}} \cdot \mathbf{Y}_{\mathrm{v}}) \end{bmatrix}$$

Open Calculator

 $[5.082N*m = -(1.2m \cdot -4.235N)]$ 

4) Vertical Tail Angle of Attack

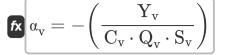
fx 
$$lpha_{
m v} = \sigma + eta$$

Open Calculator

0.117 rad = 0.067 rad + 0.05 rad



## 5) Vertical Tail Angle of Attack for given Vertical Tail Side Force



Open Calculator 🗗

$$egin{aligned} \mathbf{ex} \ 0.11 \mathrm{rad} = -igg(rac{-4.235 \mathrm{N}}{0.7 \mathrm{rad}^{-1} \cdot 11 \mathrm{Pa} \cdot 5 \mathrm{m}^2}igg) \end{aligned}$$

## 6) Vertical Tail Area for given Moment

$$\mathbf{f}_{\mathbf{v}} egin{aligned} \mathbf{f}_{\mathbf{v}} & \mathbf{N}_{\mathbf{v}} \ & oldsymbol{l}_{\mathbf{v}} \cdot \mathbf{C}_{\mathbf{v}} \cdot (\mathbf{eta} + \mathbf{\sigma}) \cdot \mathbf{Q}_{\mathbf{v}} \end{aligned}$$

Open Calculator

$$oxed{4.995005 \mathrm{m}^{2} = rac{5.4 \mathrm{N^{*}m}}{1.2 \mathrm{m} \cdot 0.7 \mathrm{rad^{-1}} \cdot (0.05 \mathrm{rad} + 0.067 \mathrm{rad}) \cdot 11 \mathrm{Pa}}}$$

## 7) Vertical Tail Area for given Vertical Tail Side Force

$$\mathbf{S_v} = -rac{\mathbf{Y_v}}{\mathbf{C_v} \cdot \mathbf{lpha_v} \cdot \mathbf{Q_v}}$$

Open Calculator 🚰

$$oxed{4.700855 m^2 = -rac{-4.235 N}{0.7 rad^{-1} \cdot 0.117 rad \cdot 11 Pa}}$$

## 8) Vertical tail area for given vertical tail volume ratio

$$\left[\mathbf{S}_{\mathrm{v}} = \mathbf{V}_{\mathrm{v}} \cdot \mathbf{S} \cdot rac{\mathrm{b}}{oldsymbol{l}_{\mathrm{v}}}
ight]$$

Open Calculator

$$4.9657 ext{m}^2 = 1.02 \cdot 5.08 ext{m}^2 \cdot rac{1.15 ext{m}}{1.2 ext{m}}$$





#### 9) Vertical Tail Area for given Yawing Moment Coefficient

 $\left. \mathbf{S}_{\mathrm{v}} = \mathrm{C_n} \cdot rac{\mathrm{S} \cdot \mathrm{b} \cdot \mathrm{Q_w}}{oldsymbol{l_{\mathrm{v}}} \cdot \mathrm{Q_v} \cdot \mathrm{C_v} \cdot (eta + \sigma)} 
ight|$ 

Open Calculator

## 10) Vertical Tail Dynamic Pressure for given Vertical Tail Side Force

 $\left|\mathbf{R} \left| \mathbf{Q}_{\mathrm{v}} = - \left( rac{\mathbf{Y}_{\mathrm{v}}}{\mathbf{C}_{\mathrm{v}} \cdot \mathbf{a}_{\mathrm{v}} \cdot \mathbf{S}_{\mathrm{v}}} 
ight) 
ight|$ 

Open Calculator

 $extbf{ex} \left| 10.34188 ext{Pa} = - \left( rac{ ext{-}4.235 ext{N}}{0.7 ext{rad}^{ ext{-}1} \cdot 0.117 ext{rad} \cdot 5 ext{m}^2} 
ight) 
ight|$ 

## 11) Vertical Tail Efficiency

 $\eta_{
m v}=rac{Q_{
m v}}{Q_{
m w}}$  ex  $16.66667=rac{11Pa}{0.66Pa}$ 

Open Calculator

12) Vertical Tail Efficiency for given Yawing Moment Coefficient

$$\eta_{
m v} = rac{{
m C_n}}{{
m V_v \cdot C_v \cdot (eta + \sigma)}}$$

Open Calculator 🗗



#### 13) Vertical Tail Lift Curve Slope

 $\left[ \mathbf{C}_{\mathrm{v}} = - \left( rac{\mathbf{Y}_{\mathrm{v}}}{\mathbf{lpha}_{\mathrm{v}} \cdot \mathbf{Q}_{\mathrm{v}} \cdot \mathbf{S}_{\mathrm{v}}} 
ight) 
ight]$ 

Open Calculator 🗗

 $oxed{ex} \left[ 0.65812 \mathrm{rad}^{\scriptscriptstyle{-1}} = - \Bigg( rac{-4.235 \mathrm{N}}{0.117 \mathrm{rad} \cdot 11 \mathrm{Pa} \cdot 5 \mathrm{m}^2} \Bigg) 
ight]$ 

## 14) Vertical Tail Lift Curve Slope for Given Moment

 $extbf{C}_{ ext{v}} = rac{ ext{N}_{ ext{v}}}{m{l}_{ ext{v}} \cdot (m{eta} + m{\sigma}) \cdot ext{Q}_{ ext{v}} \cdot ext{S}_{ ext{v}}}$ 

Open Calculator

 $oxed{ex} 0.699301 \mathrm{rad^{ ext{--}1}} = rac{5.4 \mathrm{N^*m}}{1.2 \mathrm{m} \cdot (0.05 \mathrm{rad} + 0.067 \mathrm{rad}) \cdot 11 \mathrm{Pa} \cdot 5 \mathrm{m^2}}$ 

## 15) Vertical Tail Lift Curve Slope for given Vertical Tail Efficiency

 $\mathbf{K} \ \mathrm{C_v} = rac{\mathrm{C_n}}{\mathrm{V_v} \cdot \mathrm{\eta_v} \cdot (eta + \sigma)}$ 

Open Calculator 🚰

 $0.704153 {\rm rad}^{-1} = \frac{1.4}{1.02 \cdot 16.66 \cdot (0.05 {\rm rad} + 0.067 {\rm rad})}$   $\textbf{16) Vertical Tail Lift Curve Slope for given Yawing Moment Coefficient} \quad \textbf{C}$ 

## \_ Q

 $\mathbf{C}_{\mathrm{v}} = \mathrm{C}_{\mathrm{n}} \cdot \mathrm{S} \cdot \mathrm{b} \cdot rac{\mathrm{Q}_{\mathrm{w}}}{oldsymbol{l}_{\mathrm{v}} \cdot \mathrm{S}_{\mathrm{v}} \cdot \mathrm{Q}_{\mathrm{v}} \cdot (eta + \sigma)}$ 

Open Calculator 🗗

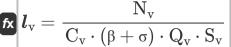
ex

 $0.699043 ext{rad}^{_{-1}} = 1.4 \cdot 5.08 ext{m}^2 \cdot 1.15 ext{m} \cdot rac{0.66 ext{Pa}}{1.2 ext{m} \cdot 5 ext{m}^2 \cdot 11 ext{Pa} \cdot \left(0.05 ext{rad} + 0.067 ext{rad}
ight)}$ 





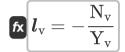
#### 17) Vertical Tail Moment Arm for given Lift Curve Slope 🗗



Open Calculator

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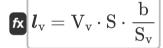
## 18) Vertical Tail Moment Arm for given Side Force



Open Calculator 🗗

$$\boxed{1.275089 \text{m} = -\frac{5.4 \text{N*m}}{-4.235 \text{N}}}$$

## 19) Vertical Tail Moment Arm for given Vertical Tail Volume Ratio



Open Calculator 🗗

$$\boxed{ 1.191768 \text{m} = 1.02 \cdot 5.08 \text{m}^2 \cdot \frac{1.15 \text{m}}{5 \text{m}^2} }$$

## 20) Vertical Tail Moment Arm for Given Yawing Moment Coefficient

$$m{l}_{
m v} = rac{
m C_n}{
m S_v \cdot Q_v \cdot C_v \cdot rac{eta + \sigma}{
m S \cdot b \cdot Q_w}}$$

Open Calculator 🗗

$$= \frac{1.4}{5 m^2 \cdot 11 Pa \cdot 0.7 rad^{-1} \cdot \frac{0.05 rad + 0.067 rad}{5.08 m^2 \cdot 1.15 m \cdot 0.66 Pa} }$$



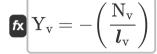
#### 21) Vertical Tail Side Force

fx  $Y_v = -C_v \cdot lpha_v \cdot S_v \cdot Q_v$ 

Open Calculator

 $extstyle{\textbf{ex}}$   $-4.5045 ext{N} = -0.7 ext{rad}^{-_1} \cdot 0.117 ext{rad} \cdot 5 ext{m}^2 \cdot 11 ext{Pa}$ 

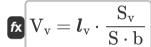
#### 22) Vertical Tail Side Force for Given Moment



Open Calculator 🗗

 $\boxed{ -4.5 \mathrm{N} = - \bigg( \frac{5.4 \mathrm{N^* m}}{1.2 \mathrm{m}} \bigg) }$ 

#### 23) Vertical tail volume ratio



Open Calculator

ex  $1.027046 = 1.2 \mathrm{m} \cdot rac{5 \mathrm{m}^2}{5.08 \mathrm{m}^2 \cdot 1.15 \mathrm{m}}$ 

## 24) Vertical Tail Volume Ratio for given Yawing Moment Coefficient

$$V_{
m v} = rac{{
m C}_{
m n}}{\eta_{
m v} \cdot {
m C}_{
m v} \cdot (eta + \sigma)}$$

Open Calculator



#### Variables Used

- **b** Wingspan (Meter)
- Cn Yawing Moment Coefficient
- C<sub>v</sub> Vertical Tail Lift Curve Slope (1 per Radian)
- N<sub>v</sub> Vertical Tail Moment (Newton Meter)
- Q<sub>v</sub> Vertical Tail Dynamic Pressure (Pascal)
- **Q**<sub>w</sub> Wing Dynamic Pressure (Pascal)
- S Reference Area (Square Meter)
- S<sub>v</sub> Vertical Tail Area (Square Meter)
- V<sub>v</sub> Vertical Tail Volume Ratio
- Y<sub>v</sub> Vertical Tail Side Force (Newton)
- α<sub>V</sub> Vertical Tail Angle of Attack (Radian)
- β Sideslip Angle (Radian)
- η<sub>V</sub> Vertical Tail Efficiency
- σ Sidewash Angle (Radian)
- **l**<sub>v</sub> Vertical Tail Moment Arm (*Meter*)





## Constants, Functions, Measurements used

- Measurement: Length in Meter (m)
   Length Unit Conversion
- Measurement: Area in Square Meter (m²)

  Area Unit Conversion
- Measurement: Pressure in Pascal (Pa)
  Pressure Unit Conversion
- Measurement: Force in Newton (N)
  Force Unit Conversion
- Measurement: Angle in Radian (rad)
   Angle Unit Conversion
- Measurement: Moment of Force in Newton Meter (N\*m)
   Moment of Force Unit Conversion
- Measurement: Reciprocal Angle in 1 per Radian (rad<sup>-1</sup>)

  Reciprocal Angle Unit Conversion





#### **Check other formula lists**

- Aerodynamic Parameters
   Formulas
- Vertical Tail Contribution Formulas
- Wing-Tail Interaction Formulas

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