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Lift Distribution Formulas

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List of 30 Lift Distribution Formulas

Lift Distribution

Elliptical Lift Distribution

1) Aspect Ratio given Induced Angle of Attack

Open Calculator

fx $$\mathrm{AR_{ELD}} = \frac{\mathrm{C_{L,ELD}}}{\pi \cdot \alpha_{i}}$$

ex $$2.470395 = \frac{1.49}{\pi \cdot 11^{\circ}}$$

2) Aspect Ratio given Induced Drag Coefficient

Open Calculator

fx $$\mathrm{AR_{ELD}} = \frac{\mathrm{C_{L,ELD}^{2}}}{\pi \cdot \mathrm{C_{D,i,ELD}}}$$

ex $$2.453749 = \frac{(1.49)^{2}}{\pi \cdot 0.288}$$

3) Circulation at given Distance along Wingspan

Open Calculator

$$\Gamma = \Gamma_o \cdot \sqrt{1 - \left(2 \cdot \frac{a}{b}\right)^2}$$

$$13.99862\text{m}^2/\text{s} = 14\text{m}^2/\text{s} \cdot \sqrt{1 - \left(2 \cdot \frac{16.4\text{mm}}{2340\text{mm}}\right)^2}$$

4) Circulation at Origin given Downwash

Open Calculator

$$\Gamma_o = -2 \cdot w \cdot b$$

$$14.04\text{m}^2/\text{s} = -2 \cdot -3\text{m}/\text{s} \cdot 2340\text{mm}$$

5) Circulation at Origin given Induced Angle of Attack

Open Calculator

$$\Gamma_o = 2 \cdot b \cdot \alpha_i \cdot V_\infty$$

$$13.92668\text{m}^2/\text{s} = 2 \cdot 2340\text{mm} \cdot 11^\circ \cdot 15.5\text{m}/\text{s}$$

6) Circulation at Origin given Lift of Wing

Open Calculator

$$\Gamma_o = 4 \cdot \frac{F_L}{\rho_\infty \cdot V_\infty \cdot b \cdot \pi}$$

$$14.0074\text{m}^2/\text{s} = 4 \cdot \frac{488.8\text{N}}{1.225\text{kg}/\text{m}^3 \cdot 15.5\text{m}/\text{s} \cdot 2340\text{mm} \cdot \pi}$$

7) Circulation at Origin in Elliptical Lift Distribution

Open Calculator

fx $$\Gamma_o = 2 \cdot V_\infty \cdot S_0 \cdot \frac{C_l}{\pi \cdot b}$$

ex $$13.97911 m^2/s = 2 \cdot 15.5 m/s \cdot 2.21 m^2 \cdot \frac{1.5}{\pi \cdot 2340 mm}$$

8) Coefficient of Lift given Circulation at Origin

Open Calculator

fx $$C_{L,ELD} = \pi \cdot b \cdot \frac{\Gamma_o}{2 \cdot V_\infty \cdot S_0}$$

ex $$1.502242 = \pi \cdot 2340 mm \cdot \frac{14 m^2/s}{2 \cdot 15.5 m/s \cdot 2.21 m^2}$$

9) Coefficient of Lift given Induced Angle of Attack

Open Calculator

fx $$C_{L,ELD} = \pi \cdot \alpha_i \cdot AR_{ELD}$$

ex $$1.495793 = \pi \cdot 11^\circ \cdot 2.48$$

10) Coefficient of Lift given Induced Drag Coefficient

Open Calculator

fx $$C_{L,ELD} = \sqrt{\pi \cdot AR_{ELD} \cdot C_{D,i,ELD}}$$

ex $$1.497949 = \sqrt{\pi \cdot 2.48 \cdot 0.288}$$

11) Downwash in Elliptical Lift Distribution

Open Calculator

$$w = -\frac{\Gamma_o}{2 \cdot b}$$

$$-2.991453\text{m/s} = -\frac{14\text{m}^2/\text{s}}{2 \cdot 2340\text{mm}}$$

12) Freestream Velocity given Circulation at Origin

Open Calculator

$$V_\infty = \pi \cdot b \cdot \frac{\Gamma_o}{2 \cdot S_0 \cdot C_{L,ELD}}$$

$$15.62735\text{m/s} = \pi \cdot 2340\text{mm} \cdot \frac{14\text{m}^2/\text{s}}{2 \cdot 2.21\text{m}^2 \cdot 1.49}$$

13) Freestream Velocity given Induced Angle of Attack

Open Calculator

$$V_\infty = \frac{\Gamma_o}{2 \cdot b \cdot \alpha_i}$$

$$15.5816\text{m/s} = \frac{14\text{m}^2/\text{s}}{2 \cdot 2340\text{mm} \cdot 11^\circ}$$

14) Induced Angle of Attack given Aspect Ratio

Open Calculator

$$\alpha_i = \frac{C_l}{\pi \cdot AR_{ELD}}$$

$$11.03094^\circ = \frac{1.5}{\pi \cdot 2.48}$$

15) Induced Angle of Attack given Circulation at Origin

Open Calculator

fx $$\alpha_i = \frac{\Gamma_o}{2 \cdot b \cdot V_\infty}$$

ex $$11.05791^\circ = \frac{14\text{m}^2/\text{s}}{2 \cdot 2340\text{mm} \cdot 15.5\text{m/s}}$$

16) Induced Angle of Attack given Coefficient of Lift

Open Calculator

fx $$\alpha_i = S_0 \cdot \frac{C_l}{\pi \cdot b^2}$$

ex $$11.04141^\circ = 2.21\text{m}^2 \cdot \frac{1.5}{\pi \cdot (2340\text{mm})^2}$$

17) Induced Angle of Attack given Downwash

Open Calculator

fx $$\alpha_i = -\left(\frac{w}{V_\infty}\right)$$

ex $$11.08951^\circ = -\left(\frac{-3\text{m/s}}{15.5\text{m/s}}\right)$$

18) Induced Drag Coefficient given Aspect Ratio

Open Calculator

fx $$C_{D,i,ELD} = \frac{C_{L,ELD}^2}{\pi \cdot AR_{ELD}}$$

ex $$0.284952 = \frac{(1.49)^2}{\pi \cdot 2.48}$$

19) Lift at given Distance along Wingspan

Open Calculator

fx $$L = \rho_{\infty} \cdot V_{\infty} \cdot \Gamma_o \cdot \sqrt{1 - \left(2 \cdot \frac{a}{b}\right)^2}$$

ex $$265.7989\text{N} = 1.225\text{kg/m}^3 \cdot 15.5\text{m/s} \cdot 14\text{m}^2\text{/s} \cdot \sqrt{1 - \left(2 \cdot \frac{16.4\text{mm}}{2340\text{mm}}\right)^2}$$

20) Lift of Wing given Circulation at Origin

Open Calculator

fx $$F_L = \frac{\pi \cdot \rho_{\infty} \cdot V_{\infty} \cdot b \cdot \Gamma_o}{4}$$

ex $$488.5416\text{N} = \frac{\pi \cdot 1.225\text{kg/m}^3 \cdot 15.5\text{m/s} \cdot 2340\text{mm} \cdot 14\text{m}^2\text{/s}}{4}$$

General Lift Distribution

21) Aspect Ratio given Induced Drag Factor

Open Calculator

fx $$AR_{GLD} = \frac{(1 + \delta) \cdot C_{L,GLD}^2}{\pi \cdot C_{D,i,GLD}}$$

ex $$15.04641 = \frac{(1 + 0.05) \cdot (1.47)^2}{\pi \cdot 0.048}$$

22) Induced Drag Coefficient given Induced Drag Factor

Open Calculator

fx $$C_{D,i,GLD} = \frac{(1+\delta)\cdot C_{L,GLD}^2}{\pi \cdot AR_{GLD}}$$

ex $$0.048149 = \frac{(1+0.05)\cdot (1.47)^2}{\pi \cdot 15}$$

23) Induced Drag Coefficient given Span Efficiency Factor

Open Calculator

fx $$C_{D,i,GLD} = \frac{C_{L,GLD}^2}{\pi \cdot e_{span} \cdot AR_{GLD}}$$

ex $$0.048269 = \frac{(1.47)^2}{\pi \cdot 0.95 \cdot 15}$$

24) Induced Drag Factor given Induced Drag Coefficient

Open Calculator

fx $$\delta = \frac{\pi \cdot AR_{GLD} \cdot C_{D,i,GLD}}{C_{L,GLD}^2} - 1$$

ex $$0.046761 = \frac{\pi \cdot 15 \cdot 0.048}{(1.47)^2} - 1$$

25) Induced Drag Factor given Span Efficiency Factor

Open Calculator

fx $$\delta = e_{span}^{-1} - 1$$

ex $$0.052632 = (0.95)^{-1} - 1$$

26) Induced Lift Slope Factor given Lift Curve Slope of Finite Wing

Open Calculator

fx
$$\tau_{FW} = \frac{\pi \cdot AR_{GLD} \cdot \left(\frac{a_0}{a_{C,l}} - 1\right)}{a_0} - 1$$

ex
$$0.002313 = \frac{\pi \cdot 15 \cdot \left(\frac{6.28\text{rad}^{-1}}{5.54\text{rad}^{-1}} - 1\right)}{6.28\text{rad}^{-1}} - 1$$

27) Lift Coefficient given Induced Drag Factor

Open Calculator

fx
$$C_{L,GLD} = \sqrt{\frac{\pi \cdot AR_{GLD} \cdot C_{D,i,GLD}}{1 + \delta}}$$

ex
$$1.467731 = \sqrt{\frac{\pi \cdot 15 \cdot 0.048}{1 + 0.05}}$$

28) Lift Coefficient given Span Efficiency Factor

Open Calculator

fx
$$C_{L,GLD} = \sqrt{\pi \cdot e_{span} \cdot AR_{GLD} \cdot C_{D,i,GLD}}$$

ex
$$1.465895 = \sqrt{\pi \cdot 0.95 \cdot 15 \cdot 0.048}$$

29) Span Efficiency Factor

Open Calculator

fx
$$e_{span} = (1 + \delta)^{-1}$$

ex
$$0.952381 = (1 + 0.05)^{-1}$$

30) Span Efficiency Factor given Induced Drag Coefficient

Open Calculator

fx $$e_{span} = \frac{C_{L,GLD}^2}{\pi \cdot AR_{GLD} \cdot C_{D,i,GLD}}$$

ex $$0.955328 = \frac{(1.47)^2}{\pi \cdot 15 \cdot 0.048}$$

Variables Used

- **a** Distance from Center to Point *(Millimeter)*
- a_0 2D Lift Curve Slope *(1 per Radian)*
- $a_{C,l}$ Lift Curve Slope *(1 per Radian)*
- AR_{ELD} Wing Aspect Ratio ELD
- AR_{GLD} Wing Aspect Ratio GLD
- **b** Wingspan *(Millimeter)*
- $C_{D,i,ELD}$ Induced Drag Coefficient ELD
- $C_{D,i,GLD}$ Induced Drag Coefficient GLD
- C_l Lift Coefficient Origin
- $C_{L,ELD}$ Lift Coefficient ELD
- $C_{L,GLD}$ Lift Coefficient GLD
- e_{span} Span Efficiency Factor
- F_L Lift Force *(Newton)*
- **L** Lift at Distance *(Newton)*
- S_0 Reference Area Origin *(Square Meter)*
- V_∞ Freestream Velocity *(Meter per Second)*
- **w** Downwash *(Meter per Second)*
- α_i Induced Angle of Attack *(Degree)*
- Γ Circulation *(Square Meter per Second)*
- Γ_o Circulation at Origin *(Square Meter per Second)*
- δ Induced Drag Factor

- ρ_∞ Freestream Density *(Kilogram per Cubic Meter)*
- τ_{FW} Induced Lift Slope Factor of Finite Wing

Constants, Functions, Measurements used

- Constant: **pi**, 3.14159265358979323846264338327950288
  Archimedes' constant
- Function: **sqrt**, sqrt(Number)
  Square root function
- Measurement: **Length** in Millimeter (mm)
  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 Degree (°)
  Angle Unit Conversion
- Measurement: **Density** in Kilogram per Cubic Meter (kg/m³)
  Density Unit Conversion
- Measurement: **Momentum Diffusivity** in Square Meter per Second (m²/s)
  Momentum Diffusivity Unit Conversion
- Measurement: **Reciprocal Angle** in 1 per Radian (rad⁻¹)
  Reciprocal Angle Unit Conversion

Check other formula lists

- **Flow and Lift Distribution Formulas**
- **Lift Distribution Formulas**

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