# Important Elliptical Lift Distribution Formulas PDF

**Formulas**
**Examples**
**with Units**

## List of 20
### Important Elliptical Lift Distribution Formulas

### 1) Aspect Ratio given Induced Angle of Attack Formula

Evaluate Formula

Formula

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

Example with Units

$$2.4704 = \frac{1.49}{3.1416 \cdot 11^\circ}$$

### 2) Aspect Ratio given Induced Drag Coefficient Formula

Evaluate Formula

Formula

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

Example

$$2.4537 = \frac{1.49^2}{3.1416 \cdot 0.288}$$

### 3) Circulation at given Distance along Wingspan Formula

Evaluate Formula

Formula

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

Example with Units

$$13.9986\,\text{m}^2/\text{s} = 14\,\text{m}^2/\text{s} \cdot \sqrt{1 - \left(2 \cdot \frac{16.4\,\text{mm}}{2340\,\text{mm}}\right)^2}$$

### 4) Circulation at Origin given Downwash Formula

Evaluate Formula

Formula

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

Example with Units

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

### 5) Circulation at Origin given Induced Angle of Attack Formula

Evaluate Formula

Formula

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

Example with Units

$$13.9267\,\text{m}^2/\text{s} = 2 \cdot 2340\,\text{mm} \cdot 11^\circ \cdot 15.5\,\text{m/s}$$

### 6) Circulation at Origin given Lift of Wing Formula

Evaluate Formula

Formula

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

Example with Units

$$14.0074\,\text{m}^2/\text{s} = 4 \cdot \frac{488.8\,\text{N}}{1.225\,\text{kg/m}^3 \cdot 15.5\,\text{m/s} \cdot 2340\,\text{mm} \cdot 3.1416}$$

## 7) Circulation at Origin in Elliptical Lift Distribution Formula

Evaluate Formula

**Formula**

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

**Example with Units**

$$13.9791\,\text{m}^2/\text{s} = 2 \cdot 15.5\,\text{m/s} \cdot 2.21\,\text{m}^2 \cdot \frac{1.5}{3.1416 \cdot 2340\,\text{mm}}$$

## 8) Coefficient of Lift given Circulation at Origin Formula

Evaluate Formula

**Formula**

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

**Example with Units**

$$1.5022 = 3.1416 \cdot 2340\,\text{mm} \cdot \frac{14\,\text{m}^2/\text{s}}{2 \cdot 15.5\,\text{m/s} \cdot 2.21\,\text{m}^2}$$

## 9) Coefficient of Lift given Induced Angle of Attack Formula

Evaluate Formula

**Formula**

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

**Example with Units**

$$1.4958 = 3.1416 \cdot 11^\circ \cdot 2.48$$

## 10) Coefficient of Lift given Induced Drag Coefficient Formula

Evaluate Formula

**Formula**

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

**Example**

$$1.4979 = \sqrt{3.1416 \cdot 2.48 \cdot 0.288}$$

## 11) Downwash in Elliptical Lift Distribution Formula

Evaluate Formula

**Formula**

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

**Example with Units**

$$-2.9915\,\text{m/s} = -\frac{14\,\text{m}^2/\text{s}}{2 \cdot 2340\,\text{mm}}$$

## 12) Freestream Velocity given Circulation at Origin Formula

Evaluate Formula

**Formula**

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

**Example with Units**

$$15.6273\,\text{m/s} = 3.1416 \cdot 2340\,\text{mm} \cdot \frac{14\,\text{m}^2/\text{s}}{2 \cdot 2.21\,\text{m}^2 \cdot 1.49}$$

## 13) Freestream Velocity given Induced Angle of Attack Formula

Evaluate Formula

**Formula**

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

**Example with Units**

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

## 14) Induced Angle of Attack given Aspect Ratio Formula

Evaluate Formula

**Formula**

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

**Example with Units**

$$11.0309^\circ = \frac{1.5}{3.1416 \cdot 2.48}$$

## 15) Induced Angle of Attack given Circulation at Origin Formula

Evaluate Formula

Formula

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

Example with Units

$$11.0579° = \frac{14\,m^2/s}{2 \cdot 2340\,mm \cdot 15.5\,m/s}$$

## 16) Induced Angle of Attack given Coefficient of Lift Formula

Evaluate Formula

Formula

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

Example with Units

$$11.0414° = 2.21\,m^2 \cdot \frac{1.5}{3.1416 \cdot 2340\,mm^2}$$

## 17) Induced Angle of Attack given Downwash Formula

Evaluate Formula

Formula

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

Example with Units

$$11.0895° = -\left(\frac{-3\,m/s}{15.5\,m/s}\right)$$

## 18) Induced Drag Coefficient given Aspect Ratio Formula

Evaluate Formula

Formula

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

Example

$$0.285 = \frac{1.49^2}{3.1416 \cdot 2.48}$$

## 19) Lift at given Distance along Wingspan Formula

Evaluate Formula

Formula

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

Example with Units

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

## 20) Lift of Wing given Circulation at Origin Formula

Evaluate Formula

Formula

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

Example with Units

$$488.5416\,N = \frac{3.1416 \cdot 1.225\,kg/m^3 \cdot 15.5\,m/s \cdot 2340\,mm \cdot 14\,m^2/s}{4}$$

## Variables used in list of Elliptical Lift Distribution Formulas above

- **a** Distance from Center to Point *(Millimeter)*
- $AR_{ELD}$ Wing Aspect Ratio ELD
- **b** Wingspan *(Millimeter)*
- $C_{D,i,ELD}$ Induced Drag Coefficient ELD
- $C_l$ Lift Coefficient Origin
- $C_{L,ELD}$ Lift Coefficient ELD
- $F_L$ Lift Force *(Newton)*
- **L** Lift at Distance *(Newton)*
- $S_0$ Reference Area Origin *(Square Meter)*
- $V_\infty$ Freestream Velocity *(Meter per Second)*
- **w** Downwash *(Meter per Second)*
- $\alpha_i$ Induced Angle of Attack *(Degree)*
- $\Gamma$ Circulation *(Square Meter per Second)*
- $\Gamma_o$ Circulation at Origin *(Square Meter per Second)*
- $\rho_\infty$ Freestream Density *(Kilogram per Cubic Meter)*

## Constants, Functions, Measurements used in list of Elliptical Lift Distribution Formulas above

- constant(s): **pi**, 3.14159265358979323846264338327950288 *Archimedes' constant*
- Functions: **sqrt**, sqrt(Number) *A square root function is a function that takes a non-negative number as an input and returns the square root of the given input number.*
- 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*

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