



Aircraft Runway Length Estimation Formulas

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List of 25 Aircraft Runway Length Estimation Formulas

Aircraft Runway Length Estimation &

1) Desired Take off Weight

D = PYL + OEW + FW

Open Calculator

 $\boxed{ \textbf{ex} \ 36.1 t = 25 t + 10 t + 1.1 t }$

2) Fuel Weight to be Carried given Desired Takeoff Weight

FW = D - PYL - OEW

Open Calculator

 $\mathbf{ex} \ 1.1 \mathbf{t} = 36.1 \mathbf{t} - 25 \mathbf{t} - 10 \mathbf{t}$

3) Lift Coefficient for Lifting Force Provided by Wing Body of Vehicle

 $ag{C_l} = rac{L_{Aircraft}}{0.5 \cdot
ho \cdot \left({{{
m{V}}^2}}
ight) \cdot {
m{S}}}$

Open Calculator



Open Calculator 2

4) Lifting Force given Friction Force due to Rolling Resistance

$$egin{aligned} extbf{K} & extbf{Open Calculation} \ L_{Aircraft} = \left(\left(\left(M_{Aircraft} \cdot [g] \cdot \cos(\Phi)
ight) - \left(rac{F_{Friction}}{\mu_r}
ight)
ight)
ight) \end{aligned}$$

$$\texttt{ex} \boxed{1588.789 \text{kN} = \left(\left(\left(50000 \text{kg} \cdot [\text{g}] \cdot \cos(5) \right) - \left(\frac{4125 \text{kN}}{0.03} \right) \right) \right)}$$

5) Lifting Force Provided by Wing Body of Vehicle

$$egin{aligned} \mathbf{fx} egin{aligned} \mathbf{L}_{\mathrm{Aircraft}} &= 0.5 \cdot
ho \cdot \mathrm{V}^2 \cdot \mathrm{S} \cdot \mathrm{C_l} \ \\ \mathbf{ex} &= 999.431 \mathrm{kN} = 0.5 \cdot 1.21 \mathrm{kg/m^3} \cdot (268 \mathrm{km/h})^2 \cdot 23 \mathrm{m^2} \cdot 0.001 \end{aligned}$$

6) Operating Empty Weight when Desired Take-off Weight is considered

OEW = D - PYL - FW

Open Calculator

Open Calculator 2

10t = 36.1t - 25t - 1.1t

7) Payload carried when desired take-off weight is considered 🗗

$$PYL = D - OEW - FW$$

Open Calculator 6

25t = 36.1t - 10t - 1.1t



8) Speed of Sound (Mach number)

fx $c = rac{V_{TAS}}{M_{True}}$

Open Calculator 🗗

 $\boxed{\textbf{ex}} 47.5 \text{km/h} = \frac{190 \text{km/h}}{4}$

9) True Aircraft Speed (Mach number)

fx $V_{TAS} = c \cdot M_{True}$

Open Calculator

 $\texttt{ex} \ 190 \text{km/h} = 47.5 \text{km/h} \cdot 4$

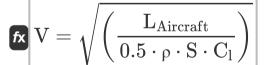
10) True Mach number when true aircraft speed 🗗

 $M_{\mathrm{True}} = rac{\mathrm{V_{TAS}}}{\mathrm{c}}$

Open Calculator

= $4 = rac{190 ext{km/h}}{47.5 ext{km/h}}$

11) Vehicle Speed for Lifting Force Provided by Wing Body of Vehicle



Open Calculator

 $ext{ex} \ 277.6098 ext{km/h} = \sqrt{\left(rac{1072.39 ext{kN}}{0.5 \cdot 1.21 ext{kg/m}^3 \cdot 23 ext{m}^2 \cdot 0.001}
ight)}$





Aerodrome Reference Temperature

12) Aerodrome Reference Temperature 🗗

$$ext{ART} = ext{T}_{ ext{a}} + \left(rac{ ext{T}_{ ext{m}} - ext{T}_{ ext{a}}}{3}
ight)$$

Open Calculator 🚰

$$oxed{ex} 34.82667 ext{K} = 49.5 ext{K} + \left(rac{5.48 ext{K} - 49.5 ext{K}}{3}
ight)$$

13) Monthly Mean of Average Daily Temperature for given ART

$$oldsymbol{ au_{
m a}} = \left(rac{(3\cdot {
m ART}) - {
m T_m}}{2}
ight)^{2}$$

Open Calculator

$$= 2 \left(\frac{(3 \cdot 35.16 \mathrm{K}) - 5.48 \mathrm{K}}{2} \right)$$

14) Monthly mean of maximum daily temperature for hottest month of year

$$\mathbf{E} \left[\mathrm{T_m} = 3 \cdot (\mathrm{ART} - \mathrm{T_a}) + \mathrm{T_a} \right]$$

Open Calculator 🗗

$$= 3 \cdot (35.16 \mathrm{K} - 49.5 \mathrm{K}) + 49.5 \mathrm{K}$$



Aircraft Gross Wing

15) Aircraft Gross Wing Area for Lifting Force Provided by Wing Body of Vehicle

$$ext{S} = rac{ ext{L}_{ ext{Aircraft}}}{0.5 \cdot
ho \cdot ext{V}^2 \cdot ext{C}_1}$$

Open Calculator 🗗

 $ext{ex} 24.67901 ext{m}^2 = rac{1072.39 ext{kN}}{0.5 \cdot 1.21 ext{kg/m}^3 \cdot \left(268 ext{km/h}\right)^2 \cdot 0.001}$

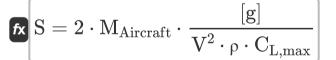
16) Aircraft Gross Wing Area given Vehicle Speed under Steady Flight Conditions



Open Calculator

 $= 11284.07 \text{m}^2 = 2 \cdot 50000 \text{kg} \cdot \frac{[\text{g}]}{1.21 \text{kg/m}^3 \cdot 0.001 \cdot \left(268 \text{km/h}\right)^2}$

17) Aircraft Gross Wing Area given Vehicle Stalling Speed



Open Calculator 🗗



18) Maximum Attainable Lift Coefficient given Vehicle Stalling Speed 🖒

 $\left| ext{C}_{ ext{L,max}} = 2 \cdot ext{M}_{ ext{Aircraft}} \cdot rac{| ext{g}|}{
ho \cdot ext{S} \cdot ext{V}^2}
ight|$

Open Calculator 🗗

 $\boxed{ 0.490612 = 2 \cdot 50000 \mathrm{kg} \cdot \frac{[\mathrm{g}]}{1.21 \mathrm{kg/m^3} \cdot 23 \mathrm{m^2} \cdot \left(268 \mathrm{km/h}\right)^2} }$

19) Vehicle Stalling Speed given Maximum Attainable Lift Coefficient

 $V = \sqrt{rac{2 \cdot M_{Aircraft} \cdot [g]}{
ho \cdot S \cdot C_{L,max}}}$

Open Calculator 🗗

 $ext{ex} \ 200.1071 ext{km/h} = \sqrt{rac{2 \cdot 50000 ext{kg} \cdot ext{[g]}}{1.21 ext{kg/m}^3 \cdot 23 ext{m}^2 \cdot 0.88}}$

Runway Takeoff Length

20) Aerodrome Reference Temperature given Corrected Take off Length



Open Calculator 🗗

 $oxed{ex} 35.15857 \mathrm{K} = \left(rac{4038 \mathrm{m} - 3360 \mathrm{m}}{3360 \mathrm{m} \cdot 0.01}
ight) + 14.98 \mathrm{K}$



21) Runway Elevation given Runway Take off Length Corrected for Elevation

 $\left| \mathbf{R}_{\mathrm{e}} = \left(rac{\mathrm{T_{c}} - \mathrm{TOR}}{\mathrm{TOR} \cdot 0.07}
ight) \cdot 300
ight|$

Open Calculator 🗗

22) Runway Slope about Take-off Length Corrected for Elevation, Temperature and Slope

 $\mathbf{S}_{\mathrm{Slope}} = rac{\mathrm{TOR_{C}} - \mathrm{TOR_{Corrected}}}{\mathrm{TOR_{Corrected}} \cdot 0.1}$

Open Calculator 🗗

23) Runway Take off Length Corrected for Elevation

 $egin{aligned} \mathbf{T}_{
m c} = \left(\mathrm{TOR} \cdot 0.07 \cdot \left(rac{\mathrm{R_e}}{300}
ight)
ight) + \mathrm{TOR} \end{aligned}$

Open Calculator 🗗

$$= 3361.386 \mathrm{m} = \left(3352 \mathrm{m} \cdot 0.07 \cdot \left(\frac{12 \mathrm{m}}{300}\right)\right) + 3352 \mathrm{m}$$



24) Runway Take off Length Corrected for Elevation, Temperature and Slope

fx

Open Calculator 🚰

 $TOR_{C} = (TOR_{Corrected} \cdot S_{Slope} \cdot 0.1) + TOR_{Corrected}$

25) Runway Takeoff Length Corrected for Elevation and Temperature

fx

Open Calculator

 $ext{TOR}_{ ext{Corrected}} = (ext{T}_{ ext{c}} \cdot (ext{ART} - ext{T}_{ ext{s}}) \cdot 0.01) + ext{T}_{ ext{c}}$



Variables Used

- ART Aerodrome Reference Temperature (Kelvin)
- C Speed of Sound (Kilometer per Hour)
- C_I Lift Coefficient
- C_{L.max} Maximum Lift Coefficient
- D Desired Takeoff Weight of Aircraft (Tonne)
- F_{Friction} Force of Friction (Kilonewton)
- **FW** Fuel Weight to be carried (*Tonne*)
- Laircraft Lifting Force of Aircraft (Kilonewton)
- Maircraft Mass Aircraft (Kilogram)
- M_{True} True Mach Number
- OEW Operating Empty Weight (Tonne)
- PYL Payload Carried (Tonne)
- Re Runway Elevation (Meter)
- S Aircraft Gross Wing Area (Square Meter)
- S_{Slope} Runway Slope
- T_a Monthly Mean of Average Daily Temperature (Kelvin)
- T_c Runway Take off Length Corrected (Meter)
- T_m Monthly Mean of Monthly Daily Temperature (Kelvin)
- T_s Standard Temperature (Kelvin)
- TOR Takeoff Run (Meter)
- TOR_C Corrected Runway Takeoff Length (Meter)
- TOR_{Corrected} Corrected Takeoff Run (Meter)





- **V** Vehicle Speed (Kilometer per Hour)
- V_{TAS} True Aircraft Speed (Kilometer per Hour)
- μ_r Coefficient of Rolling Friction
- **p** Density Altitude for flying (Kilogram per Cubic Meter)
- Angle between Runway and Horizontal Plane





Constants, Functions, Measurements used

- Constant: [g], 9.80665 Meter/Second²
 Gravitational acceleration on Farth
- Function: cos, cos(Angle)

 Trigonometric cosine function
- Function: sqrt, sqrt(Number) Square root function
- Measurement: Length in Meter (m)
 Length Unit Conversion
- Measurement: Weight in Tonne (t), Kilogram (kg)
 Weight Unit Conversion
- Measurement: Temperature in Kelvin (K)
 Temperature Unit Conversion
- Measurement: Area in Square Meter (m²)
 Area Unit Conversion
- Measurement: Speed in Kilometer per Hour (km/h)
 Speed Unit Conversion
- Measurement: Force in Kilonewton (kN)
 Force Unit Conversion
- Measurement: Density in Kilogram per Cubic Meter (kg/m³)
 Density Unit Conversion





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- Airport Distribution Models
 Formulas
- Airport Forecast Methods
 Formulas
- Engine-Out Takeoff Case under Estimation of Runway Length Formulas

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