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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

Open Calculator

fx $$D = PYL + OEW + FW$$

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

2) Fuel Weight to be Carried given Desired Takeoff Weight

Open Calculator

fx $$FW = D - PYL - OEW$$

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

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

Open Calculator

fx $$C_l = \frac{L_{Aircraft}}{0.5 \cdot \rho \cdot \left(V^2\right) \cdot S}$$

ex $$0.001073 = \frac{1072.39\text{kN}}{0.5 \cdot 1.21\text{kg/m}^3 \cdot \left((268\text{km/h})^2\right) \cdot 23\text{m}^2}$$

4) Lifting Force given Friction Force due to Rolling Resistance

Open Calculator

$$L_{Aircraft} = \left(\left(\left(M_{Aircraft} \cdot [g] \cdot \cos(\Phi)\right) - \left(\frac{F_{Friction}}{\mu_r}\right)\right)\right)$$

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

5) Lifting Force Provided by Wing Body of Vehicle

Open Calculator

$$L_{Aircraft} = 0.5 \cdot \rho \cdot V^2 \cdot S \cdot C_l$$

ex $$999.431\text{kN} = 0.5 \cdot 1.21\text{kg/m}^3 \cdot (268\text{km/h})^2 \cdot 23\text{m}^2 \cdot 0.001$$

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

Open Calculator

$$OEW = D - PYL - FW$$

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

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

Open Calculator

$$PYL = D - OEW - FW$$

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

8) Speed of Sound (Mach number)

Open Calculator

$$c = \frac{V_{TAS}}{M_{True}}$$

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

9) True Aircraft Speed (Mach number)

Open Calculator

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

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

10) True Mach number when true aircraft speed

Open Calculator

$$M_{True} = \frac{V_{TAS}}{c}$$

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

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

Open Calculator

$$V = \sqrt{\left(\frac{L_{Aircraft}}{0.5 \cdot \rho \cdot S \cdot C_l}\right)}$$

$$277.6098\text{km/h} = \sqrt{\left(\frac{1072.39\text{kN}}{0.5 \cdot 1.21\text{kg/m}^3 \cdot 23\text{m}^2 \cdot 0.001}\right)}$$

Aerodrome Reference Temperature

12) Aerodrome Reference Temperature

Open Calculator

fx $$\mathrm{ART} = \mathrm{T_a} + \left(\frac{\mathrm{T_m} - \mathrm{T_a}}{3}\right)$$

ex $$34.82667\mathrm{K} = 49.5\mathrm{K} + \left(\frac{5.48\mathrm{K} - 49.5\mathrm{K}}{3}\right)$$

13) Monthly Mean of Average Daily Temperature for given ART

Open Calculator

fx $$\mathrm{T_a} = \left(\frac{(3 \cdot \mathrm{ART}) - \mathrm{T_m}}{2}\right)$$

ex $$50\mathrm{K} = \left(\frac{(3 \cdot 35.16\mathrm{K}) - 5.48\mathrm{K}}{2}\right)$$

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

Open Calculator

fx $$\mathrm{T_m} = 3 \cdot (\mathrm{ART} - \mathrm{T_a}) + \mathrm{T_a}$$

ex $$6.48\mathrm{K} = 3 \cdot (35.16\mathrm{K} - 49.5\mathrm{K}) + 49.5\mathrm{K}$$

Aircraft Gross Wing

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

Open Calculator

$$S = \frac{L_{Aircraft}}{0.5 \cdot \rho \cdot V^2 \cdot C_l}$$

$$24.67901\text{m}^2 = \frac{1072.39\text{kN}}{0.5 \cdot 1.21\text{kg/m}^3 \cdot (268\text{km/h})^2 \cdot 0.001}$$

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

Open Calculator

$$S = 2 \cdot M_{Aircraft} \cdot \frac{[g]}{\rho \cdot C_l \cdot V^2}$$

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

17) Aircraft Gross Wing Area given Vehicle Stalling Speed

Open Calculator

$$S = 2 \cdot M_{Aircraft} \cdot \frac{[g]}{V^2 \cdot \rho \cdot C_{L,max}}$$

$$12.82281\text{m}^2 = 2 \cdot 50000\text{kg} \cdot \frac{[g]}{(268\text{km/h})^2 \cdot 1.21\text{kg/m}^3 \cdot 0.88}$$

18) Maximum Attainable Lift Coefficient given Vehicle Stalling Speed

Open Calculator

$$C_{L,max} = 2 \cdot M_{Aircraft} \cdot \frac{[g]}{\rho \cdot S \cdot V^2}$$

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

19) Vehicle Stalling Speed given Maximum Attainable Lift Coefficient

Open Calculator

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

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

Runway Takeoff Length

20) Aerodrome Reference Temperature given Corrected Take off Length

Open Calculator

$$ART = \left(\frac{TOR_{Corrected} - T_c}{T_c \cdot 0.01}\right) + T_s$$

$$35.15857\text{K} = \left(\frac{4038\text{m} - 3360\text{m}}{3360\text{m} \cdot 0.01}\right) + 14.98\text{K}$$

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

Open Calculator

$$R_e = \left(\frac{T_c - TOR}{TOR \cdot 0.07} \right) \cdot 300$$

$$10.22844\text{m} = \left(\frac{3360\text{m} - 3352\text{m}}{3352\text{m} \cdot 0.07} \right) \cdot 300$$

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

Open Calculator

$$S_{Slope} = \frac{TOR_C - TOR_{Corrected}}{TOR_{Corrected} \cdot 0.1}$$

$$0.009906 = \frac{4042\text{m} - 4038\text{m}}{4038\text{m} \cdot 0.1}$$

23) Runway Take off Length Corrected for Elevation

Open Calculator

$$T_c = \left(TOR \cdot 0.07 \cdot \left(\frac{R_e}{300} \right) \right) + TOR$$

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

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

Open Calculator

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

ex $4042.038\mathrm{m} = (4038\mathrm{m} \cdot 0.01 \cdot 0.1) + 4038\mathrm{m}$

25) Runway Takeoff Length Corrected for Elevation and Temperature

Open Calculator

$$\mathrm{TOR_{Corrected}} = (\mathrm{T_c} \cdot (\mathrm{ART} - \mathrm{T_s}) \cdot 0.01) + \mathrm{T_c}$$

ex $4038.048\mathrm{m} = (3360\mathrm{m} \cdot (35.16\mathrm{K} - 14.98\mathrm{K}) \cdot 0.01) + 3360\mathrm{m}$

Variables Used

- **ART** Aerodrome Reference Temperature *(Kelvin)*
- **c** Speed of Sound *(Kilometer per Hour)*
- C_l 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)*
- $L_{Aircraft}$ Lifting Force of Aircraft *(Kilonewton)*
- $M_{Aircraft}$ Mass Aircraft *(Kilogram)*
- M_{True} True Mach Number
- **OEW** Operating Empty Weight *(Tonne)*
- **PYL** Payload Carried *(Tonne)*
- R_e 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
- **ρ** Density Altitude for flying *(Kilogram per Cubic Meter)*
- **Φ** Angle between Runway and Horizontal Plane

Constants, Functions, Measurements used

- Constant: **[g]**, 9.80665 Meter/Second²
  Gravitational acceleration on Earth
- 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

Check other formula lists

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

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