Important Friction Devices Formulas PDF

Formulas
Examples
with Units

List of 26
Important Friction Devices Formulas

1) Pivot Bearing Formulas

1.1) Frictional Torque on Conical Pivot Bearing by Uniform Pressure Formula

Evaluate Formula

Formula

$$T = \frac{\mu_f \cdot W_t \cdot D_s \cdot h_s}{3}$$

Example with Units

$$2.4\,\mathrm{N{*}m} = \frac{0.4 \cdot 24\,\mathrm{N} \cdot 0.5\,\mathrm{m} \cdot 1.5\,\mathrm{m}}{3}$$

1.2) Frictional Torque on Conical Pivot Bearing by Uniform Wear Formula

Evaluate Formula

Formula

$$T = \frac{\mu_f \cdot W_t \cdot D_s \cdot \mathrm{cosec}\frac{\alpha}{2}}{2}$$

Example with Units

$$2.3794\,\mathrm{N{*}m} = \frac{0.4 \cdot 24\,\mathrm{N} \cdot 0.5\,\mathrm{m} \cdot \mathrm{cosec}\frac{30.286549^{\circ}}{2}}{2}$$

1.3) Frictional Torque on Flat Pivot Bearing by Uniform Pressure Formula

Evaluate Formula

Formula

$$T = \frac{2}{3} \cdot \mu_f \cdot W_t \cdot R$$

Example with Units

$$21.12\,\mathrm{N{*}m} = \frac{2}{3} \cdot 0.4 \cdot 24\,\mathrm{N} \cdot 3.3\,\mathrm{m}$$

1.4) Frictional Torque on Truncated Conical Pivot Bearing by Uniform Pressure Formula

Evaluate Formula

Formula

$$T = \frac{2}{3} \cdot \mu_f \cdot W_t \cdot \frac{r_1^{3} - r_2^{3}}{r_1^{2} - r_2^{2}}$$

Example with Units

$$67.6571\,\mathrm{N{*}m} = \frac{2}{3} \cdot 0.4 \cdot 24\,\mathrm{N} \cdot \frac{8\,\mathrm{m}^{3} - 6\,\mathrm{m}^{3}}{8\,\mathrm{m}^{2} - 6\,\mathrm{m}^{2}}$$

1.5) Mean Radius of Collar Formula

Evaluate Formula

Formula

$$R_c = \frac{R_1 + R_2}{2}$$

Example with Units

$$0.04\,\mathrm{m} = \frac{0.050\,\mathrm{m} + 0.03\,\mathrm{m}}{2}$$

1.6) Pressure over Bearing Area of Flat Pivot Bearing Formula

Evaluate Formula

Formula

$$p_i = \frac{W_t}{\pi \cdot R^{2}}$$

Example with Units

$$0.7015\,\mathrm{Pa} = \frac{24\,\mathrm{N}}{3.1416 \cdot 3.3\,\mathrm{m}^{2}}$$

1.7) Torque Required to Overcome Friction at Collar Formula

Evaluate Formula

Formula	Example with Units
$T = \mu_c \cdot W_l \cdot R_c$	$0.1696\,\text{N*m} = 0.16 \cdot 53\,\text{N} \cdot 0.02\,\text{m}$

1.8) Total Frictional Torque on Conical Pivot Bearing Considering Uniform Pressure Formula

Evaluate Formula

Formula	Example with Units
$T = \mu_f \cdot W_t \cdot D_s \cdot cosec\frac{\alpha}{3}$	$3.1726\,\text{N*m} = 0.4 \cdot 24\,\text{N} \cdot 0.5\,\text{m} \cdot cosec\frac{30.286549°}{3}$

1.9) Total Frictional Torque on Conical Pivot Bearing Considering Uniform Wear when Slant Height of Cone Formula

Evaluate Formula

Formula	Example with Units
$T = \frac{\mu_f \cdot W_t \cdot h_s}{2}$	$7.2\,\text{N*m} = \frac{0.4 \cdot 24\,\text{N} \cdot 1.5\,\text{m}}{2}$

1.10) Total Frictional Torque on Flat Pivot Bearing Considering Uniform Wear Formula

Evaluate Formula

Formula	Example with Units
$T = \frac{\mu_f \cdot W_t \cdot R}{2}$	$15.84\,\text{N*m} = \frac{0.4 \cdot 24\,\text{N} \cdot 3.3\,\text{m}}{2}$

1.11) Total Frictional Torque on Truncated Conical Pivot Bearing Considering Uniform Wear Formula

Evaluate Formula

Formula	Example with Units
$T = \mu_f \cdot W_t \cdot \frac{r_1 + r_2}{2}$	$67.2\,\text{N*m} = 0.4 \cdot 24\,\text{N} \cdot \frac{8\,\text{m} + 6\,\text{m}}{2}$

1.12) Total Vertical Load Transmitted to Conical Pivot Bearing for Uniform Pressure Formula

Evaluate Formula

Formula	Example with Units
$W_t = \pi \cdot \left(\frac{D_s}{2}\right)^2 \cdot p_i$	$1.9635\,\text{N} = 3.1416 \cdot \left(\frac{0.5\,\text{m}}{2}\right)^2 \cdot 10\,\text{Pa}$

2) Screw and Nut Formulas

2.1) Force at Circumference of Screw given Helix Angle and Coefficient of Friction Formula

Evaluate Formula

Formula

$$F = W \cdot \left(\frac{\sin(\psi) + \mu_f \cdot \cos(\psi)}{\cos(\psi) - \mu_f \cdot \sin(\psi)} \right)$$

Example with Units

$$63.8967\,\mathrm{N} = 60\,\mathrm{kg} \cdot \left(\frac{\sin(25°) + 0.4 \cdot \cos(25°)}{\cos(25°) - 0.4 \cdot \sin(25°)} \right)$$

2.2) Force at Circumference of Screw given Helix Angle and Limiting Angle Formula

Evaluate Formula

Formula

$$F = W_l \cdot \tan(\psi + \Phi)$$

Example with Units

$$40.6683\,\mathrm{N} = 53\,\mathrm{N} \cdot \tan(25° + 12.5°)$$

2.3) Helix Angle Formula

Evaluate Formula

Formula

$$\psi = atan\left(\frac{L}{C}\right)$$

Example with Units

$$0.0548° = atan\left(\frac{0.011\,\mathrm{m}}{11.5\,\mathrm{m}}\right)$$

2.4) Helix Angle for Multi-Threaded Screw Formula

Evaluate Formula

Formula

$$\psi = atan\left(\frac{n \cdot P_s}{\pi \cdot d}\right)$$

Example with Units

$$89.865° = atan\left(\frac{16 \cdot 5\,\mathrm{m}}{3.1416 \cdot 0.06\,\mathrm{m}}\right)$$

2.5) Helix Angle for Single Threaded Screw Formula

Evaluate Formula

Formula

$$\psi = atan\left(\frac{P_s}{\pi \cdot d}\right)$$

Example with Units

$$87.841° = atan\left(\frac{5\,\mathrm{m}}{3.1416 \cdot 0.06\,\mathrm{m}}\right)$$

2.6) Lead of Screw Formula

Evaluate Formula

Formula

$$L = P_s \cdot n$$

Example with Units

$$80\,\mathrm{m} = 5\,\mathrm{m} \cdot 16$$

2.7) Torque Required to Overcome Friction between Screw and Nut Formula

Evaluate Formula

Formula

$$T = W_l \cdot \tan(\psi + \Phi) \cdot \frac{d}{2}$$

Example with Units

$$1.22\,\mathrm{N{*}m} = 53\,\mathrm{N} \cdot \tan(25° + 12.5°) \cdot \frac{0.06\,\mathrm{m}}{2}$$

2.8) Torque Required to Overcome Friction between Screw and Nut while Lowering Load Formula

Evaluate Formula

Formula

$$T = W_l \cdot \tan(\Phi - \psi) \cdot \frac{d}{2}$$

Example with Units

$$-0.3525\,\text{N*m} = 53\,\text{N} \cdot \tan(12.5° - 25°) \cdot \frac{0.06\,\text{m}}{2}$$

3) Screw Jack Formulas

3.1) Efficiency of Screw Jack when Screw Friction as well as Collar Friction Considered Formula

Evaluate Formula

Formula

$$\eta = \frac{W \cdot \tan(\psi) \cdot d}{W_l \cdot \tan(\psi + \Phi) \cdot d + \mu_c \cdot W_l \cdot R_c}$$

Example with Units

$$0.6433 = \frac{60\,\text{kg} \cdot \tan(25°) \cdot 0.06\,\text{m}}{53\,\text{N} \cdot \tan(25° + 12.5°) \cdot 0.06\,\text{m} + 0.16 \cdot 53\,\text{N} \cdot 0.02\,\text{m}}$$

3.2) Efficiency of Screw Jack when only Screw Friction is Considered Formula

Evaluate Formula

Formula

$$\eta = \frac{\tan(\psi)}{\tan(\psi + \Phi)}$$

Example with Units

$$0.6077 = \frac{\tan(25°)}{\tan(25° + 12.5°)}$$

3.3) Force Required to Lower Load by Screw Jack given Weight of Load Formula

Evaluate Formula

Formula

$$F = W_l \cdot \frac{\mu_f \cdot \cos(\psi) - \sin(\psi)}{\cos(\psi) + \mu_f \cdot \sin(\psi)}$$

Example with Units

$$-2.9619\,\text{N} = 53\,\text{N} \cdot \frac{0.4 \cdot \cos(25°) - \sin(25°)}{\cos(25°) + 0.4 \cdot \sin(25°)}$$

3.4) Force Required to Lower Load by Screw Jack given weight of load and Limiting angle Formula

Evaluate Formula

Formula

$$F = W_l \cdot \tan(\Phi - \psi)$$

Example with Units

$$-11.7498\,\text{N} = 53\,\text{N} \cdot \tan(12.5° - 25°)$$

3.5) Ideal Effort to Raise Load by Screw Jack Formula

Evaluate Formula

Formula

$$P_o = W_l \cdot \tan(\psi)$$

Example with Units

$$24.7143\,\text{N} = 53\,\text{N} \cdot \tan(25°)$$

3.6) Maximum Efficiency of Screw Jack Formula

Evaluate Formula

Formula	Example with Units
$\eta = \frac{1 - \sin(\Phi)}{1 + \sin(\Phi)}$	$0.6441 = \frac{1 - \sin(12.5°)}{1 + \sin(12.5°)}$

Variables used in list of Friction Devices Formulas above

- **C** Circumference of Screw *(Meter)*
- **d** Mean Diameter of Screw *(Meter)*
- D_s Shaft Diameter *(Meter)*
- **F** Force Required *(Newton)*
- h_s Slant Height *(Meter)*
- **L** Lead of Screw *(Meter)*
- **n** Number of Threads
- p_i Pressure Intensity *(Pascal)*
- P_o Ideal Effort *(Newton)*
- P_s Pitch *(Meter)*
- **R** Radius of Bearing Surface *(Meter)*
- r_1 Outer Radius of Bearing Surface *(Meter)*
- R_1 Outer Radius of Collar *(Meter)*
- r_2 Inner Radius of Bearing Surface *(Meter)*
- R_2 Inner Radius of Collar *(Meter)*
- R_c Mean Radius of Collar *(Meter)*
- **T** Total Torque *(Newton Meter)*
- **W** Weight *(Kilogram)*
- W_l Load *(Newton)*
- W_t Load Transmitted Over Bearing Surface *(Newton)*
- **α** Semi Angle of Cone *(Degree)*
- **η** Efficiency
- μ_c Coefficient of Friction For Collar
- μ_f Coefficient of Friction
- **Φ** Limiting Angle of Friction *(Degree)*
- **ψ** Helix Angle *(Degree)*

Constants, Functions, Measurements used in list of Friction Devices Formulas above

- constant(s): **pi**, 3.14159265358979323846264338327950288 *Archimedes' constant*
- Functions: **atan**, atan(Number) *Inverse tan is used to calculate the angle by applying the tangent ratio of the angle, which is the opposite side divided by the adjacent side of the right triangle.*
- Functions: **cos**, cos(Angle) *Cosine of an angle is the ratio of the side adjacent to the angle to the hypotenuse of the triangle.*
- Functions: **cosec**, cosec(Angle) *The cosecant function is a trigonometric function that is the reciprocal of the sine function.*
- Functions: **sec**, sec(Angle) *Secant is a trigonometric function that is defined ratio of the hypotenuse to the shorter side adjacent to an acute angle (in a right-angled triangle); the reciprocal of a cosine.*
- Functions: **sin**, sin(Angle) *Sine is a trigonometric function that describes the ratio of the length of the opposite side of a right triangle to the length of the hypotenuse.*
- Functions: **tan**, tan(Angle) *The tangent of an angle is a trigonometric ratio of the length of the side opposite an angle to the length of the side adjacent to an angle in a right triangle.*
- Measurement: **Length** in Meter (m) *Length Unit Conversion*
- Measurement: **Weight** in Kilogram (kg) *Weight Unit Conversion*
- Measurement: **Pressure** in Pascal (Pa) *Pressure Unit Conversion*
- Measurement: **Force** in Newton (N) *Force Unit Conversion*
- Measurement: **Angle** in Degree (°) *Angle Unit Conversion*
- Measurement: **Torque** in Newton Meter (N*m) *Torque Unit Conversion*

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