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# Friction Devices Formulas

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# List of 27 Friction Devices Formulas

## Friction Devices

### Pivot Bearing

#### 1) Frictional Torque on Conical Pivot Bearing by Uniform Pressure

$$\text{fx } T = \frac{\mu_{\text{friction}} \cdot W_t \cdot D_{\text{shaft}} \cdot h_{\text{Slant}}}{3}$$

Open Calculator 

$$\text{ex } 2.4\text{N}\cdot\text{m} = \frac{0.4 \cdot 24\text{N} \cdot 0.5\text{m} \cdot 1.5\text{m}}{3}$$

#### 2) Frictional Torque on Conical Pivot Bearing by Uniform Wear

$$\text{fx } T = \frac{\mu_{\text{friction}} \cdot W_t \cdot D_{\text{shaft}} \cdot \cos ec \frac{\alpha}{2}}{2}$$

Open Calculator 

$$\text{ex } 2.379418\text{N}\cdot\text{m} = \frac{0.4 \cdot 24\text{N} \cdot 0.5\text{m} \cdot \cos ec \frac{0.5286\text{rad}}{2}}{2}$$

#### 3) Frictional Torque on Flat Pivot Bearing by Uniform Pressure

$$\text{fx } T = \frac{2}{3} \cdot \mu_{\text{friction}} \cdot W_t \cdot R$$

Open Calculator 

$$\text{ex } 21.12\text{N}\cdot\text{m} = \frac{2}{3} \cdot 0.4 \cdot 24\text{N} \cdot 3.3\text{m}$$



#### 4) Frictional Torque on Truncated Conical Pivot Bearing by Uniform Pressure

$$\text{fx } T = \frac{2}{3} \cdot \mu_{\text{friction}} \cdot W_t \cdot \frac{r_1^3 - r_2^3}{r_1^2 - r_2^2}$$

[Open Calculator !\[\]\(cbe80b694ebd74fcfe136a095b608235\_img.jpg\)](#)

$$\text{ex } 67.65714\text{N}\cdot\text{m} = \frac{2}{3} \cdot 0.4 \cdot 24\text{N} \cdot \frac{(8\text{m})^3 - (6\text{m})^3}{(8\text{m})^2 - (6\text{m})^2}$$

#### 5) Mean Radius of Collar

$$\text{fx } R_{\text{collar}} = \frac{R_1 + R_2}{2}$$

[Open Calculator !\[\]\(3e2231b1ad3ca8da8658228c00dd08e0\_img.jpg\)](#)

$$\text{ex } 0.04\text{m} = \frac{0.050\text{m} + 0.03\text{m}}{2}$$

#### 6) Pressure over Bearing Area of Flat Pivot Bearing

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

[Open Calculator !\[\]\(0d5ec72f61334709c3fc9450209b754f\_img.jpg\)](#)

$$\text{ex } 0.701509\text{Pa} = \frac{24\text{N}}{\pi \cdot (3.3\text{m})^2}$$

#### 7) Torque Required to Overcome Friction at Collar

$$\text{fx } T = \mu_{\text{collar}} \cdot W_{\text{load}} \cdot R_{\text{collar}}$$

[Open Calculator !\[\]\(b64b40baaee5acddc1eab8538ba84754\_img.jpg\)](#)

$$\text{ex } 0.1696\text{N}\cdot\text{m} = 0.16 \cdot 53\text{N} \cdot 0.02\text{m}$$



### 8) Total Frictional Torque on Conical Pivot Bearing Considering Uniform Pressure

$$\text{fx } T = \mu_{\text{friction}} \cdot W_t \cdot D_{\text{shaft}} \cdot \cos ec \frac{\alpha}{3}$$

[Open Calculator !\[\]\(e78f798d4ea5c530c9db49e7d26e6b95\_img.jpg\)](#)

$$\text{ex } 3.172558\text{N}\cdot\text{m} = 0.4 \cdot 24\text{N} \cdot 0.5\text{m} \cdot \cos ec \frac{0.5286\text{rad}}{3}$$

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

$$\text{fx } T = \frac{\mu_{\text{friction}} \cdot W_t \cdot h_{\text{Slant}}}{2}$$

[Open Calculator !\[\]\(05be7c7a8995decd503647c99211f7c2\_img.jpg\)](#)

$$\text{ex } 7.2\text{N}\cdot\text{m} = \frac{0.4 \cdot 24\text{N} \cdot 1.5\text{m}}{2}$$

### 10) Total Frictional Torque on Flat Pivot Bearing Considering Uniform Wear

$$\text{fx } T = \frac{\mu_{\text{friction}} \cdot W_t \cdot R}{2}$$

[Open Calculator !\[\]\(fe3aebe81acea8d45108cd2768939da7\_img.jpg\)](#)

$$\text{ex } 15.84\text{N}\cdot\text{m} = \frac{0.4 \cdot 24\text{N} \cdot 3.3\text{m}}{2}$$



## 11) Total Frictional Torque on Truncated Conical Pivot Bearing Considering Uniform Wear

$$\text{fx } T = \mu_{\text{friction}} \cdot W_t \cdot \frac{r_1 + r_2}{2}$$

[Open Calculator !\[\]\(e2376d476d06eb31946dc01a69a4403a\_img.jpg\)](#)

$$\text{ex } 67.2\text{N}\cdot\text{m} = 0.4 \cdot 24\text{N} \cdot \frac{8\text{m} + 6\text{m}}{2}$$

## 12) Total Vertical Load Transmitted to Conical Pivot Bearing for Uniform Pressure

$$\text{fx } W_t = \pi \cdot \left( \frac{D_{\text{shaft}}}{2} \right)^2 \cdot p_i$$

[Open Calculator !\[\]\(0b5e7e25e8775f7e7e80906ada4f0021\_img.jpg\)](#)

$$\text{ex } 1.963495\text{N} = \pi \cdot \left( \frac{0.5\text{m}}{2} \right)^2 \cdot 10\text{Pa}$$

## Screw and Nut

### 13) Force at Circumference of Screw given Helix Angle and Coefficient of Friction

$$\text{fx } F = W \cdot \left( \frac{\sin(\psi) + \mu_{\text{friction}} \cdot \cos(\psi)}{\cos(\psi) - \mu_{\text{friction}} \cdot \sin(\psi)} \right)$$

[Open Calculator !\[\]\(0fb13ad0bfa3d86868cdd3883e5665b3\_img.jpg\)](#)

$$\text{ex } 63.89666\text{N} = 60\text{kg} \cdot \left( \frac{\sin(25^\circ) + 0.4 \cdot \cos(25^\circ)}{\cos(25^\circ) - 0.4 \cdot \sin(25^\circ)} \right)$$



## 14) Force at Circumference of Screw given Helix Angle and Limiting Angle



$$fx \quad F = W_{\text{load}} \cdot \tan(\psi + \Phi)$$

Open Calculator

$$ex \quad 40.66833N = 53N \cdot \tan(25^\circ + 12.5^\circ)$$

## 15) Helix Angle

$$fx \quad \psi = a \tan\left(\frac{L}{C}\right)$$

Open Calculator

$$ex \quad 0.054805^\circ = a \tan\left(\frac{0.011m}{11.5m}\right)$$

## 16) Helix Angle for Multi-Threaded Screw

$$fx \quad \psi = a \tan\left(\frac{n \cdot P_{\text{screw}}}{\pi \cdot d}\right)$$

Open Calculator

$$ex \quad 89.865^\circ = a \tan\left(\frac{16 \cdot 5m}{\pi \cdot 0.06m}\right)$$

## 17) Helix Angle for Single Threaded Screw

$$fx \quad \psi = a \tan\left(\frac{P_{\text{screw}}}{\pi \cdot d}\right)$$

Open Calculator

$$ex \quad 87.84102^\circ = a \tan\left(\frac{5m}{\pi \cdot 0.06m}\right)$$



## 18) Lead of Screw

$$fx \quad L = P_{\text{screw}} \cdot n$$

[Open Calculator !\[\]\(9dfdaff1d86ba3c1f8353b4d1b61b8c5\_img.jpg\)](#)

$$ex \quad 80m = 5m \cdot 16$$

## 19) Torque Required to Overcome Friction between Screw and Nut

$$fx \quad T = W_{\text{load}} \cdot \tan(\psi + \Phi) \cdot \frac{d}{2}$$

[Open Calculator !\[\]\(2b376d1a92330ab09dad2665d2f89bf5\_img.jpg\)](#)

$$ex \quad 1.22005N \cdot m = 53N \cdot \tan(25^\circ + 12.5^\circ) \cdot \frac{0.06m}{2}$$

## 20) Torque Required to Overcome Friction between Screw and Nut during Lowering Load

$$fx \quad T = W_{\text{load}} \cdot \tan(\Phi - \psi) \cdot \frac{d}{2}$$

[Open Calculator !\[\]\(c444627dab9fee9a1550c053ffaaaae2\_img.jpg\)](#)

$$ex \quad -0.352495N \cdot m = 53N \cdot \tan(12.5^\circ - 25^\circ) \cdot \frac{0.06m}{2}$$

## 21) Torque Required to Overcome Friction between Screw and Nut while Lowering Load

$$fx \quad T = W_{\text{load}} \cdot \tan(\Phi - \psi) \cdot \frac{d}{2}$$

[Open Calculator !\[\]\(06a315363e7801bba8c7489a6694af19\_img.jpg\)](#)

$$ex \quad -0.352495N \cdot m = 53N \cdot \tan(12.5^\circ - 25^\circ) \cdot \frac{0.06m}{2}$$



## Screw Jack

### 22) Efficiency of Screw Jack when Screw Friction as well as Collar Friction Considered

fx

Open Calculator 

$$\eta = \frac{W \cdot \tan(\psi) \cdot d}{W_{\text{load}} \cdot \tan(\psi + \Phi) \cdot d + \mu_{\text{collar}} \cdot W_{\text{load}} \cdot R_{\text{collar}}}$$

ex

$$0.643257 = \frac{60\text{kg} \cdot \tan(25^\circ) \cdot 0.06\text{m}}{53\text{N} \cdot \tan(25^\circ + 12.5^\circ) \cdot 0.06\text{m} + 0.16 \cdot 53\text{N} \cdot 0.02\text{m}}$$

### 23) Efficiency of Screw Jack when only Screw Friction is Considered

fx

Open Calculator 

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

ex

$$0.607704 = \frac{\tan(25^\circ)}{\tan(25^\circ + 12.5^\circ)}$$

### 24) Force Required to Lower Load by Screw Jack given Weight of Load

fx

Open Calculator 

$$F = W_{\text{load}} \cdot \frac{\mu_{\text{friction}} \cdot \cos(\psi) - \sin(\psi)}{\cos(\psi) + \mu_{\text{friction}} \cdot \sin(\psi)}$$

ex

$$-2.961852\text{N} = 53\text{N} \cdot \frac{0.4 \cdot \cos(25^\circ) - \sin(25^\circ)}{\cos(25^\circ) + 0.4 \cdot \sin(25^\circ)}$$





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

$$fx \quad F = W_{\text{load}} \cdot \tan(\Phi - \psi)$$

[Open Calculator !\[\]\(c3d993ca47bfe2a953c700506ce31fa0\_img.jpg\)](#)

$$ex \quad -11.749817\text{N} = 53\text{N} \cdot \tan(12.5^\circ - 25^\circ)$$

## 26) Ideal Effort to Raise Load by Screw Jack

$$fx \quad P_o = W_{\text{load}} \cdot \tan(\psi)$$

[Open Calculator !\[\]\(17413706fd4997a1a4bdf85c6864eee1\_img.jpg\)](#)

$$ex \quad 24.71431\text{N} = 53\text{N} \cdot \tan(25^\circ)$$

## 27) Maximum Efficiency of Screw Jack

$$fx \quad \eta = \frac{1 - \sin(\Phi)}{1 + \sin(\Phi)}$$

[Open Calculator !\[\]\(4b7a79268f6ba26c1471d4232fffa85a\_img.jpg\)](#)

$$ex \quad 0.644142 = \frac{1 - \sin(12.5^\circ)}{1 + \sin(12.5^\circ)}$$



## Variables Used



- **C** Circumference of Screw (Meter)
- **d** Mean Diameter of Screw (Meter)
- **D<sub>shaft</sub>** Shaft Diameter (Meter)
- **F** Force Required (Newton)
- **h<sub>slant</sub>** Slant Height (Meter)
- **L** Lead of Screw (Meter)
- **n** Number of Threads
- **p<sub>i</sub>** Pressure Intensity (Pascal)
- **P<sub>o</sub>** Ideal Effort (Newton)
- **P<sub>screw</sub>** Pitch (Meter)
- **R** Radius of Bearing Surface (Meter)
- **r<sub>1</sub>** Outer Radius of Bearing Surface (Meter)
- **R<sub>1</sub>** Outer Radius of Collar (Meter)
- **r<sub>2</sub>** Inner Radius of Bearing Surface (Meter)
- **R<sub>2</sub>** Inner Radius of Collar (Meter)
- **R<sub>collar</sub>** Mean Radius of Collar (Meter)
- **T** Total Torque (Newton Meter)
- **W** Weight (Kilogram)
- **W<sub>load</sub>** Load (Newton)
- **W<sub>t</sub>** Load Transmitted Over Bearing Surface (Newton)
- **α** Semi Angle of Cone (Radian)
- **η** Efficiency







- $\mu_{\text{collar}}$  Coefficient of Friction for Collar
- $\mu_{\text{friction}}$  Coefficient of Friction
- $\Phi$  Limiting Angle of Friction (Degree)
- $\Psi$  Helix Angle (Degree)



## Constants, Functions, Measurements used

- **Constant:** **pi**, 3.14159265358979323846264338327950288  
*Archimedes' constant*
- **Function:** **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.*
- **Function:** **cos**, cos(Angle)  
*Cosine of an angle is the ratio of the side adjacent to the angle to the hypotenuse of the triangle.*
- **Function:** **cosec**, cosec(Angle)  
*The cosecant function is a trigonometric function that is the reciprocal of the sine function.*
- **Function:** **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.*
- **Function:** **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.*
- **Function:** **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 Radian (rad), Degree (°)  
*Angle Unit Conversion* 
- **Measurement: Torque** in Newton Meter (N\*m)  
*Torque Unit Conversion* 



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