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Cutting Force and Surface Roughness Formulas

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List of 21 Cutting Force and Surface Roughness Formulas

Cutting Force and Surface Roughness

1) Area of Contact given Frictional Force

$$fx \quad A_c = \frac{F_f}{(\gamma_m \cdot \tau_1) + ((1 - \gamma_m) \cdot \tau_2)}$$

Open Calculator 

$$ex \quad 1250\text{mm}^2 = \frac{25\text{N}}{(0.5 \cdot 0.03\text{N/mm}^2) + ((1 - 0.5) \cdot 0.01\text{N/mm}^2)}$$

2) Corner Radius given Roughness value

$$fx \quad r_c = 0.0321 \cdot \frac{(f)^2}{R}$$

Open Calculator 

$$ex \quad 1.523466\text{mm} = 0.0321 \cdot \frac{(0.9\text{mm})^2}{0.017067\text{mm}}$$

3) Cutting Force given Rate of Energy Consumption during Machining

$$fx \quad F_c = \frac{Q_c}{V_c}$$

Open Calculator 

$$ex \quad 900\text{N} = \frac{1.8\text{W}}{2\text{mm/s}}$$



4) Cutting Force given Specific Cutting Energy in Machining

$$f_x F_c = Q_{sc} \cdot A_{cs}$$

[Open Calculator !\[\]\(cbe80b694ebd74fcfe136a095b608235_img.jpg\)](#)

$$ex \ 900N = 2000MJ/m^3 \cdot 0.45mm^2$$

5) Diameter of Cutter given Roughness Value

$$f_x d_t = \frac{0.0642 \cdot (V_f)^2}{R \cdot (\omega_c)^2}$$

[Open Calculator !\[\]\(3e2231b1ad3ca8da8658228c00dd08e0_img.jpg\)](#)

$$ex \ 41.79606mm = \frac{0.0642 \cdot (100mm/s)^2}{0.017067mm \cdot (30Hz)^2}$$

6) Feed given Roughness value

$$f_x f = 4 \cdot (\cot(\theta) + \cot(\theta')) \cdot R$$

[Open Calculator !\[\]\(0d5ec72f61334709c3fc9450209b754f_img.jpg\)](#)

$$ex \ 0.9mm = 4 \cdot (\cot(45.17097^\circ) + \cot(4.69^\circ)) \cdot 0.017067mm$$

7) Feed given Roughness Value and corner radius

$$f_x f = \left(R \cdot \frac{r_c}{0.0321} \right)^{\frac{1}{2}}$$

[Open Calculator !\[\]\(b64b40baaee5acddc1eab8538ba84754_img.jpg\)](#)

$$ex \ 0.9mm = \left(0.017067mm \cdot \frac{1.523466mm}{0.0321} \right)^{\frac{1}{2}}$$



8) Feed Speed given Roughness Value

[Open Calculator !\[\]\(dfbd6b3763a6d1d9afaa974f64e2e4b5_img.jpg\)](#)

$$fx \quad V_f = \sqrt{R \cdot \frac{d_t}{0.0642}} \cdot \omega_c$$

$$ex \quad 100.0047 \text{mm/s} = \sqrt{0.017067 \text{mm} \cdot \frac{41.8 \text{mm}}{0.0642}} \cdot 30 \text{Hz}$$

9) Force required to remove Chip and Acting on Tool Face

[Open Calculator !\[\]\(ec9132f1d27c8919987d92907322654d_img.jpg\)](#)

$$fx \quad F_r = F_{rc} - F_p$$

$$ex \quad 500 \text{N} = 647.55 \text{N} - 147.55 \text{N}$$

10) Frictional Force required to continuously Shear Junction between Surfaces

[Open Calculator !\[\]\(758ebdf4629c903da74c2e079717ae32_img.jpg\)](#)

$$fx \quad F_f = A_c \cdot ((\gamma_m \cdot \tau_1) + ((1 - \gamma_m) \cdot \tau_2))$$

$$ex \quad 25 \text{N} = 1250 \text{mm}^2 \cdot ((0.5 \cdot 0.03 \text{N/mm}^2) + ((1 - 0.5) \cdot 0.01 \text{N/mm}^2))$$

11) Proportion of Area in which Metallic Contact occurs given Frictional Force

[Open Calculator !\[\]\(248b91fcdac4810ffd15cf33fb6aec6f_img.jpg\)](#)

$$fx \quad \gamma_m = \frac{\left(\frac{F_f}{A_c}\right) - \tau_2}{\tau_1 - \tau_2}$$

$$ex \quad 0.5 = \frac{\left(\frac{25 \text{N}}{1250 \text{mm}^2}\right) - 0.01 \text{N/mm}^2}{0.03 \text{N/mm}^2 - 0.01 \text{N/mm}^2}$$



12) Resultant Cutting Force using Force required to remove Chip

$$fx \quad F_{rc} = F_r + F_p$$

[Open Calculator !\[\]\(e2376d476d06eb31946dc01a69a4403a_img.jpg\)](#)

$$ex \quad 647.55N = 500N + 147.55N$$

13) Rotational Frequency of Cutter given Roughness Value

$$fx \quad \omega_c = \sqrt{\frac{0.0642}{R \cdot d_t}} \cdot V_f$$

[Open Calculator !\[\]\(0b5e7e25e8775f7e7e80906ada4f0021_img.jpg\)](#)

$$ex \quad 29.99859Hz = \sqrt{\frac{0.0642}{0.017067mm \cdot 41.8mm}} \cdot 100mm/s$$

14) Roughness Value

$$fx \quad R = \frac{f}{4 \cdot (\cot(\theta) + \cot(\theta'))}$$

[Open Calculator !\[\]\(bd3b31712ad9bab5a241210fa6925cdd_img.jpg\)](#)

$$ex \quad 0.017067mm = \frac{0.9mm}{4 \cdot (\cot(45.17097^\circ) + \cot(4.69^\circ))}$$


15) Roughness value given corner radius

$$fx \quad R = 0.0321 \cdot \frac{(f)^2}{r_c}$$

[Open Calculator !\[\]\(7bc43b319a082987e20f7bf78f4bab80_img.jpg\)](#)

$$ex \quad 0.017067mm = 0.0321 \cdot \frac{(0.9mm)^2}{1.523466mm}$$



16) Roughness value given feed speed 

$$fx \quad R = \frac{0.0642 \cdot (V_f)^2}{d_t \cdot (\omega_c)^2}$$

Open Calculator 

$$ex \quad 0.017065\text{mm} = \frac{0.0642 \cdot (100\text{mm/s})^2}{41.8\text{mm} \cdot (30\text{Hz})^2}$$

17) Roughness Value of Tool 

$$fx \quad R = 0.0321 \cdot \frac{(f)^2}{r_c}$$

Open Calculator 

$$ex \quad 0.017067\text{mm} = 0.0321 \cdot \frac{(0.9\text{mm})^2}{1.523466\text{mm}}$$

18) Shear Strength of Softer Lubricant Layer given Frictional force 

$$fx \quad \tau_2 = \frac{\left(\frac{F_f}{A_c}\right) - (\gamma_m \cdot \tau_1)}{1 - \gamma_m}$$

Open Calculator 

$$ex \quad 0.01\text{N/mm}^2 = \frac{\left(\frac{25\text{N}}{1250\text{mm}^2}\right) - (0.5 \cdot 0.03\text{N/mm}^2)}{1 - 0.5}$$



19) Shear Strength of Softer Metal given Frictional force 

$$fx \quad \tau_1 = \frac{\left(\frac{F_f}{A_c}\right) - (1 - \gamma_m) \cdot \tau_2}{\gamma_m}$$

[Open Calculator !\[\]\(9dfdaff1d86ba3c1f8353b4d1b61b8c5_img.jpg\)](#)

$$ex \quad 0.03N/mm^2 = \frac{\left(\frac{25N}{1250mm^2}\right) - (1 - 0.5) \cdot 0.01N/mm^2}{0.5}$$

20) Working Major Cutting Edge Angle given Roughness Value 

$$fx \quad \theta = \left(a \cot \left(\left(\frac{f}{4 \cdot R} \right) - \cot(\theta') \right) \right)$$

[Open Calculator !\[\]\(2b376d1a92330ab09dad2665d2f89bf5_img.jpg\)](#)

$$ex \quad 45.17097^\circ = \left(a \cot \left(\left(\frac{0.9mm}{4 \cdot 0.017067mm} \right) - \cot(4.69^\circ) \right) \right)$$

21) Working Minor Cutting Edge Angle given Roughness Value 

$$fx \quad \theta' = \left(a \cot \left(\left(\frac{f}{4 \cdot R} \right) - \cot(\theta) \right) \right)$$

[Open Calculator !\[\]\(c444627dab9fee9a1550c053ffaaaae2_img.jpg\)](#)

$$ex \quad 4.69^\circ = \left(a \cot \left(\left(\frac{0.9mm}{4 \cdot 0.017067mm} \right) - \cot(45.17097^\circ) \right) \right)$$











Variables Used


- A_c Real Area of Contact (Square Millimeter)
- A_{cs} Cross Sectional Area of Uncut Chip (Square Millimeter)
- d_t Diameter of Cutter (Millimeter)
- f Feed (Millimeter)
- F_c Cutting Force (Newton)
- F_f Force of Friction (Newton)
- F_p Plowing Force (Newton)
- F_r Force required to Remove Chip (Newton)
- F_{rc} Resultant Cutting Force (Newton)
- Q_c Rate of Energy Consumption during Machining (Watt)
- Q_{sc} Specific Cutting Energy in Machining (Megajoule per Cubic Meter)
- R Roughness Value (Millimeter)
- r_c Corner Radius of Tool (Millimeter)
- V_c Cutting Speed (Millimeter per Second)
- V_f Feed Speed (Millimeter per Second)
- Y_m Proportion of Area of Metallic Contact
- θ Working Major Cutting Edge Angle (Degree)
- θ' Working Minor Cutting Edge (Degree)
- T_1 Shear Strength of Softer Metal (Newton per Square Millimeter)
- T_2 Shear Strength of Softer Lubricant Layer (Newton per Square Millimeter)
- ω_c Rotational Frequency of Cutter (Hertz)



Constants, Functions, Measurements used

- **Function: acot** , $\text{acot}(\text{Number})$
The ACOT function calculates the arccotangent of a given number which is an angle given in radians from 0 (zero) to π .
- **Function: cot** , $\text{cot}(\text{Angle})$
Cotangent is a trigonometric function that is defined as the ratio of the adjacent side to the opposite side in a right triangle.
- **Function: sqrt** , $\text{sqrt}(\text{Number})$
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 Millimeter (mm^2)
Area Unit Conversion 
- **Measurement: Speed** in Millimeter per Second (mm/s)
Speed Unit Conversion 
- **Measurement: Power** in Watt (W)
Power Unit Conversion 
- **Measurement: Force** in Newton (N)
Force Unit Conversion 
- **Measurement: Angle** in Degree ($^\circ$)
Angle Unit Conversion 
- **Measurement: Frequency** in Hertz (Hz)
Frequency Unit Conversion 
- **Measurement: Energy Density** in Megajoule per Cubic Meter (MJ/m^3)
Energy Density Unit Conversion 



- **Measurement: Stress** in Newton per Square Millimeter (N/mm²)
Stress Unit Conversion 



Check other formula lists

- [Cutting Force and Surface Roughness Formulas](#) 

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