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Critical or Whirling Speed of Shaft Formulas

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List of 12 Critical or Whirling Speed of Shaft Formulas

Critical or Whirling Speed of Shaft

1) Additional Deflection of Centre of Gravity of Rotor using Natural Circular Frequency

$$\text{fx } y = \frac{\omega^2 \cdot e}{\omega_n^2 - \omega^2}$$

Open Calculator 

$$\text{ex } 0.795031\text{mm} = \frac{(11.2\text{rad/s})^2 \cdot 2\text{mm}}{(21\text{rad/s})^2 - (11.2\text{rad/s})^2}$$

2) Additional Deflection of Centre of Gravity of Rotor using Whirling Speed

$$\text{fx } y = \frac{e}{\left(\frac{\omega}{\omega_c}\right)^2 - 1}$$

Open Calculator 

$$\text{ex } 0.805009\text{mm} = \frac{2\text{mm}}{\left(\frac{11.2\text{rad/s}}{6}\right)^2 - 1}$$



3) Additional Deflection of Centre of Gravity of Rotor when Shaft Starts Rotating

$$fx \quad y = \frac{m \cdot \omega^2 \cdot e}{S_{\text{shaft}} - m \cdot \omega^2}$$

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

$$ex \quad 0.74988\text{mm} = \frac{5g \cdot (11.2\text{rad/s})^2 \cdot 2\text{mm}}{2.3\text{N/m} - 5g \cdot (11.2\text{rad/s})^2}$$

4) Centrifugal Force Causing Shaft Deflection

$$fx \quad F_c = m_{\text{max}} \cdot \omega^2 \cdot (e + y)$$

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

$$ex \quad 35.1232\text{N} = 100\text{kg} \cdot (11.2\text{rad/s})^2 \cdot (2\text{mm} + 0.8\text{mm})$$

5) Critical or Whirling Speed given Static Deflection

$$fx \quad \omega_c = \sqrt{\frac{g}{\delta}}$$

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

$$ex \quad 121.8544 = \sqrt{\frac{9.8\text{m/s}^2}{0.66\text{mm}}}$$




6) Critical or Whirling Speed given Stiffness of Shaft 

$$fx \quad \omega_c = \sqrt{\frac{S_{shaft}}{m}}$$

Open Calculator 

$$ex \quad 21.44761 = \sqrt{\frac{2.3N/m}{5g}}$$

7) Critical or Whirling Speed in R.P.S 

$$fx \quad \omega_c = \frac{0.4985}{\sqrt{\delta}}$$

Open Calculator 


$$ex \quad 19.40409 = \frac{0.4985}{\sqrt{0.66mm}}$$

8) Force Resisting Additional Deflection of Centre of Gravity of Rotor 

$$fx \quad F = k \cdot y$$

Open Calculator 

$$ex \quad 2.4N = 3000N/m \cdot 0.8mm$$

9) Mass of Rotor given Centrifugal Force 

$$fx \quad m_{max} = \frac{F_c}{\omega^2 \cdot (e + y)}$$

Open Calculator 

$$ex \quad 99.64923kg = \frac{35N}{(11.2rad/s)^2 \cdot (2mm + 0.8mm)}$$



10) Natural Circular Frequency of Shaft [Open Calculator](#) 


$$fx \quad \omega_n = \sqrt{\frac{S_{shaft}}{m}}$$

$$ex \quad 21.44761 \text{ rad/s} = \sqrt{\frac{2.3 \text{ N/m}}{5g}}$$

11) Static Deflection of Shaft [Open Calculator](#) 

$$fx \quad \delta = \frac{m \cdot g}{S_{shaft}}$$

$$ex \quad 21.30435 \text{ mm} = \frac{5g \cdot 9.8 \text{ m/s}^2}{2.3 \text{ N/m}}$$

12) Stiffness of Shaft for Equilibrium Position [Open Calculator](#) 

$$fx \quad S_{shaft} = \frac{m \cdot \omega^2 \cdot (e + y)}{y}$$

$$ex \quad 2.1952 \text{ N/m} = \frac{5g \cdot (11.2 \text{ rad/s})^2 \cdot (2 \text{ mm} + 0.8 \text{ mm})}{0.8 \text{ mm}}$$









Variables Used

- **e** Initial Distance of Centre of Gravity of Rotor (Millimeter)
- **F** Force (Newton)
- **F_c** Centrifugal Force (Newton)
- **g** Acceleration due to Gravity (Meter per Square Second)
- **k** Stiffness of Spring (Newton per Meter)
- **m** Mass of Rotor (Gram)
- **m_{max}** Maximum Mass of Rotor (Kilogram)
- **S_{shaft}** Stiffness of Shaft (Newton per Meter)
- **y** Additional Deflection of C.G of Rotor (Millimeter)
- **δ** Static Deflection of Shaft (Millimeter)
- **ω** Angular Velocity (Radian per Second)
- **ω_c** Critical or Whirling Speed
- **ω_n** Natural Circular Frequency (Radian per Second)



Constants, Functions, Measurements used

- **Function:** **sqrt**, sqrt(Number)
Square root function
- **Measurement:** **Length** in Millimeter (mm)
Length Unit Conversion 
- **Measurement:** **Weight** in Gram (g), Kilogram (kg)
Weight Unit Conversion 
- **Measurement:** **Acceleration** in Meter per Square Second (m/s^2)
Acceleration Unit Conversion 
- **Measurement:** **Force** in Newton (N)
Force Unit Conversion 
- **Measurement:** **Surface Tension** in Newton per Meter (N/m)
Surface Tension Unit Conversion 
- **Measurement:** **Angular Velocity** in Radian per Second (rad/s)
Angular Velocity Unit Conversion 



Check other formula lists

- [Load for Various Types of Beams and Load Conditions Formulas](#) 
- [Critical or Whirling Speed of Shaft Formulas](#) 
- [Effect of Inertia of Constraint in Longitudinal and Transverse Vibrations Formulas](#) 
- [Frequency of Free Damped Vibrations Formulas](#) 
- [Frequency of Under Damped Forced Vibrations Formulas](#) 
- [Natural Frequency of Free Transverse Vibrations Formulas](#) 
- [Natural Frequency of Free Transverse Vibrations Due to Uniformly Distributed Load Acting Over a Simply Supported Shaft Formulas](#) 
- [Natural Frequency of Free Transverse Vibrations of a Shaft Fixed at Both Ends Carrying a Uniformly Distributed Load Formulas](#) 
- [Values of length of beam for the various types of beams and under various load conditions Formulas](#) 
- [Values of static deflection for the various types of beams and under various load conditions Formulas](#) 
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