Important Critical or Whirling Speed of Shaft Formulas PDF

Formulas
Examples
with Units

List of 12
Important Critical or Whirling Speed of Shaft Formulas

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

Evaluate Formula

Formula

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

Example with Units

$$0.795\,\text{mm} = \frac{11.2\,\text{rad/s}^2 \cdot 2\,\text{mm}}{21\,\text{rad/s}^2 - 11.2\,\text{rad/s}^2}$$

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

Evaluate Formula

Formula

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

Example with Units

$$0.805\,\text{mm} = \frac{2\,\text{mm}}{\left(\frac{11.2\,\text{rad/s}}{6}\right)^2 - 1}$$

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

Evaluate Formula

Formula

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

Example with Units

$$0.7499\,\text{mm} = \frac{5\,\text{g} \cdot 11.2\,\text{rad/s}^2 \cdot 2\,\text{mm}}{2.3\,\text{N/m} - 5\,\text{g} \cdot 11.2\,\text{rad/s}^2}$$

4) Centrifugal Force Causing Shaft Deflection Formula

Evaluate Formula

Formula

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

Example with Units

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

5) Critical or Whirling Speed given Static Deflection Formula

Evaluate Formula

Formula

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

Example with Units

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

6) Critical or Whirling Speed given Stiffness of Shaft Formula

Evaluate Formula

Formula

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

Example with Units

$$21.4476 = \sqrt{\frac{2.3\,\text{N/m}}{5\,\text{g}}}$$

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

Evaluate Formula

Formula

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

Example with Units

$$19.4041 = \frac{0.4985}{\sqrt{0.66\,\text{mm}}}$$

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

Evaluate Formula

Formula

$$F = k \cdot y$$

Example with Units

$$2.4\,\text{N} = 3000\,\text{N/m} \cdot 0.8\,\text{mm}$$

9) Mass of Rotor given Centrifugal Force Formula

Evaluate Formula

Formula

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

Example with Units

$$99.6492\,\text{kg} = \frac{35\,\text{N}}{11.2\,\text{rad/s}^2 \cdot (2\,\text{mm} + 0.8\,\text{mm})}$$

10) Natural Circular Frequency of Shaft Formula

Evaluate Formula

Formula

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

Example with Units

$$21.4476\,\text{rad/s} = \sqrt{\frac{2.3\,\text{N/m}}{5\,\text{g}}}$$

11) Static Deflection of Shaft Formula

Evaluate Formula

Formula

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

Example with Units

$$21.3043\,\text{mm} = \frac{5\,\text{g} \cdot 9.8\,\text{m/s}^2}{2.3\,\text{N/m}}$$

12) Stiffness of Shaft for Equilibrium Position Formula

Evaluate Formula

Formula

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

Example with Units

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

Variables used in list of Critical or Whirling Speed of Shaft Formulas above

- **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 in list of Critical or Whirling Speed of Shaft Formulas above

- Functions: **sqrt**, sqrt(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: **Weight** in Gram (g), Kilogram (kg)
  Weight Unit Conversion
- Measurement: **Acceleration** in Meter per Square Second (m/s²)
  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

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